

# Annual Water Quality Monitoring Report 2017-18

## Sydney Catchment Area



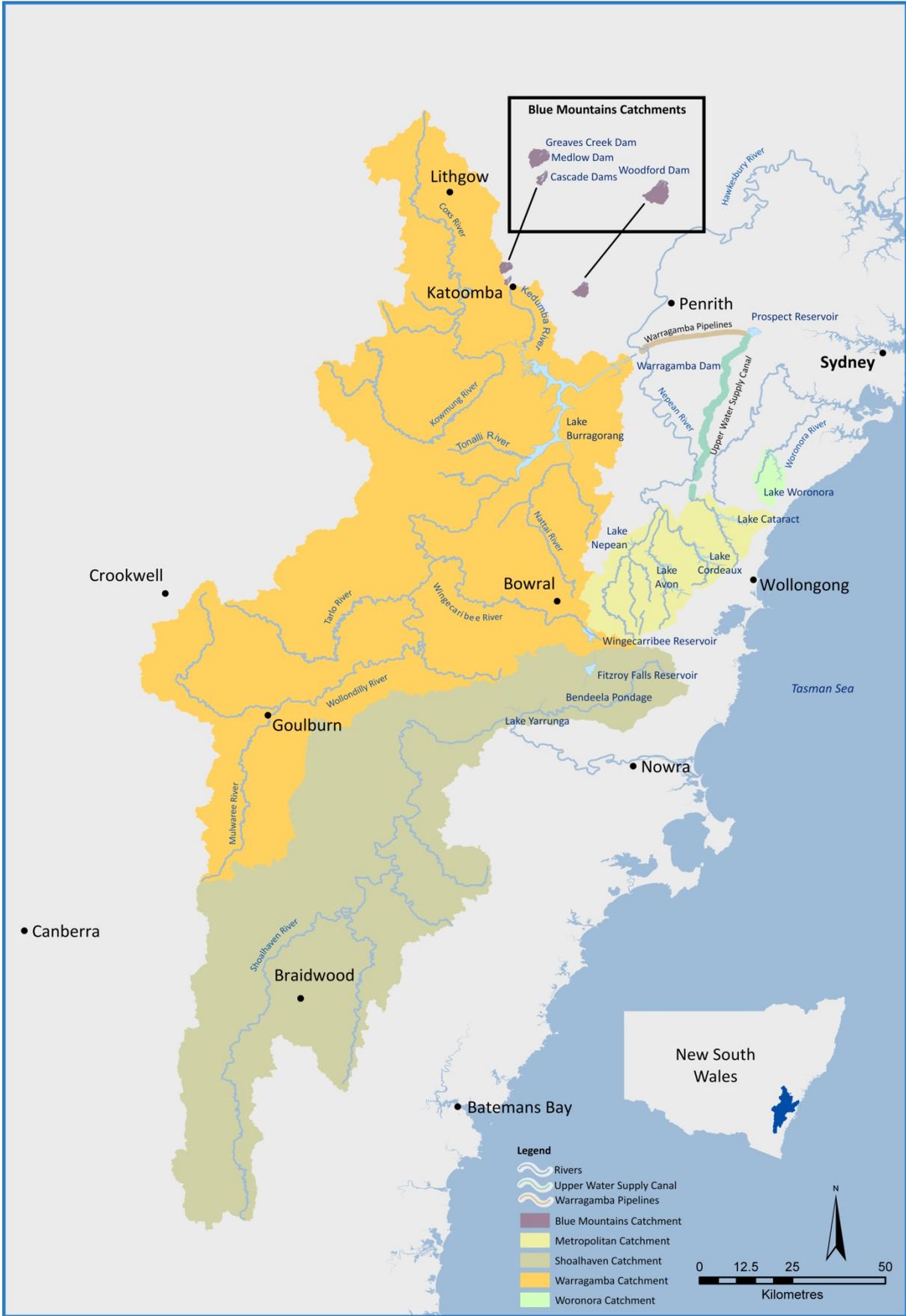


Figure 0.1: Sydney catchment area

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## Executive Summary

WaterNSW's Water Monitoring Program (WMP) for the Sydney catchment area details the comprehensive monitoring activities covering catchments, lakes, intakes to water filtration plants, picnic areas, dam safety and downstream sites. The WMP has been developed in collaboration with NSW Health, Sydney Water and other wholesale customers. The program incorporates locations, frequency, benchmarks or guideline values for more than 200 water quality characteristics. The WMP includes routine and event monitoring employing field sampling, laboratory testing and telemetered 'real-time' data collection. Monitoring provides timely water quality data and information to inform operational decisions and verification of water quality to demonstrate compliance.

This report describes the results of the water quality monitoring undertaken by WaterNSW during 2017-18. The report is prepared to meet WaterNSW's statutory obligations in addition to providing stakeholders, students, researchers and the general public with water quality information for waters managed by WaterNSW in the greater Sydney catchment area.

## Highlights

The 2017-18 reporting period commenced with the total storage volume at 93.6% on 1 July 2017. Ongoing drought and very low inflows over the reporting period caused the total storage volume to decrease to 69% by 30 June 2018. Warm weather and ongoing drought conditions have been favourable to algal growth in some storages but generally the lack of large inflow events has resulted in good, stable water quality.

Guided by its Water Quality Management System, WaterNSW successfully delivered agreed quantities of high quality water to customers in full compliance with the Australian Drinking Water Guidelines (ADWG) for health-related characteristics. Through proactive, modelling, monitoring and source selection, WaterNSW avoided or effectively managed water quality incidents to minimise impacts to customers.

Water supplied to **water filtration plants** achieved near full compliance with site specific standards in raw water supply agreements, with the exception of elevated filter clogging algal potential in raw water supplied to Illawarra water filtration plant in November 2017. Elevated true colour in raw water supplied by Lake Burragorang and Lake Nepean continued to decline throughout the year and with careful source selection and system planning, true colour in raw water supplied complied with raw water supply agreement standards.

WaterNSW continued to monitor and manage **picnic area supply** sites in accordance with the Quality Assurance Plans developed in line with NSW Private Water Supply Guidelines. Monitoring results were generally consistent with the previous year and manual dosing was implemented to improve residual chlorine levels.

Consistent with recent years, nutrients and chlorophyll *a* often exceeded ANZECC benchmarks in **catchment sites** with significant agricultural or urban development (e.g. Wollondilly and Kangaroo Rivers), although there was a general decrease in phosphorus exceedances in the Warragamba catchment. Largely natural catchments (e.g. Burke and Avon Rivers) rarely exceeded ANZECC

benchmarks and continue to demonstrate the effectiveness of Special Areas in protecting water quality.

Consistent with catchment results, levels of phosphorus declined in Lake Burragorang relative to last year, indicating a lower risk of an algal bloom over the upcoming 2018-19 season.

Water quality in 2017-18 achieved 99.99% conformance with Raw Water Supply Agreements and 100% conformance with Australian Drinking Water Guidelines

Monitoring **downstream** of WaterNSW storages is undertaken as part of the requirements of the Water Licences and Approvals package administered by Department of Industry (DoI) Water. The impact of pollutant sources from downstream catchments is evidenced by the deterioration of water quality downstream of WaterNSW release points, particularly in the Hawkesbury – Nepean system. Levels of nutrients and chlorophyll *a* were frequently higher than last year at most sites.

WaterNSW maintains a program of **scientific research projects** through internal and external collaborative arrangements. Notable research projects with a direct influence on water quality management, which were completed during 2017-18, included a review of the macroinvertebrate monitoring program and an assessment of the water quality benefits of reticulated sewerage systems in the Kangaroo Valley and Robertson townships. Ongoing research projects include investigating sources of natural organic matter, assessing potential water quality impacts of carp control in WaterNSW storages, investigating cyanobacteria and toxins on lake floors and on-line monitoring of cyanobacteria.

WaterNSW successfully managed three major and two significant **water quality incidents** as triggered by and in accordance with our Raw Water Quality Incident Response Plan:

- Potential toxin producing cyanobacteria in Wingecarribee Reservoir (two incidents);
- Potential filter clogging algae (algal ASU) in supply to Illawarra Water Filtration Plant;
- Algal ASU in supply to Cascades Water Filtration Plant; and
- Algal ASU in supply to Nepean Water Filtration Plant.

# 1 Introduction

WaterNSW is a state-owned corporation responsible for supplying water in compliance with appropriate standards of quality (Section 6(1)(b), *Water NSW Act 2014*) in the Sydney catchment area. WaterNSW undertakes extensive monitoring within its catchments, lakes and raw water supply system and in rivers downstream of storages to meet this objective.

WaterNSW's Water Monitoring Program (WMP) for the Sydney catchment area sets out the location, frequency and analytes monitored (WaterNSW, 2017). Specific and health-related characteristics are determined in consultation with our major customers and the program is endorsed by NSW Health. Monitoring for operations and planning helps WaterNSW understand the threats to water quality throughout the supply system, including rivers, lakes and the delivery system. This information aids the selection of the best source water for our customers and the environment.

Data collected through the WMP is used to:

- provide early detection of possible contaminants to protect the health of consumers
- assist in proactive operational decisions
- ensure that the raw water delivered to wholesale customers meets agreed standards and can be treated to meet the Australian Drinking Water Guidelines
- identify and target possible contamination sources in the catchments and storages
- prioritise monitoring to inform water quality risks and remedial actions
- identify emerging water quality issues and address them in forward configurational planning

WaterNSW's compliance monitoring activities are governed by four key drivers:

- Operating licence granted by the Governor of NSW and administered by Independent Pricing and Regulatory Tribunal (IPART)
- Water Licences and Approvals package granted by the Water Administration Ministerial Corporation and administered by Department of Industry Water (DOI Water)
- Raw water supply agreements between WaterNSW and its wholesale customers
- Australian Drinking Water Guidelines

This report describes the results of water quality monitoring undertaken by WaterNSW in the Sydney catchment area from 1 July 2017 to 30 June 18 under the WMP. The report is a requirement of the Reporting Manual of the Operating Licence (2017-2022). The report discusses monitoring of temperatures as required under the Water Licences and Approvals package administered by the NSW Department of Industry. The report also provides the community with information on water quality.

More specifically this report includes:

- a summary of the Water Monitoring Program, including objectives and applicable guidelines
- a summary of the results of the routine, event and investigative monitoring
- analysis of system performance relative to the criteria where relevant water quality or catchment health benchmarks are available
- information on the integrity of the data reported
- details of research activities
- summary of water quality incidents and actions taken to resolve, eliminate or mitigate the effect of those incidents, especially to protect public health during the incident.

## 2 Overview of the Sydney catchment area water supply network

WaterNSW collects water from river catchments to the south and west of Sydney and stores it in lakes and reservoirs to supply more than five million people in the Greater Sydney region. It is transported via a network of rivers, lakes, pipes and canals to water filtration plants, where it is treated for consumers in Sydney, Illawarra, Shoalhaven, Goulburn, Blue Mountains and the Southern Highlands. Water is also released from storages as environmental flows to maintain the health of the downstream river systems.

The catchments cover an area of approximately 16,000 square kilometres, extending from the headwaters of the Cocks River north of Lithgow, south to the source of the Shoalhaven River near Cooma, and from Woronora in the east to the Wollondilly River near Crookwell in the west (Figure 0.1). Raw water is collected from the river systems of five major catchments:

- Warragamba (including Prospect)
- Upper Nepean
- Woronora
- Shoalhaven
- Blue Mountains, including supplements from the Fish River system.

The transfer routes for water around the system and approximate number of people supplied by that part of the system are shown in the water supply system schematic (Figure 2.1).

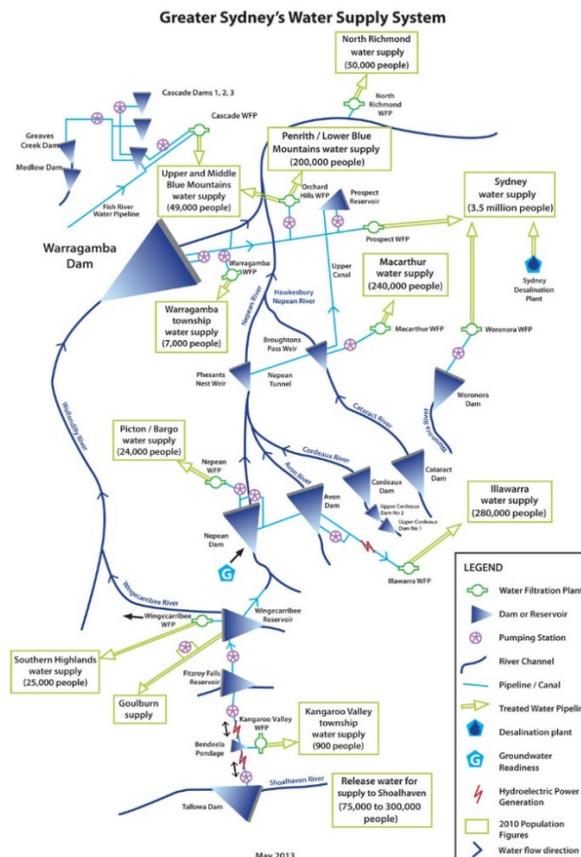


Figure 2.1: Schematic of the water supply system

### 3 Sydney catchment area water monitoring program

The Water Monitoring Program (WMP) covers routine, targeted, investigative and event-based monitoring. The WMP covers catchments, storages, inlets to water filtration plants, picnic taps, transfer canals and pipelines, as well as rivers downstream of water supply dams and weirs. Monitoring includes physical, chemical, biological, radiological, hydrological and meteorological parameters through on-line instruments, field sampling and laboratory analysis. A key feature of the WMP is an agreed list of water quality characteristics. The list contains:

- those characteristics that cannot be modified or removed by conventional treatment and for which Australian Drinking Water Guidelines (ADWG) must be met; and,
- those characteristics for which ADWG exist but are not applicable to raw water, where WaterNSW must endeavour to supply raw water so that it can be treated to meet the ADWG.

WaterNSW is subject to a range of statutory requirements and standards set by regulatory agencies. WaterNSW is also benchmarked against other raw water suppliers to maintain best practice service standards.

The principal documents that outline requirements on WaterNSW with respect to water monitoring are listed below.

- Operating Licence (Part 2), *Water NSW Act 2014 (Division 4)*
- Water Licences and Approvals Package under *Water Management Act 2000*
- Memorandum of Understanding between NSW Health and WaterNSW (2016) (Parts 5-8) *Water NSW Act 2014 (Part 20-21)*
- Raw Water Supply Arrangements
- Private Water Supply Guidelines and *Public Health Act 2010*
- *Water Act 2007 (Commonwealth)*
- *Water NSW Act 2014*.

The Water Monitoring Program specifies the requirements for water sample collection and analysis. It describes sampling locations and frequencies, and the parameters to be analysed. Additional samples are collected and analysed for quality assurance and quality control (QA/QC) purposes. The QA/QC program provides confidence in the data collected.

The collection and analysis of routine and QA/QC water samples is performed by service providers. Service contracts include requirements for quality assurance practices in the monitoring, sampling, testing and reporting processes. A chain of custody system allows individual samples to be tracked from field collection, through laboratory analysis, to the transfer of results to WaterNSW's database. Further details of the QA/QC monitoring for 2017-18 are included in Section 5.

## 4 Applicable guidelines and benchmarks

WaterNSW has adopted nationally recognised standards and guidelines for a range of water quality characteristics in each part of the water supply network. Different guidelines and standards apply to each part of the supply cycle as water passes from catchment waterways into lakes and then into the delivery network or downstream rivers.

### 4.1 Australian Drinking Water Guidelines (ADWG) 2011

The Australian Drinking Water Guidelines (NHMRC, 2011) apply to any water intended for drinking, irrespective of the source or where it is consumed. The ADWG framework for managing drinking water quality advocates risk management and preventive measures at all barriers from catchment to consumer.

For water quality characteristics that have been specified as ‘health related’, including metals, pesticides and synthetic organic compounds (Table 4.1a-b), raw water must conform to the ADWG. As conventional water treatment methods are not designed to remove these compounds from raw water, it is preferable to avoid them in the raw water supply through catchment and storage management practices.

Routine monitoring of radionuclides is performed at water filtration plants by screening for gross alpha and gross beta activity concentrations. Testing for individual radionuclides is performed in the case of a positive gross alpha or gross beta result, but all screening tests were clear in 2017-18. Radionuclide screening results are included in Appendix A.

### 4.2 Raw water supply agreements

WaterNSW has established terms and conditions of supply with wholesale customers to ensure treated water is not harmful to consumers’ health. Raw water supply agreements are in place between WaterNSW (Sydney Catchment Authority) and Sydney Water (2013), Wingecarribee Shire Council (2015), Goulburn Mulwaree Council (2012) and Shoalhaven City Council (2015). Raw water supplied for treatment is required to conform to site-specific standards specified in raw water supply agreements (Table 4.2). These standards are based on the treatment capabilities of the plants and the natural characteristics of the catchment. This ensures that raw water can be treated to meet ADWG requirements.

Table 4.1a Health-related water quality characteristics: Synthetic Organics, Radiological and Pesticide Characteristics

	SPECIFIC WATER CHARACTERISTIC	DRIVER	ADWG (2011) Health Guideline	
SYNTHETIC ORGANICS - RADIOLOGICAL - PESTICIDES	<b>Synthetic Organic Compounds</b>	Operating Licence <sup>1</sup>		
	1,1-Dichloroethane		NA	
	1,2-Dichloroethane		0.003 mg/L	
	1,2-Dichloroethene		0.06 mg/L	
	1,3-Dichloropropene (cis- and trans-)		0.1 mg/L	
	Benzene		0.001 mg/L	
	Hexachlorobutadiene		0.0007 mg/L	
	Vinyl chloride		0.0003 mg/L	
	Trichloroethylene		NA	
	<b>Pesticides</b>			
	2,4-D		0.03 mg/L	
	Acephate		0.008mg/L	
	Aminopyralid		NA	
	Amitrole		0.009 mg/L	
	Atrazine		0.02 mg/L	
	Azinphos-methyl		0.03 mg/L	
	Chlorfenvinphos		0.002 mg/L	
	Chlorothalonil		0.05 mg/L	
	Chlorpyrifos		0.01 mg/L	
	Clopyralid		2 mg/L	
	Diazinon		0.004 mg/L	
	Dichlobenil		0.01 mg/L	
	Dimethoate		0.007 mg/L	
	Diuron		0.02 mg/L	
	Fluproponate		0.009 mg/L	
	Fluroxypyr		NA	
	Glyphosate		1.0 mg/L	
	Hexazinone		0.4 mg/L	
	MCPA (2-methyl-4-chlorophenoxyacetic acid)		0.04 mg/L	
	Metsulfuron-methyl		0.04 mg/L	
	Picloram		0.3 mg/L	
	Simazine		0.02 mg/L	
Triclopyr	0.02 mg/L			
Trifluralin	0.09 mg/L			
<b>Radiological<sup>2</sup></b>				
Gross alpha	0.5 Bq/L			
Gross beta	0.5 Bq/L			

Notes:

- 1 Section shaded **yellow** contains health related water quality characteristics. These characteristics must not exceed Australian Drinking Water Guidelines (NHMRC, 2011) in raw water supplied as treatment may not remove them. Minimising these in raw water effectively minimises risk to consumers.
- 2 Australian Drinking Water Guidelines recommends that a screening level test is performed for radiological parameters.

**Table 4.1b: Health-related Water Quality Characteristics: Physical, Chemical, Biological and Organic Characteristics**

	SPECIFIC WATER CHARACTERISTIC	DRIVER	ADWG (2011) Health Guideline
PHYSICAL - CHEMICAL - BIOLOGICAL - ORGANIC	Arsenic	ADWG (2011) <sup>1</sup> Health Guideline	0.01mg/L
	Barium		2 mg/L
	Beryllium		0.06mg/L
	Boron		4 mg/L
	Iodide		0.5 mg/L
	Mercury		0.001 mg/L
	Molybdenum		0.05 mg/L
	Selenium		0.01 mg/L
	Silver		0.1 mg/L
	Tin		N/A
	Antimony	ADWG (2011) <sup>2</sup> Health Guideline via NSW Private Water Supply Guidelines (NSW Health, 2014)	0.003 mg/L
	Cadmium		0.002 mg/L
	Chromium (Cr <sup>VI</sup> )		0.05 mg/L
	Copper		2 mg/L
	Lead		0.01 mg/L
	Nickel		0.02 mg/L
	<i>E. coli</i>	Operating Licence <sup>3</sup>	Seek advice from NSW Health
	Enterococci		
	<i>C. perfringens</i>		
	<i>Cryptosporidium</i>		
<i>Giardia</i>			
Toxin producing cyanobacteria			
Toxicity			
Total cyanobacteria biovolume			
Geosmin	Operational	N/A	
MIB		N/A	
Total dissolved solids		N/A	
Algae (ASU)	Water Supply Agreements	Refer to Water Supply Agreements	
Alkalinity			
Aluminium			
Hardness			
Iron			
Manganese			
True colour			
Turbidity			
Total cyanobacteria biovolume	Water Licences and Approvals Package (WLAP) <sup>4</sup>	Refer to <i>Guidelines for Managing Risks in Recreational Water</i> (NHMRC, 2008)	
<i>Microcystis aeruginosa</i>			
Toxicity			
Enterococci			
Chlorophyll <i>a</i>	Operational	N/A	
Lorenzen		N/A	
Phaeophytin		N/A	
Secchi depth		N/A	

**Notes:**

- 1 Section shaded **yellow** contains health related water quality characteristics – these characteristics must not exceed Australian Drinking Water Guidelines (NHMRC, 2011) in raw water supplied as treatment may not remove them. Minimising these in raw water effectively minimises risk to consumers.
- 2 Section shaded **orange** contains health related water quality characteristics for private water supplies – these characteristics must not exceed Australian Drinking Water Guidelines (NHMRC, 2011) in treated waters.

- 3 Section shaded **blue** contains characteristics for which drinking water guidelines exist but these are not applicable for raw water. However, WaterNSW must endeavour to supply the best quality raw water available so that it can be treated to meet Australian Drinking Water Guidelines.
- 4 Section shaded **green** contains characteristics which apply for recreational waters and releases.

**Table 4.2: Raw water supply agreements – Site specific specifications**

	Turbidity	True Colour @400 nm	Iron	Manganese	Aluminium	Hardness	Alkalinity	pH	Odour	Algae
	NTU	CU	mg/L	mg/L	mg/L	mg/L as CaCO <sub>3</sub>	mg/L as CaCO <sub>3</sub>	pH units	Rating	ASU
<b>Prospect WFP</b>	40	60	3.50	1.40	2.6	25 – 70	15 - 60	NA	NA	1000 <sup>(i)</sup>
<b>Warragamba WFP</b>										2000
<b>Orchard Hills WFP</b>										
<b>Macarthur WFP</b> Based on Demand (ML/day)	185 - <265	40	0.60	0.20	0.40	6 – 30	15		100 <sup>(ii)</sup>	
	125 - <185		0.80	0.25	0.50	6 – 32.20			500 <sup>(ii)</sup>	
	80 - <125		1.10	0.30	0.75					
	<80		1.30	0.35	0.95					
<b>Illawarra WFP</b>	10	50	1.1	0.4	1.4	30	10		Not objectionable	5000
<b>Woronora WFP</b>		70	1	0.1	0.4	2 – 30	15			
<b>Nepean WFP</b>	150	60	5.0	1.5	1.0	2 – 35	0.5 – 25		NA	2000
<b>Cascade WFP</b>	15		3.0	0.3	0.2	40	30			
<b>Kangaroo Valley WFP</b>	20	70	1.1	NA	NA	36.5	29	6.5 – 8.5		
<b>Wingecarribee WFP</b>	40						35			
<b>Goulburn Mulwaree</b>										

- (i) Maximum for Prospect WFP is 1000 ASU, except if turbidity is greater than 10 NTU or true colour is greater than 30 CU, then the algae maximum will be 500 ASU.
- (ii) Algal limits for Macarthur WFP (average of 3 samples): 500 ASU small individual cells (<10 µm) of filamentous or colonial species, typically *Chlorella*, *Dolichospermum*, *Monodus* and *Melosira*; or 100 ASU large (>10 µm) cells, branching species, and/or gelatinous species, typically *Asterionella*, *Tabellaria*, *Fragillaria*, *Synedra*, *Cyclotella*, *Dinobryan*, *Elakatothrix*, and *Volvox*.
- (iii) Upper limits are shown for analytes where ranges are not provided.

## 4.3 ANZECC 2000

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) (referred to as ANZECC, 2000) provide a guide for setting water quality objectives required to sustain current or likely future environmental values for natural and semi-natural water resources in Australia and New Zealand. Water quality in WaterNSW Sydney catchment area waterways are compared against relevant sections of the ANZECC Guidelines.

### 4.3.1 Benchmarks for storages

Benchmarks for storages are derived from the guidelines for freshwater lakes and reservoirs (ANZECC, 2000) for the 95-99 percent level of species protection (Table 4.3). Site specific benchmarks are to be developed for temperature and conductivity, and as such are not included in the table below.

**Table 4.3: Water quality benchmarks for storages**

Analyte	Units	Benchmark range
pH	pH units	6.5 - 8.0
Chlorophyll <i>a</i>	µg/L	< 5
Dissolved oxygen	%sat	90 – 110
Total nitrogen	mg/L	< 0.35
Oxidised nitrogen	mg/L	< 0.01
Ammoniacal nitrogen	mg/L	< 0.01
Total phosphorus	mg/L	< 0.01
Filterable reactive phosphorus	mg/L	< 0.005
Turbidity	NTU	< 20.0
Total manganese	mg/L	< 1.9
Total aluminium	mg/L	< 0.055

### 4.3.2 Benchmarks for catchments

WaterNSW benchmarks water quality in metropolitan catchment streams against the ANZECC (2000) guideline ranges for upland rivers (Table 4.4).

**Table 4.4: Water quality benchmarks for catchment streams**

Analyte	Units	Benchmark range
pH	pH units	6.5 – 8.0
Chlorophyll <i>a</i>	µg/L	< 5
Dissolved oxygen	% sat	90 – 110
Total nitrogen	mg/L	< 0.25
Ammoniacal nitrogen	mg/L	< 0.013
Oxidised nitrogen	mg/L	< 0.015
Total phosphorus	mg/L	< 0.02
Filterable reactive phosphorus	mg/L	< 0.015
Turbidity	NTU	< 25
Total aluminium	mg/L	< 0.055
Total manganese	mg/L	< 1.9
Conductivity	mS/cm	< 0.35

### 4.4 Benchmarks for recreational areas

To minimise risks to public health, WaterNSW manages recreational exposure risk by benchmarking water quality against the Guidelines for Managing Risks in Recreational Waters (NHMRC, 2008) and the Cyanobacterial Response Plan (Table 4.5).

**Table 4.5: Water quality benchmarks for recreation areas**

Analyte	Units	Primary Contact		Secondary Contact
		Minor Alert Threshold	Major Alert Threshold	Alert Threshold
<i>Enterococci</i>	cfu/100mL	< 40	< 200	<200
<i>Microcystis aeruginosa</i>	cells/mL	< 5,000	< 50,000	<50,000
Total cyanobacteria biovolume	mm <sup>3</sup> /L	< 0.4	< 4	<4
Algal toxins (microcystin variants)	µg/L	NA	< 10	<10

## 4.5 Benchmarks for downstream rivers

Benchmarks for water quality downstream of WaterNSW’s dams and weirs are derived from ANZECC lowland rivers ecosystem types (Table 4.6).

**Table 4.6: Water quality benchmarks downstream of storages**

Analyte	Units	Benchmark range
pH	pH units	6.5 - 8.5
Chlorophyll <i>a</i>	µg/L	< 5
Dissolved oxygen	%sat	85 – 110
Total nitrogen	mg/L	< 0.5
Total phosphorus	mg/L	< 0.05
Turbidity	NTU	< 50

## 4.6 Benchmarks for picnic area supplies

Benchmarks for the picnic area supplies are based on ADWG (2011) threshold ranges, where relevant (Table 4.7). Some benchmarks are prompts for action, such as chlorophyll *a*, which triggers algal monitoring in the picnic area supply.

**Table 4.7: Water quality guidelines for specific parameters at picnic areas**

Analyte	Units	Threshold
Free chlorine residual	mg/L	> 0.5
pH	pH units	6.5 - 8.5
Turbidity	NTU	< 5
Total iron	mg/L	< 0.3
Total aluminium	mg/L	< 0.2
Total manganese	mg/L	< 0.1
<i>E. coli</i>	orgs/100 mL	Should not be detected
Algal toxins (microcystin variants)	µg/L	< 1.3
Chlorophyll <i>a</i>	µg/L	< 5
Potentially toxin producing algal cells	cells/mL	< 6,500 <sup>(i)</sup>

(i) See cyanobacteria benchmarks in Table 4.8.

## 4.7 Benchmarks for cyanobacteria

WaterNSW routinely monitors levels of algae in major storages to provide early warning of possible bloom conditions and to ensure that raw water supplied to customers can be treated to meet drinking water guidelines. Algal monitoring is also conducted to avoid contaminating downstream waterways through environmental releases or transfers.

While the ADWG stipulate cyanobacteria guidelines and alert levels for drinking water, WaterNSW applies those guidelines to the raw water supplied for treatment in Greater Sydney. Lake Yarrunga and Fitzroy Falls Reservoir being the only WaterNSW storages in the Sydney catchment area with recreational access, WaterNSW applies the National Health and Medical Research Council Recreational Waters Guidelines (NHMRC, 2008) for catchments and lakes (Table 4.8). The raw water and picnic areas benchmarks are from the ADWG.

**Table 4.8: Cyanobacteria benchmarks throughout Sydney catchment area**

Analyte		Units	Threshold
<b>Catchment and lake sites<sup>(i)</sup></b>			
Cells	<i>Microcystis aeruginosa</i>	cells/mL	50,000
Toxicity	Microcystin variants	µg/L	10
Biovolume	Total cyanobacteria	mm <sup>3</sup> /L	4
<b>Raw water and picnic area water supplies<sup>(ii)</sup></b>			
Cells	<i>Microcystis aeruginosa</i>	cells/mL	6,500
	<i>Cylindrospermopsis raciborskii</i>	cells/mL	15,000
	<i>Dolichospermum circinale</i>	cells/mL	20,000
Toxicity	Microcystin variants	µg/L	1.3
	Cylindrospermopsin	µg/L	1.0
	Saxitoxin	µg/L	3.0
Biovolume	Potentially microcystin-producing species	mm <sup>3</sup> /L	0.6
	Potentially cylindrospermopsin-producing species	mm <sup>3</sup> /L	0.6
	Potentially saxitoxin-producing species	mm <sup>3</sup> /L	5

(i) National Health and Medical Research Council Guidelines for Managing Risks in Recreational Water 2008.

(ii) These triggers are based on cell counts, toxin concentration and biovolume ADWG 2011 specify actions in response to various alert level ranges for *Microcystis aeruginosa*, *Dolichospermum circinale* and *Cylindrospermopsis raciborskii*, and the consolidated biovolumes of the species known to produce microcystin, saxitoxins and cylindrospermopsin toxins.

## 4.8 Benchmarks for *Cryptosporidium* and *Giardia*

The ADWG do not contain guideline values for *Cryptosporidium* and *Giardia* in raw or treated drinking water. However, ADWG (2011) recommends a multi-barrier approach to minimise the risks of these pathogens. Investigative testing is encouraged in response to events that could increase the risk of contamination. WaterNSW implements additional monitoring during high risk events. *Cryptosporidium* and *Giardia* monitoring in the catchments is undertaken to provide early warning to enable optimal configuration of the raw water supply system in the event of high levels of *Cryptosporidium* and/or *Giardia* detections within the storages. Catchment monitoring also contributes to the understanding of sources which can then improve the robustness of risk assessments and catchment actions.

## 5 Routine monitoring

Water quality monitoring was conducted as per the Water Monitoring Program. Samples were collected from catchment streams, lakes and delivery sites and analysed by National Association of Testing Authorities (NATA) accredited laboratories. Online instruments were used to supplement this monitoring. This report summarises the results of routine monitoring compared against appropriate guidelines or benchmarks.

Data from routine samples was extracted from the WaterNSW water quality database, the data was filtered so that only composite samples from 0-6 metres and samples taken between 0 m and 6 m remained. On each sampling date, the mean of the data was taken and compared to the relevant guideline value for each analyte. The number of guideline exceedances was calculated as a percentage of the total samples taken in the reporting year.

Compliance was 100% for the ADWG and 99.99% Raw Water Supply Agreements. Overall, the water quality monitoring of the reservoirs in the declared catchment areas indicated good water quality when taking into account environmental variation, historical performance and weather events.

### 5.1 Quality Assurance and Quality Control

Additional samples were collected and analysed for quality assurance and quality control (QA/QC) purposes. Field collected QA/QC samples include field duplicates and field blanks. Trip blanks are also prepared at the laboratory and taken on designated sampling trips. The QA/QC program provides confidence in the sampling data collected, 11% of the number of routine samples were taken for QA/QC purposes in 2017-18 to ensure the validity and accuracy of the WaterNSW's water quality data.

In addition to WaterNSW QA/QC samples, WaterNSW's analytical service providers have management systems that require them to maintain their own internal QA/QC program. These systems are accredited with the NATA and aligns with ISO 17025. The analytical service providers conduct internal quality control analysis per each batch of samples including matrix spikes, duplicates, blanks, replicate analysis and inter laboratory proficiency trials. The service providers' QA/QC specialists analyse conformance with specified standards of accuracy and precision to identify any contamination, outliers or errors.

#### **Trip blanks**

A total of 142 trip blanks were taken in 2017-18 across the Sydney catchment area. Three trip blanks detected at least one analyte, representing a 2% anomaly rate (a decrease of 4% from 2016-17). The three anomalous detections were for UV-absorbing constituents, ammoniacal nitrogen and organic carbon. Due to the low level of analytes detected, the interpretation of the routine monitoring results was not impacted significantly. The results also indicated that no systemic issues in sample contamination needed to be addressed.

#### **Field blanks**

A total of 146 field blanks were taken in 2017-18. Ten field blanks returned positive results, equating to an anomaly rate of 7% (a decrease of 6% from 2016-17). The analytes detected were nitrogen (TKN

and total), dissolved and total organic carbon, lorenzen, phaeophytin, manganese, aluminium, trihalomethanes, organic carbon, chlorophyll *a* and odour. The detections were low level and did not indicate a consistent issue in the sampling process. Moreover, any bias that was introduced by these results was minor and did not influence water quality management or compliance.

### **Duplicates**

Duplicate samples can identify any contamination or procedural errors in all elements of sampling and analysis. The samples are used as a pass/fail performance metric. Duplicate results are assessed on the acceptable performance criteria determined by WaterNSW and the respective laboratory. If the variation of the sample is outside the performance criteria the duplicate is reanalysed. During 2017-18, a small number of duplicates required reanalysis but after further investigation no duplicate pair showed variation of a magnitude to which WaterNSW would not accept the result.

## 5.2 Warragamba system

Sampling sites in the Warragamba system (including Prospect Reservoir) are shown Figure 5.1 in below.

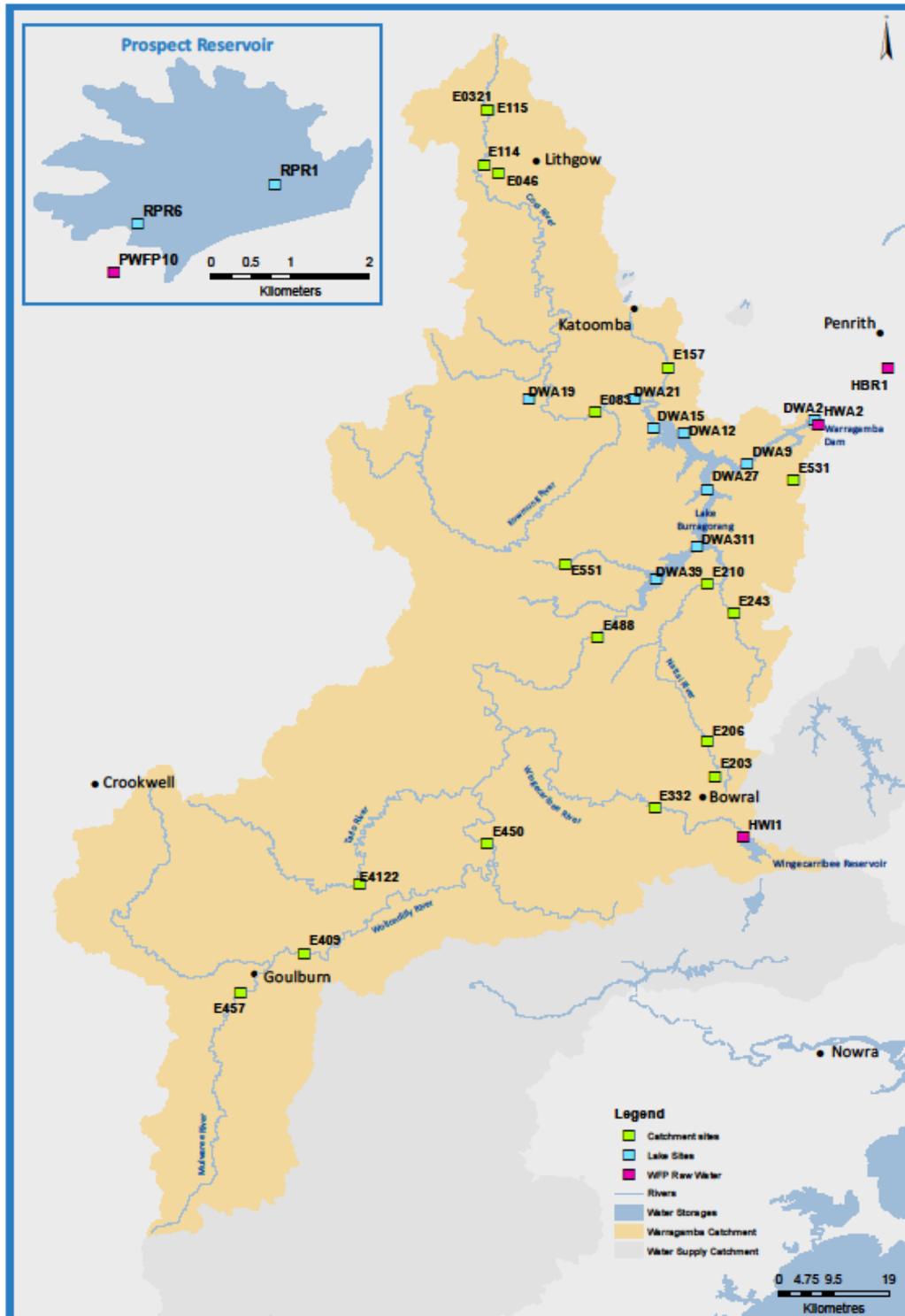


Figure 5.1: Sampling sites in the Warragamba system (including inset Prospect Reservoir)

Table 5.1: Warragamba system catchments - percentage of samples outside benchmarks.

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Alkalinity (mgCaCO <sub>3</sub> /L)	Dissolved Oxygen (%Sat)	pH (Lab/Field)	Total Hardness (mgCaCO <sub>3</sub> /L)	True Colour at 400nm	Turbidity Lab/Field (NTU)	Conductivity (mS/cm)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Filtered Reactive Phosphorus (mg/L)	Oxidised Nitrogen (mg/L)	Ammoniacal Nitrogen(mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll a (ug/L)
Catchments (ANZECC guidelines refer Table 4.4, where there is no applicable benchmark the cells are greyed out).																		
Coxs River D/S Lake Lyell	E0114		33	100			0	100	100	83	58	100	33	8		0		0
Coxs River U/S Lake Lyell	E0115		8	100			0	100	100	92	17	50	33	8		0		58
Coxs River at Lithgow (next to the Power Station)	E0321		17	100			0	100	100	0	0	100	83	100		0		0
Farmers Creek Mt Walker	E046		25	17			8	58	100	83	50	100	25	25		0		33
Coxs River @ Kelpie Point	E083		17	92			0	67	42	17	0	17	17	17		0		15
Kowmung River @Cedar Ford	E130		33	8			0	0	8	17	0	50	8	8		0		17
Kedumba River@ Maxwells Crossing	E157		25	0			0	0	92	0	0	92	25	25		0		0
Gibbergunyah Ck 400m d/s of Mittagong STP Disch.	E203		17	0			0	92	100	92	17	100	83	92		0		17
Nattai River @ The Craggs	E206		17	8			8	67	100	17	0	100	33	25		0		8
Nattai River @ Smallwoods Crossing	E210		33	0			0	58	75	8	0	50	33	50		0		58
Little River @ Fireroad W4I	E243		17	0			0	0	8	0	0	8	0	0		0		0
Wingecarribee River @ Berrima	E332		42	33			0	17	100	75	0	83	50	100		0		92
Wollondilly River @ Murrays Flat	E409		58	33			0	92	100	92	25	29	21	83		0		96
Wollondilly at Upper Tarlo	E4122		67	0			33	92	83	42	8	8	25	8		0		42
Wollondilly River @ Golden Valley	E450		0	56			0	100	78	0	0	22	11	56		0		56
Mulwaree River @ Towers Weir	E457		50	58			0	100	92	92	75	67	75	67		0		100
Wollondilly River @ Jooriland (Fowlers Flat)	E488		25	92			0	83	92	0	0	25	8	50		0		33
Werriberri Creek @ Werombi	E531		100	25			0	33	8	8	0	33	50	33		0		17
Tonalli River at Fireroad W2	E551		100	25			0	75	25	25	0	50	25	0		0		25

Site	Station Code	Physico-Chemical						Nutrients					Metals			Cyanobacteria	
		Alkalinity (mgCaCO3/L)	Dissolved Oxygen (%Sat)	pH (Lab/Field)	Total Hardness (mgCaCO3/L)	True Colour at 400nm	Turbidity Lab/Field (NTU)	Conductivity (mS/cm)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Filtered Reactive Phosphorus (mg/L)	Oxidised Nitrogen (mg/L)	Ammoniacal Nitrogen (mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)
<b>Storages (ANZECC guidelines refer Table 4.3)</b>																	
Lake Burrangorang 9km d/s of DWA15	DWA12		42	46		0		81	0	4	69	12	0		0		0
Lake Burrangorang @ 4KM U/S BUTCHERS CK.	DWA15		67	33		0		83	0	0	50	33	0		0		33
Lake Burrangorang @ Kedumba River arm	DWA19		50	33		0		100	0	0	50	33	0		0		67
Lake Burrangorang @ 500m u/s Dam Wall	DWA2		35	50		0		88	0	0	62	8	0		0		4
Lake Burrangorang @ Coxs Arm 37km u/s Dam	DWA21		50	33		0		83	0	0	50	17	0		0		100
Lake Burrangorang @ Woll. Arm 23 km u/s Dam	DWA27		46	50		0		85	0	0	73	8	0		0		0
Lake Burrangorang @ Woll. Arm 300m u/s of Nattai R.	DWA311		33	50		0		83	0	0	50	0	17		0		17
Lake Burrangorang @ Wollondilly Arm, 40km from dam	DWA39		17	17		0		83	0	0	67	17	33		0		83
Lake Burrangorang @ 14km u/s of Dam Wall	DWA9		31	50		0		88	0	0	69	12	4		0		4
Lake Prospect @ Midlake	RPR1		0	2		0		0	0	0	33	25	0		0		10
Lake Prospect @ Inlet to RWPS	RPR6		0	0		0		0	0	0	33	17	17		0		0
<b>Raw Water (raw water supply agreement site specific standards refer Table 4.2)</b>																	
Orchard Hills WFP raw water	HBR1	0			8	0	0							0	0	0	0
Warragamba WFP raw water	HWA2	0			0	0	0							0	0	0	0
Prospect WFP inlet - Channel 2, 2nd dosing bridge	PWFP10	0			0	0	0							0	0	0	0

### 5.2.1 Catchments

Water quality in Lake Burragorang's river catchments in 2017-18 followed similar trends to previous years. Catchments dominated by agricultural and urban land uses regularly exceeded ANZECC benchmarks. Water monitoring sites in the Mulwaree, Wingecarribee, Wollondilly and upper Coxs catchments most frequently exceeded benchmarks, particularly for nutrient loads and conductivity.

Sites downstream of sewage treatment plants also regularly exceeded benchmarks. These sites are located at Farmers and Gibbergunyah Creeks. Aluminium exceeded benchmarks for 100% of samples and similarly for total nutrients.

Highly protected natural catchments such as the Kowmung, Kedumba and Little Rivers returned much lower values for most parameters. Improvements in results in comparison to upstream were noted in the lower Coxs River catchment where the river enters protected areas.

### 5.2.2 Storages

Water was generally of good quality in Lake Burragorang during 2017-18.

Nitrogen exceeded guidelines more frequently at all Lake Burragorang sites than in 2016-17, indicating increasing nutrient concentrations, a trend identified in last year's report. Phosphorus concentrations over the last year were lower across all storage sites. Chlorophyll *a* decreased at all sites except the upper reaches of the Coxs and Wollondilly arms.

Aluminium concentrations were significantly lower this year, likely due to drier conditions. The majority of lake sites were below benchmarks for all samples taken. True colour has continued to drop in Lake Burragorang during 2017-18 after the increase in colour following large inflow events in 2016.

Water quality in Prospect Reservoir was of good quality with most parameters below benchmarks for all samplings. While total nitrogen was below benchmarks for each site, a small number of exceedances were noted for oxidised nitrogen (nitrate + nitrite) and ammoniacal nitrogen.

### 5.2.3 Water Filtration Plants

On 6 February 2018 at Orchard Hills total hardness recorded <1 mg/L as CaCO<sub>3</sub>. Due to other water quality parameters on the day of sampling and the uncharacteristic result it is highly likely that this result was due to an analytical error. Excluding this result, all water sample results were within the raw water supply agreement specifications for raw water supplied to Warragamba, Orchard Hills and Prospect water filtration plants. All water samples were well within ADWG for health-related characteristics.

## 5.3 Upper Nepean system

Sampling sites in the Upper Nepean system are shown in Figure 5.2 below.

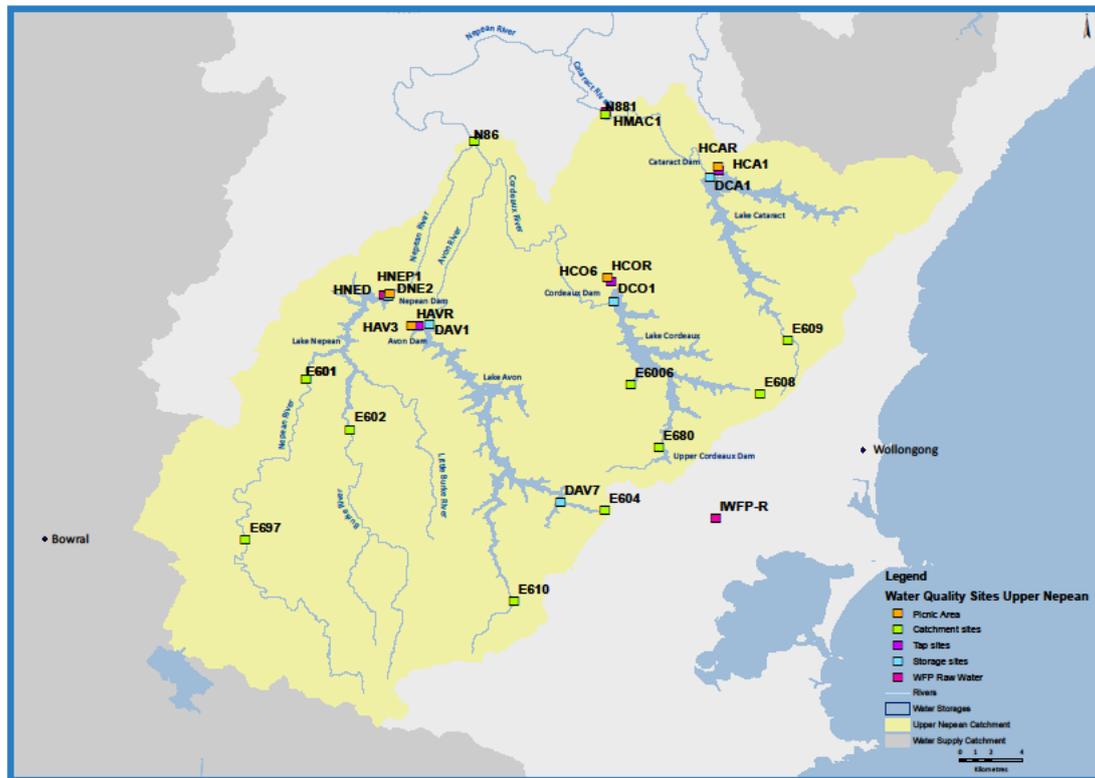


Figure 5.2: Sampling sites in the Upper Nepean system.

### 5.3.1 Catchments

Water quality across the Upper Nepean catchment sites varies according to land use and natural catchment characteristics. The Nepean River sites typically record the highest nutrient levels of the Upper Nepean catchments. This year the maximum nitrogen concentration was recorded in the Nepean River at McGuire's Crossing. Flying Fox Creek in the Avon catchment recorded the highest median concentration for total nitrogen.

pH was frequently lower than the ANZECC benchmark range at some sites, particularly Sandy Creek, Burke River and Cataract River, but typical for this catchment and less frequently than in the previous year.

Aluminium was highest in Sandy Creek which may be influenced by natural geology, drought and groundwater contributions.

**Table 5.2: Upper Nepean catchments - percentage of samples outside benchmarks.**

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Alkalinity (mgCaCO3/L)	Dissolved Oxygen (%Sat)	pH (Lab/Field)	Total Hardness (mgCaCO3/L)	True Colour at 400nm	Turbidity Lab/Field (NTU)	Conductivity (mS/cm)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Filtered Reactive Phosphorus (mg/L)	Oxidised Nitrogen (mg/L)	Ammoniacal Nitrogen(mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll a (ug/L)
Catchments (ANZECC guidelines refer Table 4.4). Where there is no applicable benchmark cells are greyed out.																		
Sandy Creek inflow	E6006		83	100		0	0	8	58	0	8	17	92		0		8	
Nepean River @ Inflow to Lake Nepean	E601		8	0		0	0	33	0	0	83	8	33		0		0	
Burke River @ inflow to Lake Nepean	E602		8	50		0	0	0	0	0	8	0	17		0		0	
Flying Fox Creek No.3	E604		58	8		0	0	42	0	0	92	0	17		0		8	
Goondarin Creek inflow	E608		75	8		0	0	8	0	0	100	0	75		0		8	
Cataract River inflow	E609		67	42		0	0	0	0	0	92	83	83		0		0	
Avon River - Summit Tank	E610		42	0		0	0	0	0	0	0	0	8		0		0	
Cordeaux River at causeway between U.Cord. 1 & 2	E680		75	8		0	0	8	8	0	83	25	17		0		0	
Nepean River @ McGuire's Crossing	E697		33	0		0	0	42	0	0	67	25	83		0		8	
Storages (ANZECC guidelines refer Table 4.3)																		
Lake Avon @ Dam Wall	DAV1		25	58		0		0	0	0	67	42	0		0		8	
Lake Avon @ Upper Avon Valve Chamber	DAV7		17	8		0		0	0	0	33	17	0		0		33	
Lake Cataract @ Dam wall	DCA1		8	17		0		0	0	0	42	33	50		0		33	
Lake Cordeaux @ Dam wall	DCO1		17	0		0		0	8	0	25	25	0		0		75	
Lake Nepean @ 300m u/s dam wall	DNE2		25	25		0		17	25	0	67	25	33		0		42	
Raw Water (raw water supply agreement site specifications refer Table 4.2)																		
Nepean WFP raw water	HNED	0			0	0	0						0	0	0	0		
Illawarra WFP raw water	IWFP-R	0			0	0	0						0	0	0	8		
Macarthur WFP raw water	HMAC1	0			0	0	0						0	0	0	0		

### 5.3.2 Storages

Water quality in the Upper Nepean lakes continued to record a high compliance against ANZECC benchmarks. Turbidity and manganese achieved full compliance. Local geology results in pH levels outside of the ANZECC range at most sites.

Chlorophyll *a* exceedance against the ANZECC benchmark was highest in Lake Cordeaux where 75% of samples were above the 5 µg/L benchmark, which is a rise from 22% of samples last year. There was an associated increase in algal concentrations from March 2018 with cell counts peaking in June 2018. Lake Cordeaux was taken off supply for a short period in June 2018 to improve quality supplied to downstream customers.

Aluminium concentrations improved this year with exceedances only recorded in Lake Cataract and Lake Nepean. Local geology, groundwater and wet weather runoff influences the aluminium concentrations received in the lakes. This year's reductions are likely to be associated with a decrease in wet weather.

### 5.3.3 Water Filtration Plants

Filter clogging algae exceeded the raw water standards on one occasion at Illawarra WFP. The WFP continued to supply water which met the Australian Drinking Water Guidelines. The raw water complied with ADWG for health-related characteristics.

## 5.4 Woronora system

Sampling sites in the Woronora system are shown in Figure 5.3 below.

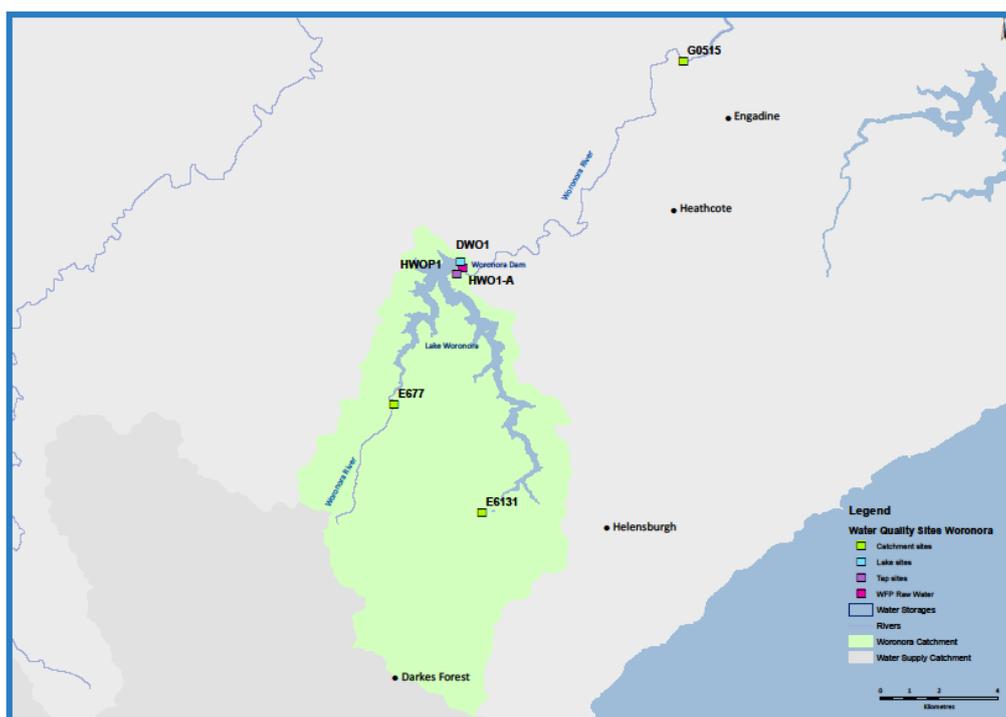


Figure 5.3: Sampling sites in the Woronora system.

Table 5.3: Woronora system catchments - percentage of samples outside benchmarks.

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Alkalinity (mgCaCO <sub>3</sub> /L)	Dissolved Oxygen (%Sat)	pH (Lab/Field)	Total Hardness (mgCaCO <sub>3</sub> /L)	True Colour at 400nm	Turbidity Lab/Field (NTU)	Conductivity (mS/cm)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Filtered Reactive Phosphorus (mg/L)	Oxidised Nitrogen (mg/L)	Ammoniacal Nitrogen(mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll a (ug/L)
Catchments (ANZECC guidelines refer Table 4.4). Where there is no applicable benchmark cells are greyed out.																		
Waratah Rivulet d/s Flatrock Crossing	E6131		25	0		0	0	0	0	0	17	8	0		0		0	
Woronora River	E677		75	75		0	0	0	8	0	8	25	58		0		17	
Storages (ANZECC guidelines refer Table 4.3)																		
Lake Woronora @ Dam Wall	DWO1		33	8		0		0	17	0	100	33	33		0		0	
Raw Water (raw water supply agreement site specific specifications refer Table 4.2)																		
Woronora WFP	HWO1-A	0			0	0	0						0	0	0	0		

### 5.4.1 Catchments

Water quality at the Lake Woronora catchment sites was consistently good. Turbidity was very low in all samples collected from the Woronora River and Waratah Rivulet. Low pH in the Woronora River catchment is common due to groundwater infiltration from surrounding Hawkesbury sandstone.

A small number of samples exceeded the ANZECC benchmarks for nutrients. Chlorophyll *a* in the Woronora River exceeded the benchmark in January and February. Despite the increase in chlorophyll *a* there were no issues with problematic algae at this site.

The Woronora River experienced lower dissolved oxygen saturation levels than typically recorded. The low dissolved oxygen saturation is likely to be related to low flow.

### 5.4.2 Storage

Water quality in Lake Woronora remained at a superior standard with high compliance against ANZECC benchmarks. The pH during one month of the year fell below the lower benchmark, with the pH being influenced by natural processes in the lake. Full compliance was also achieved for nutrients, turbidity, manganese and chlorophyll *a*.

High levels of dissolved oxygen saturation were maintained throughout the year in Lake Woronora. These oxygen levels are maintained naturally during the cooler months and by using the aeration system throughout spring and summer. Operation of the aeration system at times can contribute to dissolved oxygen saturation above the benchmark. Keeping the lake de-stratified avoids water quality issues which occur under very low oxygen conditions.

Aluminium has steadily decreased in Lake Woronora following peaks recorded from June 2016 wet weather inflow. A total of 33% of samples exceeded the lake benchmark this year compared to 83% last year. Concentrations are expected to remain low during periods of drought.

### 5.4.3 Water Filtration Plant

All water sample results were within the raw water supply agreement specifications for raw water supplied to Woronora Water Filtration Plant. Significant improvements were observed in some analytes, such as true colour which decreased to baseline levels. All samples complied with ADWG for health-related characteristics.

## 5.5 Blue Mountains system

Sampling sites in the Blue Mountains system are shown in Figure 5.4 below.

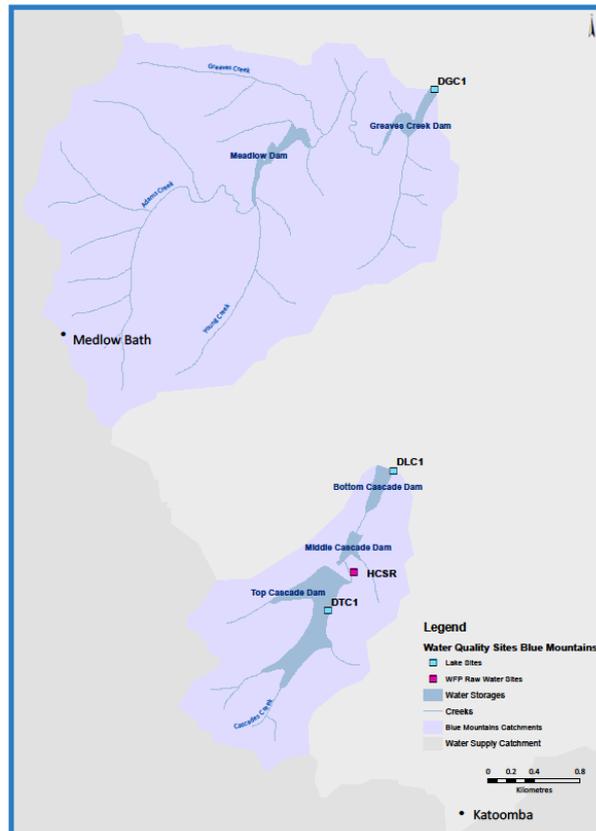


Figure 5.4: Sampling sites in the Blue Mountains system.

### 5.5.1 Catchments

The Blue Mountains catchments are very small (<20 km<sup>2</sup> in total) and inflow quality is represented by water quality in the lakes. There are no routine monitoring sites in the Blue Mountains catchments.

### 5.5.2 Storages

Water quality in the Blue Mountains lakes reflected drier weather and the increased proportion of flow sourced from Lake Oberon. Dissolved oxygen levels are kept high through use of destratification fans in all three lakes. Dissolved oxygen at times fell below the 90% saturation benchmark, however minimum levels ranged from 83 to 87% saturation which did not impact on lake or water supply quality.

High oxygen levels contributed to low manganese and iron concentrations. Drier conditions also improved aluminium concentrations with full compliance this year in Top Cascade Lake.

There were slight increases in the total nitrogen concentrations at both Top Cascade Lake and Lake Greaves. Despite increases the nitrogen compliance remained stable with only Top Cascade Lake exceeding the benchmark in some samples. Top Cascade and Lower Cascade lakes achieved full conformance with the phosphorus benchmark. Chlorophyll *a* was elevated in some samples at all sites, with maximum recorded in May to June in Lake Greaves.

**Table 5.4: Blue Mountains system storages - percentage of samples outside benchmarks.**

Site	Station Code	Physico-Chemical						Nutrients					Metals			Cyanobacteria		
		Alkalinity (mgCaCO3/L)	Dissolved Oxygen (%Sat)	pH (Lab/Field)	Total Hardness (mgCaCO3/L)	True Colour at 400nm	Turbidity Lab/Field (NTU)	Conductivity (mS/cm)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Filtered Reactive Phosphorus (mg/L)	Oxidised Nitrogen (mg/L)	Ammoniacal Nitrogen(mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll-a (ug/L)
Storages (compliance with ANZECC guidelines – refer Table 4.3). Where there is no applicable benchmark cells are greyed out.																		
Lake Greaves @ dam wall	DGC1		75	92			0	67	0	25	8	92	83	100		0		33
Lake Lower Cascade@ 50m U/S	DLC1		67	0			0	100	0	0		100	67	0		0		17
Lake Top Cascade @ 100m u/s Dam Wall	DTC1		58	0			0	100	29	0	0	83	42	0		0		25
Raw Water (compliance with raw water supply agreement site specific standards - refer Table 4.2)																		
Cascade WFP raw water	HCSR	0			0	0	0							0	0	0	0	

### 5.5.3 Water Filtration Plant

Transfers from Lake Oberon are reflected in the water quality in Top Cascade Lake, with raw water alkalinity rising from 15 mg/L as CaCO<sub>3</sub> last year to 21.5 mg/L as CaCO<sub>3</sub> this year. All samples at Cascades Water Filtration Plant were compliant with raw water supply agreement standards and the ADWG.

### 5.6 Shoalhaven system

Sampling sites in the Shoalhaven system are shown in Figure 5.5 below.



Figure 5.5: Sampling sites in the Shoalhaven system

Table 5.5: Shoalhaven system catchments - percentage of samples exceeding benchmarks.

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Alkalinity (mgCaCO <sub>3</sub> /L)	Dissolved Oxygen (%Sat)	pH (Lab/Field)	Total Hardness (mgCaCO <sub>3</sub> /L)	True Colour at 400nm	Turbidity Lab/Field (NTU)	Conductivity (mS/cm)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Filtered Reactive Phosphorus (mg/L)	Oxidised Nitrogen (mg/L)	Ammoniacal Nitrogen(mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll a (ug/L)
Catchments (ANZECC guidelines refer Table 4.4). Where there is no applicable benchmark cells are greyed out.																		
Wildes Meadow Creek at gauge	E300		83	50			8	0	100	42	0	100	83	100		0		33
Caalang CK Old Kangaloon Rd Ford	E301		33	0			0	0	92	42	0	100	17	83		0		17
Bundanoon Creek at the Rocks	E520		0	0			0	0	8	0	0	83	0	25		0		0
Brogers Creek@Clinton Park	E7021		42	42			0	0	42	50	0	67	25	92		0		15
Kangaroo River @ Hampden Bridge	E706		50	8			0	0	83	75	67	100	92	92		0		58
Kangaroo River at Oakdale	E7061		50	8			0	0	8	25	0	67	25	67		0		25
Mongarlowe R. at Mongarlowe	E822		67	25			0	0	8	17	0	25	33	92		0		8
Corang River	E8311		25	33			0	0	25	0	0	0	0	92		0		8
Shoalhaven R @ Fossickers Flat	E847		0	0			0	0	25	0	0	42	0	50		0		8
Shoalhaven R @ Mount View	E860		8	0			0	0	42	58	0	17	8	67		0		25
Shoalhaven R @ Hillview	E861		9	27			9	0	55	9	0	36	0	64		0		27
Boro Ck @ Marlowe	E890		100	42			8	8	50	83	0	33	33	100		0		42
Gillamatong Creek @ Braidwood	E891		92	0			0	100	92	67	25	58	42	17		0		67

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Alkalinity (mgCaCO3/L)	Dissolved Oxygen (%Sat)	pH (Lab/Field)	Total Hardness (mgCaCO3/L)	True Colour at 400nm	Turbidity Lab/Field (NTU)	Conductivity (mScm-1)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Filtered Reactive Phosphorus (mg/L)	Oxidised Nitrogen (mg/L)	Ammoniacal Nitrogen(mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll a (ug/L)
<b>Storages (ANZECC guidelines refer Table 4.3)</b>																		
Bendeela Pondage	DBP1		33	0		0		83	100	0	83	67	83		0		97	
Lake Fitzroy Falls @ Midlake	DFF6		8	8		0		92	83	0	83	83	75		0		92	
Lake Yarrunga@ 100m from Dam Wall	DTA1		50	8		0		17	25	8	58	33	50		0		50	
Lake Yarrunga @ Shoalhaven River	DTA5		83	8		8		33	25	8	75	58	67		0		75	
Lake Yarrunga @ Kangaroo River at Bendeela PS	DTA8		58	8		0		83	100	17	83	83	100		0		90	
Wingecarribee Lake at outlet	DWI1		8	0		0		83	75	0	83	67	92		0		100	
<b>Raw Water (raw water supply agreement site specifications refer Table 4.2)</b>																		
Kangaroo Valley WFP Inlet	HKV1	0		0	0	0	0							0		0		
Wingecarribee WFP raw water	HWI1	0		0	0	0	0							0		0		

### 5.6.1 Catchments

Water quality was consistent with previous years, sampling sites in agricultural and urbanised regions returned results that were regularly above ANZECC benchmarks. Notable mentions include the nutrient concentrations at Wildes Meadow Creek, Kangaloon Creek, Kangaroo River and Gillamatong Creek.

### 5.6.2 Recreational Monitoring

Water quality was predominately good for primary and secondary contact recreational users of Bendeela Campground and secondary contact recreation at Lake Yarrunga and Fitzroy Falls Reservoir. Only one minor alert level threshold exceedance for total cyanobacteria biovolume was recorded at Bendeela Camping Ground during 2017-18.

Elevated counts of indicator bacteria exceeding the minor alert benchmarks were observed at Bendeela Camping Ground, the risk was managed through public notification.

**Table 5.6: Recreational monitoring - percentage of samples exceeding benchmarks**

Site	Station Code	Primary Contact/Minor Alert Benchmark Percentage Exceedance				Secondary Contact/Major Alert Benchmark Percentage Exceedance			
		Enterococci (cfu/100 mL)	Microcystin LR+ YR + RR (µg/L)	Total Cyanobacterial biovolume (mm3/L)	Toxic Cyanobacterial cell count (cells/mL)	Enterococci (cfu/100 mL)	Microcystin LR+ YR + RR (µg/L)	Total Cyanobacterial biovolume (mm3/L)	Toxic Cyanobacterial cell count (cells/mL)
Recreational monitoring (MRRW and ADWG guidelines – refer Table 4.8).									
Fitzroy Falls	DFF	NA	NA	NA	NA	0	0	0	0
Bendeela Camping Ground	DPAE	54	NA	3	10	21	0	0	0
Lake Yarrunga	DTA8	NA	NA	NA	NA	2	0	0	0

### 5.6.3 Storages

Analysis of the storages in the Shoalhaven system returned high exceedance rates for chlorophyll *a* and all nutrients except filtered reactive phosphorus. This is typical of the Shoalhaven system and reflects the agricultural land use in the catchment.

Aluminium concentrations exceeded the benchmark in all samples collected from near Bendeela pumping station and Wingecarribee Reservoir. Concentrations continued to be high elsewhere in the Shoalhaven storages but less frequently than in the previous year. The high levels of aluminium are the result of the geology of the region and is consistent with knowledge of the area and previous analyses.

Due to its history of high numbers of toxin producing cyanobacteria, Wingecarribee Reservoir was closely monitored throughout 2017-18. Wingecarribee Water Filtration Plant effectively managed the risk of algal cells and toxins through the use of powdered activated carbon in the treatment process.

Multiple incidents were recorded throughout the monitoring period, details of incidents involving potential toxin producing cyanobacteria in Wingecarribee Reservoir are reported in section 8.1.

#### 5.6.4 Water Filtration Plants

All routine sampling undertaken throughout the year met the site-specific guidelines of Kangaroo Valley and Wingecarribee water filtration plants.

### 5.7 Algal monitoring

All routine catchment and lake samples are analysed for algae if chlorophyll *a* exceeds 5 µg/L. There are selected lake sites, which are the closest point to supplying water filtration plants, which have unconditional algae counts and speciation undertaken regardless of chlorophyll *a*. At locations with a history of algal activity, seasonal monitoring is conducted more frequently in the warmer months between October and May to facilitate early detection of emerging algal events. Routine algal monitoring is also undertaken in raw water supplied to water filtration plants. Statistical summaries are provided in Appendix A. Refer to Table 4.8 for relevant benchmarks.

#### 5.7.1 Warragamba system

Chlorophyll *a* concentrations in the Wollondilly catchments regularly exceeded benchmarks triggering speciation but cyanobacteria were rarely detected. Chlorophyll *a* was low in the Coxs River sites excluding the site upstream of Lake Lyell. This was due to a potentially toxic cyanobacteria bloom in the upstream Lake Wallace in early 2018, however this bloom did not move downstream of Lake Lyell.

In Lake Burragorang speciation was triggered relatively infrequently in the upper reaches of the Wollondilly arm. Chlorophyll *a* in the Kedumba River arm spiked in May 2018 recording 22 µg/L however algal concentrations were not overly concerning as the samples were dominated by diatoms and dinoflagellates. Near the dam wall algal concentrations were low throughout the year apart from a moderate increase in non-toxic diatoms around January to February 2018. There were no algal toxins detected during the reporting period.

Chlorophyll *a* concentrations in Prospect Reservoir exceeded 5 µg/L in 10% of the routine samples collected at the midlake site but not at the inlet to Prospect Pumping Station. Concentrations of potentially toxin producing algal species remained below levels of concern and no algal toxins were detected during the reporting period.

Raw water supplied to Orchard Hills, Warragamba and Prospect WFPs continued to meet the Raw Water Supply Agreement and ADWG criteria with respect to algae.

#### 5.7.2 Upper Nepean system

Catchment sites in the Upper Nepean system showed very low chlorophyll *a* concentrations most of the time in 2017-18. Four of the nine catchment sites in the system recorded one exceedance above the 5 µg/L benchmark throughout the year but with no sustained algal growth.

Algal monitoring in the Upper Nepean storages recorded nil to very low concentrations of potentially toxin producing cyanobacteria (<100 cells/mL).

Upper Lake Avon recorded uncharacteristically high algae counts from September to December 2017. Filter clogging algae were particularly high in Upper Avon due to high counts of the diatom *Urosolenia*. Raw water to Illawarra WFP was also impacted with a maximum filter clogging potential of 10,240 ASU/mL on 11 October 2017. Special algae monitoring was conducted on a weekly basis in the upper lake and raw water to Illawarra WFP during this algal bloom.

Lake Cordeaux recorded unseasonally high algae counts in May and June, with a diatom *Synedra* contributing to high filter clogging counts. Special monitoring commenced in June 2017 to track algae and reports of strong odour. Monitoring in June 2017 also recorded high filter clogging algae in the raw water to Macarthur WFP above the minor incident level for the WFP. Options for supply to Macarthur WFP were reviewed and releases adjusted to minimise impacts of filter clogging algae in the Broughtons Pass area.

Cyanobacteria in the Upper Nepean lakes for the period 2017-18 did not exceed Australian Drinking Water Guideline levels. The raw water to Illawarra WFP exceeded the site-specific specification for filter clogging potential (areal standard units) in November 2017 (as listed in Table 4.2), but reported no issues with water treatment.

### 5.7.3 Woronora system

As in previous years, chlorophyll *a* remained below the threshold for additional analysis at the site Waratah Rivulet. A slight increase in chlorophyll *a* was recorded in the Woronora River this year, with two samples above the benchmark and a maximum of 6.4 µg/L. There were no potentially toxin producing cyanobacteria species detected in the lake or in raw water supplied for treatment.

### 5.7.4 Blue Mountains system

Chlorophyll *a* concentrations increased this year in Lake Greaves to a maximum of 11.7 µg/L while decreasing at Top Cascade Lake to a maximum of 6.7 µg/L.

A bloom of green algae in Lake Greaves resulted in very high filter clogging potential for several months, with a peak of 10,540 ASU/mL during March 2018. The green alga *Kirchneriella* provided the largest biomass and filter clogging potential during the bloom. Management of transfers from Lake Greaves to the Cascade lakes mitigated the impacts of algae in the receiving lakes and raw water supply.

Low counts of potentially toxin-producing cyanobacteria were recorded in Top Cascade Lake only once during February. There were no potentially toxin-producing cyanobacteria recorded in Lake Greaves during 2017-18.

The raw water recorded low counts of potentially toxin-producing cyanobacteria on several occasions throughout the year, with the maximum of 1,610 cells/mL recorded in July. These counts were sporadic

and generally not present in follow up sampling. The raw water supplied to the Cascades WFP complied with cyanobacteria guidelines in all samples during 2017-18. There was also full compliance to the raw water supply standards.

### 5.7.5 Shoalhaven system

Algae are historically common in the Shoalhaven system and chlorophyll *a* exceeded the 5 µg/L threshold at most catchment sites at least once during the year. Gillamatong Creek exceeded the threshold in 67% of the samples analysed (a decrease of 16% from 2016-17), the highest concentration being recorded on 20 December 2017 at 69 µg/L. Total nitrogen and total phosphorus levels exceeded the benchmarks 92% and 67% respectively.

Similarly to 2016-17, the Hampden Bridge site on the Kangaroo River exceeded the chlorophyll *a* criterion in 58% of samples. Total nitrogen and total phosphorus samples exceeded the benchmark in 83% and 75% of samples respectively, a decrease of 17% for both analytes from the previous year.

All storages in the Shoalhaven system exceeded the chlorophyll *a* benchmark  $\geq 50\%$  throughout the year. The Lake Yarrunga dam wall site was the least affected by algal growth and had less nutrient exceedances than other Shoalhaven sampling sites within the lake. The sites on the Shoalhaven and Kangaroo River arms exceeded the chlorophyll *a* threshold 75% and 90% respectively.

Most samples taken from Fitzroy Falls Reservoir, Bendeela Pondage and Wingecarribee Reservoir exceeded the chlorophyll *a* benchmark but toxins and cell counts of potentially toxic species were low except in Wingecarribee Reservoir. Notably, the highest concentration of microcystins in the Shoalhaven storages was 2.7 µg/L on 12 March 2018 at the outlet of Wingecarribee Lake. Details of algal incidents and the responses can be found in Appendix C.

Raw water supplied to Kangaroo Valley and Wingecarribee complied with the ADWG cyanobacteria guidelines throughout the reporting period. The highest concentration of microcystins was 1.2 µg/L on 14 May 2018 at Wingecarribee Water Filtration Plant.

## 5.8 *Cryptosporidium* and *Giardia* monitoring

Routine monitoring is undertaken in catchments, storages and delivery networks at varying frequencies as agreed between WaterNSW, Sydney Water and NSW Health. Statistical summaries are provided in Appendix A.

### 5.8.1 Catchments

Monitoring for *Cryptosporidium* and *Giardia* is undertaken at seven selected streams in the Warragamba catchment as part of the routine program. The sampling schedule is monthly, except for Werriberri Creek (E531) which is weekly. This section discusses routine monitoring for *Cryptosporidium* and *Giardia*, refer to Section 7.1 for wet weather monitoring.

*Cryptosporidium* oocysts were detected at only one of the catchment sites during the reporting period; 1/51 (2%) of samples from Werriberri Creek (E531) at a concentration of 2.1 oocysts/10 L.

*Giardia* was not detected at any of the seven catchment sites during the reporting period.

### 5.8.2 Storages

Routine monitoring was conducted six days per week at one lake site in Lake Burragorang (DWA2), weekly at Prospect (RPR1) and Wingecarribee (DWI1) reservoirs and monthly at Prospect Reservoir (RPR6). There were no (oo)cyst detections at any of these sites during the reporting period.

### 5.8.3 Water Filtration Plants

A joint monitoring program in raw water at the inlet of water filtration plants is undertaken by Sydney Water and results are provided to WaterNSW and NSW Health for:

- Macarthur WFP (MACSP1A)
- Prospect WFP (PWFP10)
- Warragamba WFP (HWA2)
- Orchard Hills WFP (HBR1)
- Nepean WFP (HNED)
- Illawarra WFP (IWFP-R)
- Woronora WFP (HWO1-A)
- Cascade WFP (HCSR).

The sampling procedure changed from 1 July 2017 in that the practice of using composite water samples was discontinued and replaced by individual raw water samples, and the sample volumes were increased from 10 L to a volume that could be processed, which was variable but greater than 10 L in an attempt to collect more low level positive results to assist in quantifying catchment risk.

There were no incident level detections (i.e.  $\geq 10$  (oo)cysts/10 L) of *Cryptosporidium* or *Giardia* from routine monitoring of water filtration plants during the reporting period.

(Oo)cysts were detected at alert levels ( $\geq 1$  (oo)cysts/10 L) at only one raw water supply during the reporting period. *Cryptosporidium* oocysts exceeded the alert threshold on two occasions (max. 1.7/10 L) and *Giardia* cysts on one occasion (1.0/10 L) at Macarthur WFP.

## 5.9 Picnic area monitoring

WaterNSW undertakes routine monitoring at picnic taps where the water is supplied directly from the storages or where potable water is carted in, both water sources undergo chlorination prior to distribution. Monitoring is also undertaken at the picnic areas which receive reticulated town water.

**Table 5.7: Picnic areas - percentage of samples exceeding benchmarks.**

Site	Station Code	Physico-chemical		Metals			Inorganics	Cyanobacteria			Enteric Pathogens
		pH (Lab/Field)	Turbidity Lab/Field (NTU)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Free Chlorine residuals (mg/L)	Chlorophyll a (ug/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (ug/L)	E. coli (orgs/100 mL)
Picnic taps (ANZECC guidelines refer Table 4.6).											
Avon Picnic Area Tap	HAV3	0	0	0	2	0	94	0	-	-	0
Bendeela Picnic Area Tap	HBPP1	0	0	0	0	0	-	0	-	-	0
Cataract Picnic Area Tap	HCA1	2	0	0	100	2	52	0	-	-	0
Cordeaux Picnic Area Tap	HCO6	0	4	0	37	15	94	0	-	-	0
Fitzroy Falls Picnic Area Tap	HFFR2	0	2	0	2	0	6	0	-	-	0
Nepean Picnic Area Tap	HNEP1	0	0	0	0	0	-	0	-	-	0
Warragamba Picnic Area Tap	HWAP1	0	0	0	0	0	0	0	-	-	0
Wingecarribee Picnic Area Tap	HWIP1	0	0	0	0	0	-	0	-	-	0
Woronora Picnic Area Tap	HWOP1	100	0	0	0	0	-	0	-	-	0

Overall the picnic taps showed results consistent with previous years. Low residual chlorine is common due to the long residence times and chlorine decay in the reticulation system. The effectiveness of chlorination at the picnic areas is based on the chlorine concentrations, chlorine contact times and the absence of bacterial indicators. No *E. coli* were detected at the picnic areas in this reporting period.

The daily operational monitoring records of chlorine and flow (where available) at Avon, Cataract, Cordeaux and Fitzroy Falls picnic areas are used to calculate chlorine contact time (C.t). Calculations indicate that the systems are exceeding the target of 15 mg/L.min C.t. for the majority of the time.

Cordeaux picnic area recorded two turbidity exceptions at 5.2 NTU and 6.9 NTU most likely due to biofilm sloughing within the pipes. Additionally, Fitzroy Falls picnic area showed one turbidity exception at 5.2 NTU, most likely due to low water level and the subsequent replenishment by the water carter. In response to the elevated turbidity the systems were flushed and turbidity returned to below threshold values within two weeks at all sites.

Total iron at the Cataract picnic site consistently exceeded the ADWG aesthetic guideline of 0.3 mg/L, with the most notable exceedance being 2.15 mg/L, however this was a transient concentration and water quality returned to normal levels within two weeks. Offtake management is used to minimise the impact of metal content on water supplied to the picnic areas.

Annual sampling of the five picnic areas supplied by reticulated town water showed full compliance for all analytes and sites, except for one incidence of pH exceedance at Woronora picnic area where pH reached 9.1 units.

## 6 Monitoring for the Water Licences

### 6.1 Water quality

Sampling of downstream storages in accordance with the requirements of the Water Licences is undertaken by WaterNSW. Table 6.1 reports the results of downstream sampling against the ANZECC benchmarks.

**Table 6.1: Downstream of storages - percentage of samples exceeding benchmarks**

Site	Station Code	Number of samples	pH (Lab/Field)	Turbidity Lab/Field (NTU)	Dissolved Oxygen (%Sat)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Chlorophyll <i>a</i> (ug/L)
<b>Wingecarribee River</b>								
Wingecarribee River @ Sheepwash Bridge	E303	12	0	0	0	58	0	100
<b>Shoalhaven River</b>								
Shoalhaven R @ d/s Tallowa Dam	E851	12	0	0	0	0	0	67
<b>Woronora River</b>								
Woronora River @ the Needles	G0515	12	75	0	92	0	0	42
<b>Nepean River</b>								
Nepean River @ Yarramundi	N44	12	0	0	8	92	0	67
Nepean River at Penrith Weir	N57	12	17	0	25	42	0	58
Nepean River 500m D/S of confluence of Warragamba River	N64	12	0	0	25	75	0	42
Warragamba River U/S of confluence of Nepean River	N641	12	0	0	25	8	0	0
Nepean River @ Wallacia Bridge	N67	12	8	0	42	92	0	92
Nepean River @ Sharpes Weir	N75	12	0	0	0	92	0	75
Nepean River @ Menangle Br	N85	12	0	0	0	0	0	50
Pheasant's Nest Weir Pool	N86	12	0	0	8	0	0	8
Cataract River @ Broughtons Pass	N881	12	0	0	0	0	0	8
Nepean River @ Maldon Weir	N92	12	25	0	17	0	8	58

Water quality in the Hawkesbury-Nepean system typically declines in a downstream direction. This trend is particularly evident in chlorophyll *a* concentrations, which increase downstream of WaterNSW control structures (Pheasants Nest, Broughtons Pass). Two sites showed less chlorophyll *a* than last year (Yarramundi and downstream of Warragamba River confluence), however total nitrogen exceeded benchmarks more frequently. Data indicates increased algal presence at most downstream sites.

Similarly to the prior two years, all samples at the Wingecarribee River site exceeded the chlorophyll *a* benchmark of 5 µg/L this year. There was a decrease in nitrogen exceedance in the Wingecarribee River compared to 2016-17 and five of the thirteen sites monitored exceeded benchmarks for total nitrogen greater than 50% of the time. The remaining water quality analytes either improved or remained the same throughout 2017-18.

The pH levels in the Woronora River were outside of ANZECC benchmarks for the majority of samples. Much like pH in Lake Woronora and Woronora River, the pH was below the ANZECC benchmark and is affected by the local geology. Dissolved oxygen also continued to remain low at this site throughout the year.

## 6.1 Thermal impacts of environmental releases

Water released from storages can often be significantly warmer or cooler than downstream systems due to the depth of offtake, thermal stratification and greater thermal mass. Large releases of thermally disparate waters into downstream systems can significantly impact downstream riverine systems. To investigate the effect of environmental releases, water temperature is measured at several locations downstream of WaterNSW storages.

To determine the potential thermal impacts of environmental releases, the temperature of storage inflows and environmental releases are compared. Storage inflows provide a measure of expected water temperatures in the natural conditions. Downstream temperatures are taken from the closest downstream hydrometric station. Only systems with environmental release requirements are presented.

### 6.1.1 Upper Nepean system

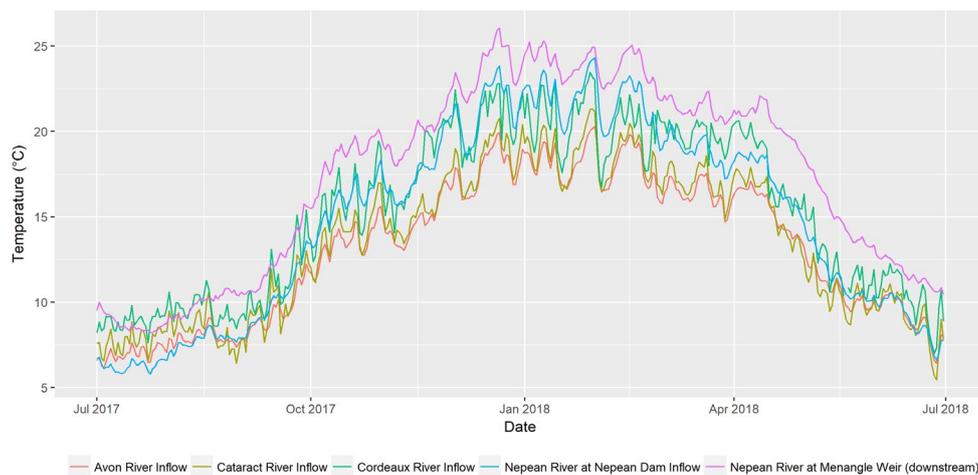
The Upper Nepean System comprises of the Avon, Cataract, Cordeaux and Nepean catchments. While WaterNSW endeavours to provide the highest quality water for environmental release, system configuration precludes selection for environmental releases from the Upper Nepean storages. All Upper Nepean environmental releases are sourced from offtake depths determined to provide the highest quality water for human consumption. WaterNSW is particularly interested in detecting suppressed downstream water temperatures, also known as “cold water pollution”, resulting from deep water offtakes.

Daily temperature data recorded at the following hydrometric stations represents reference catchment conditions:

- Avon catchment - Avon River at Summit Tank
- Cataract catchment – Cataract River at Corrimal
- Cordeaux catchment – Sandy Creek at Fire Road 15
- Nepean catchment – Nepean River at Nepean Dam inflow

Downstream water temperature was recorded at Menangle Weir on the Nepean River which represents the first hydrometric station after the confluence of all Upper Nepean Storage releases. The station is approximately 20 km downstream of the furthest Upper Nepean storage, Lake Cordeaux.

As shown in Figure 6.1, downstream temperatures at Menangle Weir are consistently higher than the inflow reference temperatures, this suggests no persistent downstream cold water pollution as a result of environmental releases. Downstream temperature and reference temperature profiles exhibit small scale changes and seasonal trends. Reference temperatures tend to display greater small scale variability due to smaller flows. These results are consistent with previous years.



**Figure 6.1: Upper Nepean system temperature profile**

### 6.1.2 Woronora system

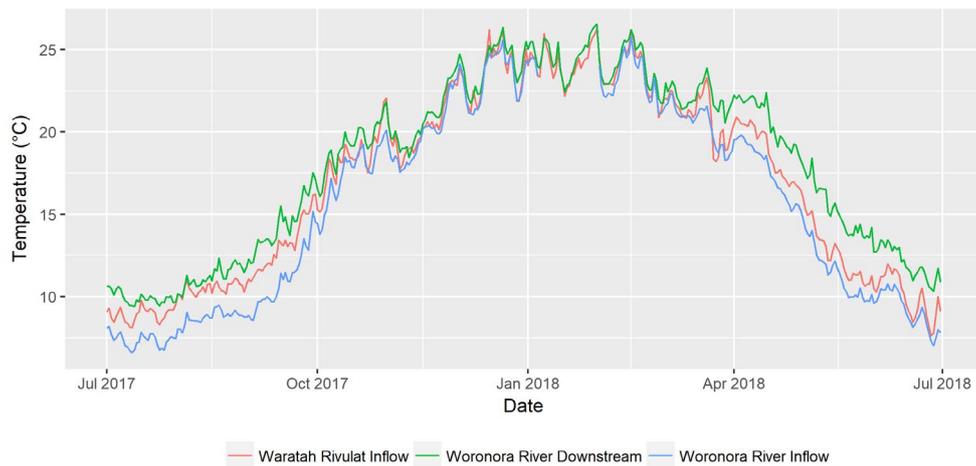
Similarly to the Upper Nepean storages, the system configuration at Lake Woronora does not support selecting offtakes specifically for environmental releases. As a result, environmental releases may be significantly cooler than surface waters due to thermal stratification. Downstream water temperatures in the Woronora River are recorded to detect any evidence of persistent cold water pollution.

Reference temperatures for the Woronora catchment are recorded daily at the major inflow locations to Lake Woronora:

- Woronora River at Fire Rd 9F
- Waratah Rivulet at Flatrock Crossing

Downstream temperatures were recorded daily at The Needles on the Woronora River, approximately 10 km downstream from the environmental release point.

As seen in Figure 6.2, the downstream temperature in the Woronora River at the Needles closely matches that of the reference temperatures recorded at upstream sites, indicating minimal cold water pollution. A strong seasonal trend is detected in the reference and downstream temperatures and all three sites show very similar small scale variations reflecting local weather conditions.



**Figure 6.2: Woronora system temperature profile**

### 6.1.3 Shoalhaven system

Environmental releases from Lake Yarrunga are supplied via an overshoot gate on the dam and the fishway which allows for the preferential release of surface waters.

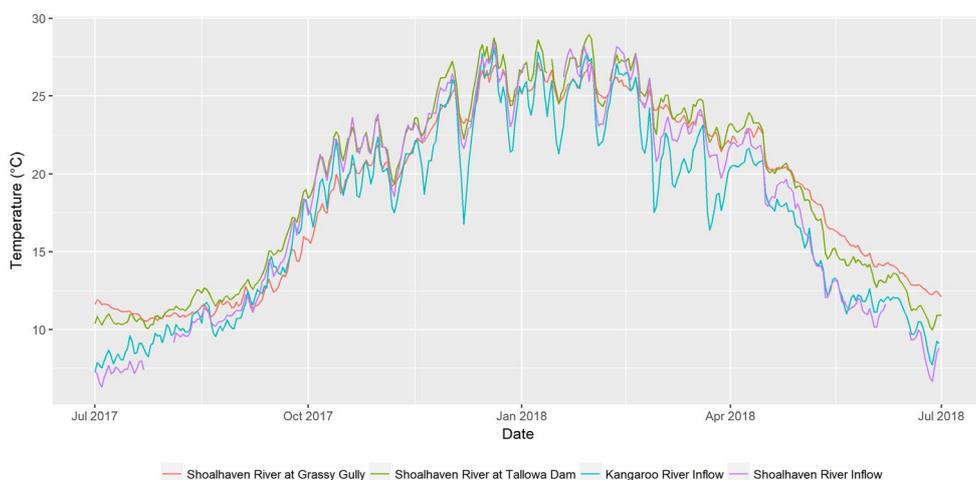
Reference temperatures for Lake Yarrunga are recorded daily on the major tributaries:

- Shoalhaven River at Fossickers Flat
- Kangaroo River at Hampden Bridge

Downstream temperatures were recorded daily at:

- Shoalhaven River downstream of Tallowa Dam (immediately downstream)
- Shoalhaven River at Grassy Gully (20 km downstream)

Figure 6.3 shows that temperatures at both downstream sites closely match those of the upstream reference sites. The similarity between the two downstream sites suggests the environmental releases are very near ambient condition. The Kangaroo River catchment is small, so temperatures fluctuate more in response to local rain events.



**Figure 6.3: Shoalhaven system temperature profile**

## 7 Targeted and investigative monitoring

WaterNSW undertakes targeted and investigative monitoring to understand and assess impacts that are not addressed by the routine monitoring program. The results of the monitoring are discussed in greater detail in the sections below.

A summary of water quality incidents during 2017-18 is included in Section 8.

### 7.1 Wet weather inflow monitoring

WaterNSW conducts wet weather sampling to assist in evaluating impacts on water quality from runoff during significant rainfall events. A key component of the wet weather monitoring program is the use of autosampler stations at strategic catchment sites which are programmed to automatically take samples once a river height trigger has been reached.

Wet weather monitoring is used to quantify the water quality risks for incoming waters to storages. During high rainfall events, catchments are often closed to operational traffic and storages closed to boat traffic to protect the health and safety of staff and members of the public. Using autosamplers helps to acquire valuable water quality information on the water quality effects of rainfall events.

Autosamplers are programmed to collect samples for:

- total organic carbon, suspended solids, total phosphorus, total nitrogen, total aluminium, total iron and total manganese (Type 1).
- *Cryptosporidium* and *Giardia* (Type 2), plus total nitrogen, total phosphorus (site E203 only).
- Or both Type 1 and Type 2.

Where specific water quality issues have been identified, additional characteristics are analysed on request. At high priority reservoir inflow locations, both autosampler types have been installed. Given the differing sampling mechanisms, trigger values may differ between the two autosampler types. Type 2 samples are reserved for locations identified as potentially significant pathogen sources, requiring a much larger sample volume (hence the lower number of samples). Appendix B tabulates the number of Type 1 and Type 2 autosamples collected for each site during the year.

### 7.2 Catchment Risk Characterisation

The average pathogen risk for catchments supplying each storage lake was determined from an assessment of catchment hazards and historical water quality monitoring data based on the Health Based Targets (HBT) procedure developed by Water Services Association of Australia (WSAA).

It is recognised that the greatest challenges to water treatment occur during heavy rain events when contaminants from the catchment and higher river flows cause a decrease in water quality. At such times water quality monitoring is increased at raw water intakes and selected catchment and storage sites. The Pathogen Campaign Monitoring Program was instituted to enhance pathogen monitoring during high inflow events at selected catchment sites to allow the pathogen risk to be refined during events.

During an event the pathogen risk factors such as the condition of the storages and catchments, rainfall, inflow volumes, reports of overflows from sewage treatment plants, dairy effluent ponds and stormwater overflows, and turbidity and pathogen data are used to reassess pathogen risk. No campaign sampling was conducted during 2017-18 due to a lack of high flow events.

### 7.3 Macroinvertebrate monitoring

The Macroinvertebrate Monitoring Program (MMP) is an annual assessment of ecological health at stream sites in the Sydney catchment area. In 2017, 124 individual macroinvertebrate samples were collected as duplicates from 62 sites across 27 sub-catchments. Site information and AUSRIVAS scores are presented in Table 7.1. In 2017, 43 of 62 sites (69%) had mean AUSRIVAS ratings that were at reference condition (A rating), while 16 sites (26%) were rated below reference (B rating) and one site (2%) was rated well below reference (C rating). Two sites could not be scored as they were outside the experience of the AUSRIVAS model. These results show an overall improvement in ecological health at MMP sites since 2016, where 28 of 63 sites (44%) of monitored sites were rated at reference condition.

In 2017, macroinvertebrate sampling was conducted at 26 sites across 12 sub-catchments in the Lake Burragorang catchment. Of these sites, 17 (65%) were rated at reference condition and the remaining eight (31%) fell within the category of 'below reference'. Compared to 2016, the rating for 5 sites (19%) improved, 5 (19%) declined, and 15 (57%) remained stable.

Macroinvertebrates were monitored at 27 sites from 12 Lake Yarrunga sub-catchments in 2017. Of the sites that were sampled, 20 (77%) were in reference condition, 5 (19%) were classified as 'below reference'. One site was rated 'well below reference condition'; MMP192 in the Nerrimunga sub-catchment. Across the Yarrunga catchment, the 2017 AUSRIVAS band rating increased at 12 sites (46%), decreased at one site (4%) and remained the same at 12 sites (46%) compared to the previous year.

A total of four sites in the Upper Nepean catchments were monitored for macroinvertebrates in 2017. All four sites were in reference condition, representing an increase in the AUSRIVAS band rating for three of the four sites since 2016, and a stable rating for one site. In the Blue Mountains sub-catchments, three sites were sampled for the 2017 MMP, of which one was ranked in reference condition and the remaining two were categorised as 'below reference'. All three of the Blue Mountains sub-catchment sites retained the same AUSRIVAS rating as 2016. In the Woronora sub-catchment, one site improved from a C to a B rating, and one site improved from a B to an A rating in 2017.

The MMP98 site in the Bungonia sub-catchment was added to the MMP schedule in 2014 to address perceived declines in sub-catchment health. This site was removed from the sampling program in 2017 due to access constraints and a stabilisation in sub-catchment AUSRIVAS scores. The MMP08 site in the Jerrabattagulla sub-catchment was also removed due to ongoing access constraints and replaced with the new site MMP273.

**Table 7.1: Mean AUSRIVAS ratings for each site monitored in 2017. Site conditions are At Reference (A), Below Reference (B), Well Below Reference (C) or Outside the Experience of the AUSRIVAS Model (OEM). AUSRIVAS band thresholds are adjusted to the mean edge and riffle band value for sites where both edge and riffle habitats were sampled.**

Site Code	Site Name	Combined AUSRIVAS rating	Site Code	Site Name	Combined AUSRIVAS rating
<b>Warragamba Dam sites</b>			<b>Tallowa Dam sites</b>		
E130	Kowmung River at Cedar Ford	A	MMP09	Jerrabattgulla Creek at Warragandra	A
MMP14	Kowmung River at Kowmung Fire Trail	A	MMP16	Witts Creek at Krawarree Road	A
MMP251	Tonalli River u/s Lake Burragorang FSL	A	E890	Boro Creek at Marlowe	A
MMP59	Butchers Creek u/s of Lake Burragorang	B	MMP33	Kings Creek u/s of Boro Creek	B
E243	Blue Gum Creek at Fire Road W4I	B	E860	Shoalhaven River at Mount View	A
MMP05	Little River at Fire Trail W4I	A	MMP17	Shoalhaven River at Farrington Crossing	A
E157	Kedumba River at Kedumba Crossing	A	MMP62	Jembaicumbene Creek at Bendoura	A
MMP76	Leura Falls Creek at FT W7F	A	A8	Bungonia Creek at Bungonia	A
E083	Cox's River at Kelpie Point	A	E847	Shoalhaven River at Fossickers Flat	A
MMP55	Little River at Six Foot Track	A	MMP11	Titringo Creek at High Forest	OEM
A5	Mulwaree River at Lake Bathurst	A	MMP12	Endrick River at Nerriga	A
E457	Mulwaree River at The Towers	B	MMP269	Jinden Creek at Tallanganda State Forest	A
E206	Nattai River at The Crags	A	E706	Kangaroo River at Hampden Bridge	A
E210	Nattai River at the causeway	A	MMP43	Kangaroo River at upper Kangaroo Valley	A
A16	Cox's River at Lidsdale	OEM	E8311	Corang River at Meangora	A
MMP37	Cox's River at McKanes Bridge	A	MONG1	Mongarlowe River at Charleyong	A
MMP27	Wollondilly River at Goonagulla	A	R13	Mongarlowe River at Monga	A
Uwol1	Wollondilly River at Baw Baw Bridge	A	MMP273	Shoalhaven River at Wyanbene Rd	A
MMP57	Werri Berri Creek at The Oaks	B	E8361	Nerrimunga Creek at Minshull Trig	B
E531	Werri Berri Creek at Serenity Park	B	MMP192	Budjong Creek at Sandy Point	C
U10	Wingecarribee River at Berrima	B	MMP51	Jacqua Creek at Lumley Road	B
Winge2	Wingecarribee River at Greenstead	A	MMP52	Nadgigomar Creek at Oallen Ford	B
A6	Tarlo River at Tarlo	B	MMP258	Durran Durra Creek at Nerriga Road	B
E488	Wollondilly River at Jooriland	B	R7	Mulloon Creek at Tawarri	A
MMP130	Long Swamp Creek u/s Paddy's River	A	REED1	Reedy Creek at Mayfield Road	A
MMP226	Tarlo River at Swallowtail Pass	A	MMP06	Shoalhaven River at Yarra Glen	A
<b>Blue Mountains Dams sites</b>			R8	Currumbene Creek at Krawarree Road	A
MMP246	Woodford Creek u/s Woodford Dam	A	<b>Metropolitan Dams sites</b>		
MMP39	Woodford Creek at Woodford Dam	B	E604	Flying Fox Creek No.3 u/s of Gauge	A
MMP60	Cascade Creek d/s of lower Cascade dam	B	MMP100	Wongawilli Creek d/s of Fire Road 6	A
			MMP136	Lizard Creek d/s Fire Road 8H	A
			MMP20	Nepean River at Maguires Crossing	A
			<b>Woronora Dam sites</b>		
			E677	Woronora River at Fire Road 9F	B
			E678	Waratah Rivulet at Flat Rock Crossing	A

## 7.4 Investigative monitoring

WaterNSW's investigative monitoring program is designed to target known risks, emerging issues and to enhance modelling and management options. Investigative monitoring can be used for identifying pollution sources, understanding pollutant fate and transport in a variety of flow conditions and investigating the risk of pollutants reaching inflows and raw water offtake points. Investigative monitoring is also one method used in evaluating the effectiveness of actions in the catchments and lakes to address pollutants.

### 7.4.1 Investigative monitoring for operational decision making

#### 7.4.1.1 Freshwater jellyfish in Cascades raw water

A bloom of freshwater jellyfish, *Craspedacusta sowerbii*, was identified in Top Cascade Lake in late March 2018. Individuals were also recorded in the raw water to Cascades Water Filtration Plant (WFP). Initial attempts using standard water sampling methods were shown to be ineffective in collecting jellyfish. A specialised jellyfish survey to assess abundance, maturity stage, size and potential predation on zooplankton was conducted during April 2018. This study also aimed to identify an appropriate method of jellyfish collection.



**Figure 7.1: Images of the freshwater jellyfish *Craspedacusta sowerbii* sourced from Hamrsky, J (2018). Adult medusae grow to 25 mm. Life in Freshwater: Freshwater jellyfish. Available at: <http://lifeinfreshwater.net/freshwater-jellyfish-craspedacusta-sowerbyi/>**

Two sampling methods were deployed, vertical haul and horizontal tow, with the vertical haul collecting the most jellyfish. A total of 488 jellyfish medusae were collected on three sampling dates in Top Cascade Lake. Peak abundance on 12 April equated to approximately 1.3 million jellyfish in the lake. Abundance decreased to 470,000 jellyfish on 19 April and then a slight rise to 674,000 jellyfish on 26 April. The decreases were likely to be associated with decreasing water temperatures, reduced food availability and an aging population all resulting in death of medusae. This study involved monitoring up to five weeks after the initial sighting in Top Cascade Lake. An associated literature review identified that jellyfish individuals are likely to live for three to eleven weeks under laboratory conditions. They are also reported to grow to 25 mm in size. However, the largest specimen collected during this study was 17 mm.

The *C. sowerbii* bloom was shown to have a significant impact on zooplankton abundance in Top Cascade Lake. Decreases in zooplankton reduces the grazing on algae, thus potentially increasing algae

concentrations in the lake. The largest perceived impact from this jellyfish bloom on the quality of raw water supply is an associated rise in algae. Algae blooms can impact on raw water by clogging filters or potentially producing toxins.

Despite a significant jellyfish biomass, the risk to filter clogging was low given minimal ingress into supply. Symptoms that may be experienced include a reduction in head-loss and filter run times. There were no reported issues at the Cascades WFP and no reporting drinking water quality issues during the bloom period. Understanding the ecology of this water body improves the ability to forecast risks and potential impacts to water quality. Increased algal monitoring is recommended during any future jellyfish blooms. It is likely that jellyfish blooms will reoccur in future and this information will inform these events.

#### **7.4.1.2 Prospect Reservoir Acceptance Criteria**

Water can be pumped from Prospect Reservoir to supply Prospect WFP. Pumping may be undertaken to manage water levels and water quality in the reservoir, supplement supply when other sources are unavailable due to maintenance or to improve the quality of water supplied to Prospect WFP. Commencement of pumping from Prospect Reservoir is usually subject to water quality meeting the acceptance criteria. The acceptance criteria comprise specific water quality analytes with agreed limits.

Water was pumped from Prospect Reservoir during August-September when repairs to the Upper Canal were being undertaken. This involved 25 days of pumping approximately 4,900 ML from Prospect Reservoir to Prospect WFP. There were also two periods of 8 days each in November (approximately 1,600 ML) and June 2018 (approximately 1,200 ML). In addition to pumping periods, the reservoir was on stand-by during maintenance programs where supply from the Warragamba Pipelines was restricted. Special monitoring for acceptance criteria was undertaken in Prospect Reservoir during these periods, either prior to pumping or during pumping from the reservoir.

During 2017-18 Prospect Reservoir was sampled on 69 days, the majority being for routine monitoring but was also supplemented by special monitoring for acceptance criteria. High frequency water monitoring has shown that water quality is generally stable within the reservoir and within the acceptance criteria for pumping. There are at times seasonal trends for algae and taste and odour, which are captured under the routine monitoring program.

Acceptance criteria monitoring also includes extensive monitoring in the Upper Canal and Warragamba Pipelines, the usual sources of supply to Prospect WFP. A review of the water monitoring program has recommended that the Upper Canal at Prospect be routinely monitored on a fortnightly basis, similar to the existing frequency for the Warragamba Pipelines. This will provide regular information on all sources to the supply shandy which will inform shandy projections if Prospect Reservoir is required to be online at short notice.

#### **7.4.1.3 Glyphosate Monitoring in Prospect Reservoir**

In 2014, *Ludwigia peruviana* was identified by WaterNSW staff growing predominantly on the south and western sides of Prospect Reservoir. In NSW, *L. peruviana* is a Class 3 regionally controlled weed. Native to Central and South America, it is a large, perennial, wetland shrub growing to 4 m. In 2016,

WaterNSW gained 'off label' approval from the Australian Pesticides and Veterinary Medicines Authority (APVMA) to spray stands of *L. peruviana* in Prospect Reservoir using Roundup Biactive herbicide (containing 360 g/L glyphosate). A condition of the permit granted by APVMA was that WaterNSW monitor for glyphosate and aminomethylphosphonic acid (AMPA), its principal degradation product after spraying and could only release water for supply if any detectable residues were below Australian Drinking Water Guideline values.

In 2018 12 water samples were collected and analysed for the presence of glyphosate and AMPA in the reservoir. Samples were collected prior to spraying, immediately after spraying and several weeks following spraying prior to the reservoir being returned online for supply mode. All water samples collected were below <10 µg/L (limits of reporting) and the ADWG guideline value of 1 mg/L for glyphosate (and AMPA) in drinking water.

## **7.4.2 Scientific research**

### **7.4.2.1 Completed Projects**

#### ***Macroinvertebrate monitoring program data review***

The macroinvertebrate monitoring program (MMP) consists of annual spring AUSRIVAS sampling at sites across the declared catchment areas. A data review was carried out on the existing 15-year macroinvertebrate dataset from selected core sites of the MMP. The review objectives were to:

- Identify spatiotemporal trends in macroinvertebrate community health;
- Investigate relationships between environmental variables, catchment land use and macroinvertebrate community composition; and,
- Determine the level of site replication required to detect a change in macroinvertebrate health at the sub-catchment scale.

The data review identified sites where significant trends in macroinvertebrate health were evident, and highlighted the specific habitat, environmental and land use variables most important in structuring macroinvertebrate communities in the Sydney catchment area. The review showed that a higher level of site replication is required to reliably detect trends in macroinvertebrate health at the sub-catchment scale. The review provided several recommendations for modifications to the MMP to improve the program design.

#### ***Kangaroo Valley and Robertson onsite sewage evaluation study: post sewer assessment***

This study assessed the water quality benefits of installing reticulated sewerage systems in the Kangaroo Valley and Robertson townships. A suite of pharmaceutical and personal care products (PPCPs) were monitored as tracers of human sewage pollution, as well as dissolved nutrients, *E. coli*, and physical and chemical water quality variables. PPCPs were detected in local waterways of both towns prior to sewerage, and in follow-up monitoring carried out three years following installation of sewerage systems. In 2017 an additional four rounds of wet-weather event sampling were carried out four years after sewerage to capture flow conditions more representative of the pre-sewerage sampling period. The diminishing frequency of PPCP detections with time indicated that an extended lag time may be required for residual PPCP pollution to be flushed from the catchment. A reduction in total and

oxidized nitrogen also showed that sewerage was effective in ameliorating nutrient pollution in watercourses within one of the towns.

#### **7.4.2.2 Ongoing Projects**

##### ***Natural Organic Matter Investigation***

The project is a joint initiative with Sydney Water to address problems associated with natural organic matter (NOM) in raw water in the Nepean catchment. Better management of NOM in raw water will enable increased water production and reduce treatment costs, improving the continuity of supply and reducing overall cost to the end consumer. After preliminary monitoring last financial year, a three year ARC-Linkage project involving dry weather sampling on a monthly basis began in September 2017. Event driven monitoring has also occurred to investigate NOM character shifts due to wet weather events.

Results to date from advanced NOM characterization techniques have shown some anomalies in NOM profiles in some samples. This is being further investigated to determine if these compounds are the cause of treatment performance decline. Climatic and environmental conditions are also being assessed in the lead up to anomalous NOM events to determine whether these events can be predicted. Monitoring has been extended into next financial year to capture more of these events to assess predictive capacity of monitoring climatic conditions.

##### ***Proposed Koi herpes virus release***

As part of the National Carp Control Program, DPI Fisheries propose to release Koi herpes virus (KHV) in 2020 to control European carp in Australian waterways. If the release goes ahead in WaterNSW storages, there is a concern that in the short term the resulting fish kill could have a significant impact on water quality.

##### **Phase 1 Investigation into chemicals and compounds released from decaying carp**

A field based mesocosm trial of the potential water quality impacts of decaying carp has been completed. The results from the trial were presented at the Australian Society for Limnology Conference in September 2017 and at the Oz Water Conference in May 2018. More detailed results on phytoplankton biomass and succession are to be presented at the Australian Freshwater Science Society September 2018. Results from the experiments show linear relationships between dead carp biomass and nutrient release, chlorophyll *a* and algal biomass response. These results will be combined with biomass results to predict water quality changes from a fish kill caused by the virus.

##### **Phase 2 Biomass surveys of carp in WaterNSW drinking water reservoirs**

Surveys have been completed in Prospect Reservoir and Lake Burragorang using varying techniques including sonar, electrofishing and netting. Surveys in Wingecarribee, Fitzroy Falls and Lake Yarrunga are to be completed by December 2018. Completed surveys show low numbers of carp (< 200 kg/ha) in Prospect Reservoir and Lake Burragorang.

##### ***Compilation of mining monitoring, spatial databases and development of mining consequence thresholds.***

Assessing and managing risks from mining, particularly from mining-induced subsidence from underground mining within the Special Areas, requires development of consequence

thresholds. These thresholds assist us to rank the risks of mining proposals to WaterNSW values in terms of project-specific and cumulative reductions in water yields, water quality and ecological integrity. WaterNSW has developed the consequence thresholds with internal subject-matter experts and has since consulted with a range of stakeholders about them, including government agencies, industry and community representatives. It is proposed that the thresholds will be embedded within an assessment framework which, if approved, will inform WaterNSW's policy and approach to future mining proposals.

Several research projects are being progressed to support the refinement of the consequence thresholds and to address key knowledge gaps about project-level and cumulative impacts from mining on WaterNSW values. The prioritised projects are seeking to develop appropriate interpretative approaches and tools for (a) quantifying project and cumulative water losses from undermined streams and swamps and (b) assessing catchment and raw water quality impacts based on quantification of pollutant loads from mining areas into downstream storages.

Data sharing agreements between WaterNSW and the mining companies operating in Special Areas have been negotiated. Implementation of these agreements is enabling WaterNSW to acquire and compile most of the monitoring data used for regulatory reporting. Development of confidential databases with company-sourced environmental and catchment monitoring data are being progressed.

### ***Benthic Cyanobacteria***

Samples were collected in four WaterNSW lakes as part of a nationwide survey of benthic cyanobacteria across Australia for a Water Research Australia collaborative industry project. The samples were analysed at Adelaide University for the presence of toxins, taste and odour compounds and the genes associated with production of these compounds. Like many locations around the country, waterbodies managed by WaterNSW had cyanotoxins and taste and odour compounds present in benthic samples. The project is broad and further investigation is needed to verify the results as the genes associated with toxin and taste and odour compound production were rarely detected.

### ***Fluorescence project***

Online monitoring using fluorescence probes was undertaken in the Wingecarribee Reservoir as part of an Australian Research Council Linkage grant: On-line monitoring of cyanobacteria to predict coagulant doses and powdered activated carbon application in water treatment (LP130100033). The monitoring at Wingecarribee Reservoir inlet will be used to both assess the accuracy and precision of commercial fluorometers for the monitoring of cyanobacteria in Australian natural waters and to understand the utility of fluorescence probes for treatment optimisation. Concurrent monitoring in the water filtration plant also occurred during this period.

## 8 Incidents and events

Water quality incidents are managed in accordance with the WaterNSW Water Quality Incident Response Plan. The plan sets out agreed water quality trigger levels for various actions and notifications. Any issue that poses a potential risk to public health is reported to NSW Health immediately and incident responses are developed in consultation with NSW Health and relevant customers.

The Water Monitoring Program also specifies monitoring required in anticipation of events which pose potential threats to raw water quality, such as large inflow events and seasonal turnover in lakes. The pre-planned monitoring during periods leading to and during such events allows operational changes to be made proactively and prevents such events manifesting into incidents.

During 2017–18 there were three major, two significant and 11 minor water quality incidents recorded in the Sydney catchment area (see Appendix C for details of these incidents). A further 26 ‘events’ were recorded indicating hazards with a potential water quality impact, such as animals falling into the Upper Canal. Some animals, such as cattle, can carry large numbers of pathogenic organisms like *Giardia*, which may be infectious to humans. If a high risk animal is found in the Upper Canal, the water can be diverted away from direct supply to the water filtration plant and into Prospect Reservoir. Other animals, such as wallabies pose less of a risk and can simply be removed.

### 8.1 Major and significant water quality incidents

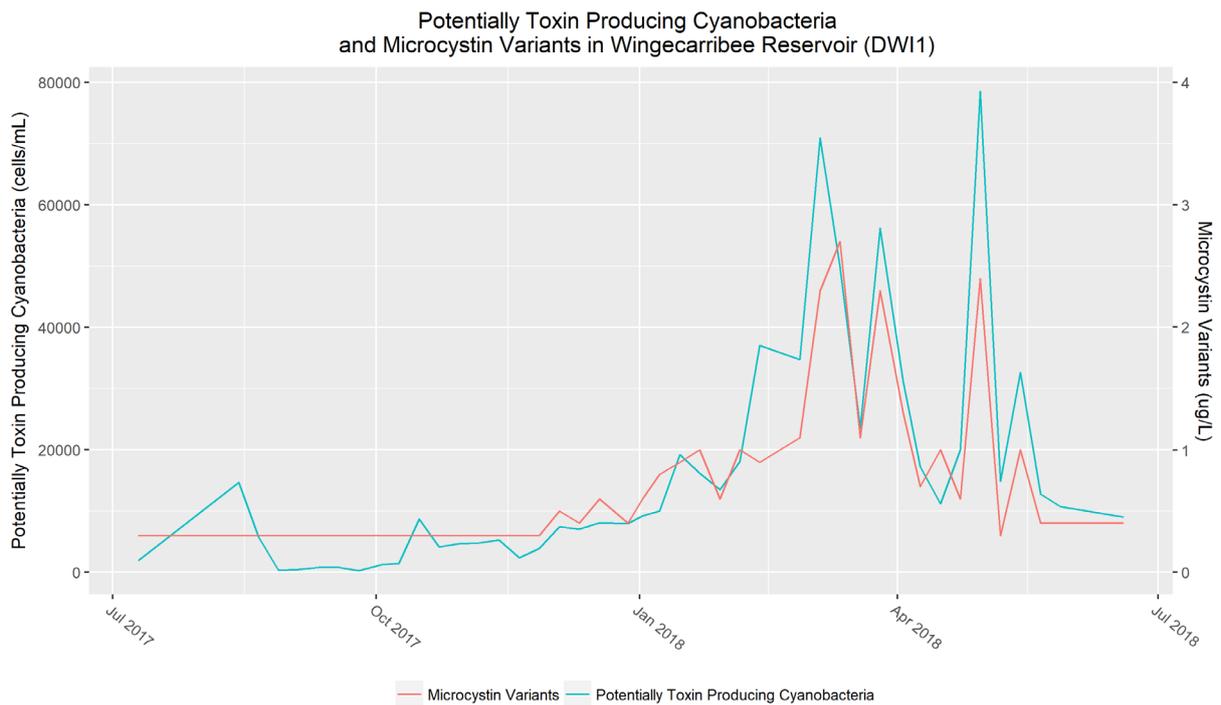
There were three major and two significant incidents relating to water quality during 2017-18. Details of these incidents and their management are provided in Appendix C. Prompt notifications and effective incident response ensured no reported issues or customer complaints relating to the water supply. Examples of incident management response for major and significant incidents are discussed in detail below.

#### 8.1.1 Potentially toxin producing cyanobacteria in Wingecarribee Reservoir

A bloom of potentially toxin producing algae persisted in the storage for most of 2017-18 (see Figure 8.1). A composite sample from 0-6 m depth in the lake on 14 August 2017 contained a combined biovolume of 1.579 mm<sup>3</sup>/L of potential toxin producing species, including the genera *Microcystis* and *Nostocaceae*. Both of these algae are capable of producing microcystin toxin but toxins remained below the level of detection in 2017. After declining through late spring, algal cell counts started to increase again from November and biovolume exceeded minor incident level again from January, increasing to major incident levels in February 2018. The second bloom was dominated by *Microcystis* and *Radiocystis* algae and microcystin toxins were detected in the composite lake sample and in raw water supplied to the water filtration plant. Maximum cell count in the lake reached 80,345 cells/mL (biovolume 1.233 mm<sup>3</sup>/L) of potential toxin producing algae on 30 April 2018, and a peak of 28,557 cells/mL (biovolume 0.428 mm<sup>3</sup>/L) in the raw water supply on 19 March 2018. Total toxins (microcystin variants) peaked in the lake on 12 March 2018 with 2.7 µg/L and in the raw water supply on 14 May 2018 at 1.2 µg/L (drinking water guideline is 1.3 µg/L). Potentially toxic cell counts and biovolume

remained elevated into June and July, but the associated microcystin toxin declined to below the limit of detection.

Algal blooms are naturally common in Wingecarribee Reservoir and the Wingecarribee Water Filtration Plant has been designed to manage algal cells and toxins using Dissolved Air Flootation and Powdered Activated Carbon (PAC). PAC dosing continued throughout this event and the water was successfully treated to meet ADWG with no increase in customer complaints. Following advice from NSW Health, Wingecarribee Shire Council tested treated water but no toxins were detected, confirming effectiveness of treatment processes.



**Figure 8.1: Potentially toxin producing cyanobacteria and microcystin toxin variants in Wingecarribee Reservoir (DW11).**

### 8.1.2 Potential filter clogging algae (Algal ASU)

Algal Areal Standard Units (ASU) is a measure of the filter clogging potential of large or colony forming microalgae. This is not directly related to algal toxicity and it is typically non-toxic species such as diatoms that can clog filters and reduce production in filtration plants. The ability to cope with high algal ASU varies between filtration plants, so different target levels have been set at different sites, as documented in the relevant Raw Water Supply Agreements.

Only one sample breached Raw Water Supply Agreement standards during the year, being a result for algal ASU in raw water supplied to Illawarra Water Filtration Plant in November 2017. The site specific standard for ASU at Illawarra is 5,000 ASU/mL but a sample of raw water taken on 1 November returned a value of 8,104.4 ASU/mL, resulting in the incident being escalated to a major incident. The diatom *Urosolenia* was dominant in the sample, increasing from minor incident level in September 2017. Weekly sampling was implemented and another high result of 5,817 ASU/mL was observed on 20 December 2017, this time due to the large green algae, *Micrasterias*, which was not observed in the equivalent sample from Lake Avon. This taxa is not identified as a filter clogging risk, rarely detected and was not expected to cause an ongoing issue. The plant operator responded that the plant was performing normally. Total algae ASU levels decreased significantly from January 2018.

Two other incidents involving algal ASU in November 2017 were classified as significant, including raw water supplied to Nepean and Cascades WFPs. Both lakes were also impacted by large numbers of the diatom *Urosolenia* but levels remained below the major incident trigger of 2,000 ASU/mL. WaterNSW provided regular updates to the water filtration plants and in the case of Nepean, recommended moving the supply outlet to deeper in the water column. Sydney Water responded that they were having no issues treating the water and preferred to maintain the outlet at the higher level to avoid colour from deeper water.

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WaterNSW – Sydney Catchment Area

# Annual Water Quality Monitoring Report

2017-18

Appendices

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## Appendix A Statistical summaries

### 1. Warragamba system

Table A1 Warragamba system – catchments – benchmarked characteristics

Station Code	Statistic	Dissolved Oxygen (%Sat)	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)
E0114	n	12	12	12	12	12	12	12	12
	Min	73.7	8.2	0.9	0.3	0.014	0.005	0.02	0.005
	Median	96	8.4	1.3	0.37	0.045	0.008	0.06	0.03
	Max	97.8	8.6	4.6	0.52	0.079	0.23	0.4	0.06
	Above Max Guideline	0	12	0	12	10	4	12	7
	Below Min Guideline	4	0	-	-	-	-	-	-
E0115	n	12	12	12	12	12	12	12	12
	Min	92	8.6	1.2	0.28	0.02	0.005	0.002	0.003
	Median	104.6	8.9	2.9	0.43	0.04	0.005	0.019	0.009
	Max	110.4	9.1	13.9	0.86	0.097	0.09	0.17	0.03
	Above Max Guideline	1	12	0	12	11	4	6	2
	Below Min Guideline	0	0	-	-	-	-	-	-
E0321	n	12	12	12	12	12	12	12	12
	Min	93.7	8.6	1	0.35	0.006	0.005	0.22	0.001
	Median	101.9	8.8	3.5	0.52	0.013	0.08	0.4	0.005
	Max	118.7	8.9	7.6	0.65	0.02	0.15	0.5	0.01
	Above Max Guideline	2	12	0	12	0	10	12	0
	Below Min Guideline	0	0	-	-	-	-	-	-
E046	n	12	12	12	12	12	12	12	12
	Min	80.2	7.6	0.7	0.6	0.016	0.005	0.24	0.005
	Median	96.1	7.8	1.9	1.15	0.037	0.009	0.95	0.02
	Max	103.6	8.1	27.5	3.4	0.09	0.05	2.65	0.05
	Above Max Guideline	0	2	1	12	10	3	12	6
	Below Min Guideline	3	0	-	-	-	-	-	-
E083	n	12	12	12	12	12	12	12	12
	Min	80.3	7.9	0.9	0.13	0.005	0.005	0.002	0.001
	Median	95.6	8.1	2.9	0.23	0.009	0.005	0.004	0.003
	Max	99.4	8.3	6.1	0.43	0.02	0.03	0.024	0.006
	Above Max Guideline	0	11	0	5	2	2	2	0
	Below Min Guideline	2	0	-	-	-	-	-	-
E130	n	12	12	12	12	12	12	12	12
	Min	74.1	7.3	0.3	0.05	0.005	0.005	0.002	0.001
	Median	94.2	7.5	1.7	0.18	0.009	0.005	0.014	0.003
	Max	103.2	8.8	3.4	0.55	0.04	0.03	0.095	0.006
	Above Max Guideline	0	1	0	1	2	1	6	0
	Below Min Guideline	4	0	-	-	-	-	-	-
E157	n	12	12	12	12	12	12	12	12
	Min	72	6.8	0.8	0.24	0.005	0.005	0.004	0.001
	Median	93.7	7.0	3.0	0.33	0.007	0.005	0.16	0.002
	Max	99	7.5	9.3	0.51	0.02	0.03	0.47	0.005
	Above Max Guideline	0	0	0	11	0	3	11	0
	Below Min Guideline	3	0	-	-	-	-	-	-
E203	n	12	12	12	12	12	12	12	12
	Min	81.8	7.2	1.2	0.39	0.005	0.007	0.26	0.001
	Median	95	7.7	2.0	4.13	0.05	0.02	2.95	0.01

	Max	101.8	7.8	15.5	8.82	0.4	3.7	4.93	0.28
	Above Max Guideline	0	0	0	12	11	10	12	2
	Below Min Guideline	2	0	-	-	-	-	-	-
E206	n	12	12	12	12	12	12	12	12
	Min	67.7	7.4	0.7	0.61	0.005	0.005	0.3	0.001
	Median	97.8	7.7	1.4	0.81	0.01	0.01	0.69	0.003
	Max	102.2	8.5	44.6	1.94	0.04	0.05	1.31	0.01
	Above Max Guideline	0	1	1	12	2	4	12	0
	Below Min Guideline	2	0	-	-	-	-	-	-
E210	n	12	12	12	12	12	12	12	12
	Min	81.3	7.3	2.3	0.23	0.005	0.005	0.002	0.001
	Median	92.2	7.7	4.6	0.31	0.011	0.01	0.016	0.002
	Max	99.4	7.9	8.6	0.46	0.02	0.02	0.18	0.014
	Above Max Guideline	0	0	0	9	1	4	6	0
	Below Min Guideline	4	0	-	-	-	-	-	-
E243	n	12	12	12	12	12	12	12	12
	Min	87.8	6.7	0.2	0.01	0.005	0.005	0.002	0.001
	Median	96.6	6.9	0.9	0.065	0.005	0.005	0.005	0.003
	Max	101.3	7.5	3	0.28	0.02	0.01	0.23	0.005
	Above Max Guideline	0	0	0	1	0	0	1	0
	Below Min Guideline	2	0	-	-	-	-	-	-
E332	n	12	12	12	12	12	12	12	12
	Min	59	7.1	4.9	0.53	0.02	0.005	0.002	0.001
	Median	93.4	7.9	7.0	0.76	0.02	0.02	0.39	0.002
	Max	106.8	8.6	15.8	0.99	0.04	0.19	0.52	0.009
	Above Max Guideline	0	4	0	12	9	6	10	0
	Below Min Guideline	5	0	-	-	-	-	-	-
E409	n	24	24	24	24	24	24	24	24
	Min	40.7	7.2	2.31	0.29	0.01	0.005	0.002	0.002
	Median	92.8	7.8	4.4	0.6	0.04	0.005	0.002	0.006
	Max	110.3	8.3	19.9	1.74	0.17	0.07	0.34	0.07
	Above Max Guideline	2	8	0	24	22	5	7	6
	Below Min Guideline	12	0	-	-	-	-	-	-
E4122	n	12	12	12	12	12	12	12	12
	Min	21	6.9	2.01	0.24	0.005	0.005	0.002	0.001
	Median	56.5	7.5	3	0.44	0.016	0.006	0.003	0.004
	Max	94.8	8.0	76.4	2	0.14	0.33	0.69	0.03
	Above Max Guideline	0	0	4	10	5	3	1	1
	Below Min Guideline	8	0	-	-	-	-	-	-
E450	n	9	9	9	9	9	9	9	9
	Min	95.1	7.6	1.9	0.22	0.005	0.005	0.002	0.001
	Median	100.4	8.0	3.1	0.4	0.007	0.005	0.006	0.002
	Max	105.9	8.2	5.3	0.62	0.015	0.031	0.09	0.005
	Above Max Guideline	0	5	0	7	0	1	2	0
	Below Min Guideline	0	0	-	-	-	-	-	-
E457	n	12	12	12	12	12	12	12	12
	Min	71.2	7.1	1	0.71	0.03	0.005	0.002	0.002
	Median	97.5	8.2	4.7	1	0.08	0.08	0.12	0.03
	Max	138.8	9.2	12.3	1.87	0.4	0.42	0.19	0.2
	Above Max Guideline	2	7	0	11	11	9	8	9
	Below Min Guideline	4	0	-	-	-	-	-	-
E488	n	12	12	12	12	12	12	12	12
	Min	84.2	7.9	1.2	0.18	0.005	0.005	0.002	0.001
	Median	103.6	8.2	3.3	0.39	0.006	0.005	0.006	0.001
	Max	117.1	8.7	7.4	0.86	0.02	0.02	0.09	0.002
	Above Max Guideline	2	11	0	11	0	1	3	0
	Below Min Guideline	1	0	-	-	-	-	-	-
E531	n	12	12	12	12	12	12	12	12
	Min	33.9	6.0	1.8	0.08	0.005	0.006	0.002	0.001
	Median	63.8	6.8	3.6	0.12	0.008	0.01	0.008	0.002
	Max	88.6	7.6	5.8	0.21	0.03	0.03	0.08	0.005
	Above Max Guideline	0	0	0	1	1	6	4	0
	Below Min Guideline	12	3	-	-	-	-	-	-
E551	n	4	4	4	4	4	4	4	4
	Min	41.2	6.3	0.2	0.08	0.006	0.005	0.002	0.002
	Median	62.2	7.0	0.4	0.14	0.01	0.005	0.01	0.003
	Max	77.8	7.3	3.3	0.44	0.09	0.02	0.05	0.01
	Above Max Guideline	0	0	0	1	1	1	2	0
	Below Min Guideline	4	1	-	-	-	-	-	-

Station Code	Statistic	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Conductivity Field (mS/cm)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)
E0114	n	12	12	12	12	12	0	0	0
	Min	0.01	0.03	0.012	0.54	2.4	-	-	-
	Median	0.02	0.05	0.022	0.67	3.1	-	-	-
	Max	0.15	0.24	0.031	0.75	4.6	-	-	-
	Above Max Guideline	1	-	0	12	0	-	-	-
Below Min Guideline	-	-	-	-	-	-	-	-	
E0115	n	12	12	12	12	12	7	4	7
	Min	0.02	0.05	0.019	0.69	1.4	0	LOR	0
	Median	0.04	0.07	0.0355	1.1	5.35	1330	LOR	1
	Max	0.38	0.61	0.097	1.19	28.2	83770	LOR	20.3
	Above Max Guideline	1	-	0	12	7	1	0	1
Below Min Guideline	-	-	-	-	-	-	-	-	
E0321	n	12	12	12	12	12	0	0	0
	Min	0.06	0.07	0.01	1.20	0.7	-	-	-
	Median	0.14	0.14	0.019	1.26	1.75	-	-	-
	Max	0.21	0.21	0.061	1.4	3.2	-	-	-
	Above Max Guideline	12	-	0	12	0	-	-	-
Below Min Guideline	-	-	-	-	-	-	-	-	
E046	n	12	12	12	12	12	4	0	4
	Min	0.01	0.07	0.008	0.22	0.7	0	-	0
	Median	0.04	0.17	0.018	0.41	1.35	0	-	0.002
	Max	0.4	0.56	0.026	0.59	11.7	0	-	0.006
	Above Max Guideline	3	-	0	7	4	0	-	0
Below Min Guideline	-	-	-	-	-	-	-	-	
E083	n	12	12	12	12	13	2	1	2
	Min	0.02	0.06	0.007	0.22	0.7	0	LOR	0
	Median	0.04	0.11	0.032	0.4	2.8	0	LOR	0
	Max	0.08	0.22	0.079	0.53	7.9	0	LOR	0
	Above Max Guideline	2	-	0	8	2	0	0	0
Below Min Guideline	-	-	-	-	-	-	-	-	
E130	n	12	12	12	12	12	2	0	2
	Min	0.01	0.1	0.004	0.09	0.4	0	-	0
	Median	0.025	0.13	0.014	0.12	1.4	0	-	0.005
	Max	0.12	0.54	0.059	0.16	16.2	0	-	0.009
	Above Max Guideline	1	-	0	0	2	0	-	0
Below Min Guideline	-	-	-	-	-	-	-	-	
E157	n	12	12	12	12	12	0	0	0
	Min	0.01	0.11	0.003	0.06	0.2	-	-	-
	Median	0.045	0.27	0.013	0.07	0.8	-	-	-
	Max	0.2	0.46	0.032	0.09	3.6	-	-	-
	Above Max Guideline	3	-	0	0	0	-	-	-
Below Min Guideline	-	-	-	-	-	-	-	-	
E203	n	12	12	12	12	12	2	0	2
	Min	0.03	0.05	0.016	0.22	0.6	0	-	0
	Median	0.48	0.19	0.037	0.52	2.3	0	-	0
	Max	0.75	0.47	0.093	0.60	8.9	0	-	0
	Above Max Guideline	11	-	0	11	2	0	-	0
Below Min Guideline	-	-	-	-	-	-	-	-	
E206	n	12	12	12	12	12	1	0	1
	Min	0.02	0.06	0.004	0.2	0.7	402	-	0.026
	Median	0.03	0.11	0.013	0.38	1.7	402	-	0.026
	Max	0.73	0.89	0.088	0.46	8.1	402	-	0.026
	Above Max Guideline	3	-	0	8	1	0	-	0
Below Min Guideline	-	-	-	-	-	-	-	-	
E210	n	12	12	12	12	12	7	0	7
	Min	0.02	0.17	0.039	0.29	1.1	0	-	0.001
	Median	0.05	0.38	0.071	0.37	6.7	0	-	0.009
	Max	0.1	1.07	0.14	0.41	11.2	332	-	0.077
	Above Max Guideline	6	-	0	7	7	0	-	0
Below Min Guideline	-	-	-	-	-	-	-	-	
E243	n	12	12	12	12	12	0	0	0
	Min	0.01	0.08	0.006	0.13	0.2	-	-	-
	Median	0.02	0.21	0.016	0.14	1.1	-	-	-

	Max	0.03	0.5	0.06	0.17	5	-	-	-
	Above Max Guideline	0	-	0	0	0	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
E332	n	12	12	12	12	12	11	0	11
	Min	0.06	0.17	0.028	0.24	4.2	0	-	0
	Median	0.24	0.38	0.069	0.31	19.5	0	-	0.058
	Max	0.39	0.6	0.15	0.36	97.3	842	-	0.21
	Above Max Guideline	12	-	0	2	11	0	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E409	n	12	12	12	24	24	12	1	12
	Min	0.03	0.14	0.028	0.35	4.6	0	LOR	0
	Median	0.07	0.32	0.099	0.78	13	0	LOR	0.016
	Max	0.4	0.95	0.17	1.1	57.5	1140	LOR	0.185
	Above Max Guideline	10	-	0	22	23	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E4122	n	12	12	12	12	12	5	0	5
	Min	0.01	0.21	0.009	0.23	3.1	0	-	0.003
	Median	0.02	0.52	0.076	0.62	4.55	0	-	0.008
	Max	1.38	4.78	0.63	0.70	119.6	0	-	0.203
	Above Max Guideline	1	-	0	11	5	0	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E450	n	9	9	9	9	9	5	0	5
	Min	0.03	0.15	0.013	0.39	2.8	0	-	0
	Median	0.07	0.18	0.027	0.53	5.2	0	-	0.001
	Max	0.14	0.82	0.063	0.81	11.7	0	-	0.002
	Above Max Guideline	5	-	0	9	5	0	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E457	n	12	12	12	12	12	12	6	12
	Min	0.04	0.12	0.047	0.36	6.3	0	LOR	0
	Median	0.13	0.35	0.19	0.94	16.65	2646	LOR	0.108
	Max	0.58	1.8	0.47	1.11	31.3	121500	LOR	2.88
	Above Max Guideline	8	-	0	12	12	1	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E488	n	12	12	12	12	12	4	1	4
	Min	0.03	0.11	0.006	0.27	1.2	0	LOR	0
	Median	0.06	0.16	0.028	0.6	3.2	0	LOR	0.0055
	Max	0.17	0.45	0.071	0.86	12.1	2780	LOR	0.301
	Above Max Guideline	6	-	0	10	4	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E531	n	12	12	12	12	12	2	0	2
	Min	0.03	0.37	0.06	0.29	1.3	0	-	0.002
	Median	0.05	0.91	0.17	0.33	3.2	0	-	0.002
	Max	0.11	1.49	0.53	0.4	6.5	0	-	0.002
	Above Max Guideline	4	-	0	4	2	0	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E551	n	4	4	4	4	4	1	0	1
	Min	0.01	0.11	0.026	0.35	0.2	0	-	0.06
	Median	0.01	0.12	0.033	0.39	0.3	0	-	0.06
	Max	0.05	1.82	0.76	0.46	16.8	0	-	0.06
	Above Max Guideline	0	-	0	3	1	0	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-

**Table A2 Warragamba system – catchments – *Cryptosporidium* and *Giardia***

Station Code	Statistic	<i>Cryptosporidium</i> IFA (Adj for Recovery for 10L)	<i>Giardia</i> cysts IFA (Adj for Recovery to 10L)
E531	n	51	51
	Min	0	0
	Median	0.04	0
	Max	2.1	0
	Above Max Guideline	1	0
	Below Min Guideline	-	-
E083	n	12	12
	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-
E488	n	12	12
	Min	0	0

	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-
	n	12	12
E243	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-
E210	n	12	12
	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
E130	Below Min Guideline	-	-
	n	12	12
	Min	0	0
	Median	0	0
	Max	0	0
E157	Above Max Guideline	-	-
	Below Min Guideline	-	-
	n	12	12
	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-
	n	12	12
	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-
	n	12	12

**Table A3 Warragamba system – storages – benchmarked characteristics**

Station Code	Statistic	Dissolved Oxygen (mg/L)	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)
DWA12	n	26	26	26	26	26	26	26	26
	Min	67.2	7.2	0.3	0.1	0.005	0.005	0.002	0.001
	Median	94.5	7.9	0.7	0.32	0.005	0.005	0.03	0.001
	Max	109.4	8.7	1.9	0.41	0.013	0.052	0.126	0.006
	Above Max Guideline	0	12	0	21	0	3	18	1
	Below Min Guideline	11	0	-	-	-	-	-	-
DWA15	n	6	6	6	6	6	6	6	6
	Min	79.4	7.4	0.6	0.18	0.01	0.01	0.00	0.00
	Median	81.9	7.7	0.8	0.29	0.01	0.01	0.03	0.00
	Max	103.6	8.6	1.1	0.34	0.01	0.10	0.10	0.00
	Above Max Guideline	0	2	0	5	0	2	3	0
	Below Min Guideline	4	0	-	-	-	-	-	-
DWA19	n	6	6	6	6	6	6	6	6
	Min	85.2	7.6	0.8	0.26	0.01	0.01	0.00	0.00
	Median	89.3	7.8	1.5	0.31	0.01	0.01	0.02	0.00
	Max	104.4	8.2	2.2	0.35	0.01	0.02	0.09	0.00
	Above Max Guideline	0	2	0	6	0	2	3	0
	Below Min Guideline	3	0	-	-	-	-	-	-
DWA2	n	26	26	26	26	26	26	26	26
	Min	80.1	7.5	0.3	0.20	0.01	0.01	0.00	0
	Median	99.9	8	0.5	0.31	0.01	0.01	0.04	0
	Max	110.9	8.8	1.1	0.44	0.01	0.02	0.15	0
	Above Max Guideline	1	13	0	23	0	2	16	0
	Below Min Guideline	8	0	-	-	-	-	-	-
DWA21	n	6	6	6	6	6	6	6	6
	Min	83.1	7.6	0.8	0.25	0.01	0.01	0	0
	Median	88.3	7.7	1.1	0.33	0.01	0.01	0	0
	Max	104.9	8.3	1.7	0.35	0.01	0.02	0.07	0
	Above Max Guideline	0	2	0	5	0	1	3	0
	Below Min Guideline	3	0	-	-	-	-	-	-
DWA27	n	26	26	26	26	26	26	26	26
	Min	69	7.3	0.5	0.1	0.005	0.005	0.002	0.001

	Median	96.2	8.	0.8	0.33	0.005	0.005	0.0405	0.001
	Max	111.3	8.8	1.5	4.07	0.007	0.035	1.92	0.003
	Above Max Guideline	2	13	0	22	0	2	19	0
	Below Min Guideline	10	0	-	-	-	-	-	-
DWA311	n	6	6	6	6	6	6	6	6
	Min	77.5	7.5	0.7	0.08	0.005	0.005	0.002	0.001
	Median	92.5	7.9	0.8	0.315	0.005	0.005	0.0305	0.001
	Max	105	8.6	2.9	0.36	0.006	0.007	0.106	0.001
	Above Max Guideline	0	3	0	5	0	0	3	0
	Below Min Guideline	2	0	-	-	-	-	-	-
DWA39	n	6	6	6	6	6	6	6	6
	Min	86.9	7.7	1.1	0.24	0.01	0.01	0.00	0
	Median	93	7.9	2	0.34	0.01	0.01	0.06	0
	Max	97.3	8.1	4.9	0.37	0.01	0.01	0.09	0
	Above Max Guideline	0	1	0	5	0	1	4	0
	Below Min Guideline	1	0	-	-	-	-	-	-
DWA9	n	26	26	26	26	26	26	26	26
	Min	73	7.3	0.3	0.180	0.005	0.005	0.002	0.001
	Median	96	7.9	0.7	0.315	0.005	0.005	0.046	0.001
	Max	109.5	8.6	2	0.450	0.010	0.012	0.157	0.003
	Above Max Guideline	0	13	0	23	0	3	18	0
	Below Min Guideline	8	0	-	-	-	-	-	-
RPR1	n	58	58	58	12	12	12	12	12
	Min	93.7	7.5	0.7	0.15	0.005	0.005	0.002	0.001
	Median	99.1	7.7	1.1	0.22	0.005	0.005	0.005	0.001
	Max	106.1	8.1	1.9	0.24	0.005	0.024	0.052	0.003
	Above Max Guideline	0	1	0	0	0	3	4	0
	Below Min Guideline	0	0	-	-	-	-	-	-
RPR6	n	57	57	57	6	6	6	6	6
	Min	91.7	7.3	0.9	0.14	0.01	0.01	0.00	0
	Median	99	7.7	1.4	0.20	0.01	0.01	0.01	0
	Max	106	8	2.7	0.25	0.01	0.01	0.03	0
	Above Max Guideline	0	0	0	0	0	1	2	0
	Below Min Guideline	0	0	-	-	-	-	-	-

Station Code	Statistic	Total Manganese (mg/L)	Total Aluminium (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Conductivity Field (mS/cm)	Temperature (°C)
DWA12	n	26	26	26	0	0	0	26	26
	Min	0.001	0.01	1.5	-	-	-	0.19	13
	Median	0.004	0.02	2.7	-	-	-	0.21	20.2
	Max	0.09	0.05	4.3	-	-	-	0.22	26.9
	Above Max Guideline	0	0	0	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DWA15	n	6	6	6	2	0	2	6	6
	Min	0.00	0.01	2.4	0	-	0	0.18	13.1
	Median	0.01	0.02	3.9	0	-	0.01	0.20	20.5
	Max	0.02	0.02	6	0	-	0.02	0.22	26.5
	Above Max Guideline	0	0	2	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DWA19	n	6	6	6	4	0	4	6	6
	Min	0.00	0.02	3.3	0	-	0	0.17	13.4
	Median	0.01	0.02	6.8	0	-	0.02	0.20	21.1
	Max	0.02	0.03	22.1	0	-	0.07	0.22	27.3
	Above Max Guideline	0	0	4	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DWA2	n	26	26	26	26	0	26	26	26
	Min	0.00	0.01	1.9	0	-	0	0.19	13.1
	Median	0.00	0.02	3.	0	-	0.02	0.21	20.6
	Max	0.01	0.03	5.9	293	-	0.08	0.21	25.4
	Above Max Guideline	0	0	1	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DWA21	n	6	6	6	4	0	4	6	6
	Min	0	0.01	5.4	0	-	0	0.17	13.5
	Median	0.01	0.02	8.5	5	-	0.02	0.21	21.4

	Max	0.02	0.02	14	893	-	0.09	0.23	27.2
	Above Max Guideline	0	0	6	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DWA27	n	26	26	26	0	0	0	26	26
	Min	0.001	0.01	1.3	-	-	-	0.2	13.2
	Median	0.003	0.02	2.8	-	-	-	0.21	20.3
	Max	0.035	0.04	4.2	-	-	-	0.22	27.2
	Above Max Guideline	0	0	0	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DWA311	n	6	6	6	1	0	1	6	6
	Min	0.002	0.01	2.6	0	-	0.01	0.2	12.9
	Median	0.004	0.02	3.4	0	-	0.01	0.22	20.4
	Max	0.014	0.07	5.3	0	-	0.01	0.23	26
	Above Max Guideline	0	1	1	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DWA39	n	6	6	6	3	2	3	6	6
	Min	0.01	0.03	2.9	0	LOR	0	0.21	12.9
	Median	0.01	0.05	5.3	2190	LOR	0.2	0.22	20
	Max	0.02	0.12	8.8	3710	LOR	0.2	0.25	26.2
	Above Max Guideline	0	2	5	0	0	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DWA9	n	26	26	26	1	0	1	26	26
	Min	0.001	0.010	1.9	0	-	0.08	0.19	12.9
	Median	0.004	0.020	2.6	0	-	0.08	0.21	20.1
	Max	0.065	0.060	6.7	0	-	0.08	0.22	25.4
	Above Max Guideline	0	1	1	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
RPR1	n	12	12	39	67	39	67	58	58
	Min	0.005	0.03	2.2	0	LOR	0	0.17	12.6
	Median	0.01	0.04	3.2	0	LOR	0.02	0.18	16.8
	Max	0.016	0.05	5.3	1220	LOR	0.3	0.19	26.1
	Above Max Guideline	0	0	4	0	0	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
RPR6	n	6	6	6	1	0	1	57	57
	Min	0.01	0.02	2.1	0	-	0	0.16	12.4
	Median	0.01	0.04	3.3	0	-	0	0.18	16.2
	Max	0.01	0.06	4.5	0	-	0	0.19	26.5
	Above Max Guideline	0	1	0	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-

**Table A4 Warragamba system – storages – *Cryptosporidium* and *Giardia***

Station Code	Statistic	<i>Crypto</i> oocysts IFA (Adj for Recovery for 10L)	<i>Giardia</i> cysts IFA (Adj for Recovery to 10L)
DWA2	n	307	307
	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-
RPR1	n	62	62
	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-
RPR6	n	35	35
	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-

**Table A5 Warragamba system – water filtration plants – benchmarked characteristics**

Station Code	Statistic	Alkalinity (CaCO3 mg/L)	Total Hardness (CaCO3 mg/L)	True Colour at 400 nm	Turbidity (NTU)	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Areal Standard Unit (ASU)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Conductivity Field (mS/cm)
HBR1	n	12	12	12	12	12	12	12	12	12	0	12	12
	Min	41	1	6	0.6	0.02	0.03	0.001	4.14	0	-	0	0.19
	Median	43	50	8	1.7	0.04	0.05	0.006	62	0	-	0	0.2
	Max	49	56	11	2.7	0.06	0.09	0.01	346.3	0	-	0.001	0.21
	Above Max Guideline	0	0	0	0	0	0	0	0	0	0	0	-
	Below Min Guideline	0	1	-	-	-	-	-	-	-	-	-	-
HWA2	n	12	12	12	12	11	11	11	12	12	0	12	12
	Min	40	46	5	0.5	0.01	0.03	0.002	11.1	0	-	0	0.19
	Median	46	50	9	1.3	0.03	0.06	0.002	67.4	0	-	0	0.2
	Max	53	59	11	2.1	0.08	0.1	0.01	441.9	0	-	0.013	0.21
	Above Max Guideline	0	0	0	0	0	0	0	0	0	0	0	-
	Below Min Guideline	0	0	-	-	-	-	-	-	-	-	-	-
PWFP10	n	12	12	12	12	12	12	12	12	12	0	12	12
	Min	33	38	7	0.6	0.03	0.05	0.003	4.2	0	-	0	0.15
	Median	44	47	8	1.6	0.05	0.06	0.006	65.3	0	-	0	0.2
	Max	48	52	10	2.7	0.09	0.1	0.01	334.4	18	-	0.005	0.2
	Above Max Guideline	0	0	0	0	0	0	0	0	0	0	0	-
	Below Min Guideline	0	0	-	-	-	-	-	-	-	-	-	-

**Table A6 Warragamba system – water filtration plants - cyanobacteria**

Station Code	Statistic	Algal Total Count (cells/mL)	Algal Biovolume (mm <sup>3</sup> /mL)	Total Cyanobacterial cell count (cells/mL)	Total Cyanobacterial biovolume (mm <sup>3</sup> /L)	Microcystin LR + RR + YR (µg/L)	Toxic Cyanobacterial cell count (cells/mL)	Toxic Cyanobacterial biovolume (mm <sup>3</sup> /L)
HBR1	n	12	12	12	12	0	12	12
	Min	69	0.004	0	0	-	0	0
	Median	642	0.1	243	0	-	0	0
	Max	3800	0.9	2810	0.001	-	0	0
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-
HWA2	n	12	12	12	12	0	12	12
	Min	104	0.016	0	0	-	0	0
	Median	783	0.2	401	0	-	0	0
	Max	4890	1	3940	0.02	-	0	0.01
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-
PWFP10	n	12	12	12	12	0	12	12
	Min	54	0.01	0	0	-	0	0
	Median	361	0.2	190	0	-	0	0
	Max	5510	1.4	4540	0.005	-	18	0.002
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-

**Table A7 Warragamba system – water filtration plants – indicator bacteria**

Station Code	Statistic	<i>Clostridium perfringens</i> (cfu/100 mL)	<i>E. coli</i> (orgs/100mL)	Enterococci (cfu/100ml)
PWFP10	n	13	13	13
	Min	LOR	LOR	LOR
	Median	LOR	LOR	LOR
	Max	10	18	8
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
HBR1	n	14	14	14
	Min	LOR	LOR	LOR
	Median	LOR	LOR	LOR
	Max	2	LOR	1
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
HWA2	n	14	14	14
	Min	LOR	LOR	LOR
	Median	LOR	LOR	LOR
	Max	LOR	2	1
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-

**Table A8 Warragamba system – water filtration plants – health related physical chemical**

Station Code	Statistic	Arsenic Total (mg/L)	Barium Total (mg/L)	Beryllium-Total (mg/L)	Boron Total (mg/L)	Mercury Total (mg/L)	Molybdenum Total (mg/L)	Selenium Total (mg/L)	Silver Total (mg/L)	Tin Total (mg/L)	Iodide (mg/L)
PWFP10	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.02	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.02	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.02	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-
HBR1	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.02	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.02	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.02	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-
HWA2	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.02	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.02	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.02	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-

**Table A9 Warragamba system – water filtration plants – pesticides**

Station Code	Statistic	2,4-D (ug/L)	Amitrole (ug/L)	Atrazine (ug/L)	Chlorfenvinphos (E) (ug/L)	Chlorpyrifos (ug/L)	Clopyralid (ug/L)	Dichlobenil (ug/L)	Dimethoate (ug/L)	Diuron (ug/L)	Fluroxypyr (ug/L)	Glyphosate (ug/L)	Hexazinone (ug/L)	MCPA (ug/L)
PWFP10	n	4	4	12	12	4	12	4	12	4	4	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
HBR1	n	4	4	12	12	4	12	4	12	4	4	12	12	4

	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HWA2	n	4	4	12	12	4	12	4	12	4	4	12	12	4	
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Max	LOR	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-	
Station Code	Statistic	Azinphos-methyl (ug/L)	Picloram (ug/L)	Triclopyr (ug/L)	Trifluralin (ug/L)	Metsulfuron Methyl (ug/L)	Chlorothalonil (ug/L)	Acephate (ug/L)	Aminopyralid (ug/L)	Fluproprate (ug/L)	Simazine (ug/L)	cis-1,3-Dichloropropene (ug/L)	trans-1,3-Dichloropropene (ug/L)		
PWFP10	n	4	12	12	12	4	4	4	4	4	12	4	4		
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR		
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR		
	Max	LOR	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR		
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-		
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-		
HBR1	n	4	12	12	12	5	4	4	4	4	12	4	4		
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR		
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR		
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	0.00	LOR	LOR		
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-		
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-		
HWA2	n	4	12	12	12	5	4	4	4	4	12	4	4		
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR		
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR		
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR		
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-		
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-		

**Table A10 Warragamba system – water filtration plants – synthetic organic compounds & radionuclides**

Station Code	Statistic	Gross Alpha	Gross Beta	1,1-Dichloroethane (ug/L)	1,2-Dichloroethane (ug/L)	cis-1,2-Dichloroethene (ug/L)	trans-1,2-Dichloroethene (ug/L)	Benzene (ug/L)	Hexachlorobutadiene (ug/L)	Trichloroethene (ug/L)
PWFP10	n	1	1	4	12	12	12	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HBR1	n	1	1	4	12	12	12	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HWA2	n	1	1	4	12	12	12	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-

**Table A11 Warragamba system- water filtration plants- *Cryptosporidium* and *Giardia***

Station Code	Statistic	<i>Cryptosporidium</i> oocysts IFA (Adj for Recovery for 10L)	<i>Giardia</i> cysts IFA (Adj for Recovery to 10L)
HBR1	n	150	150
	Min	0	0
	Median	0.003	0.01
	Max	0.4	0.2
	Above Max Guideline	1	1
	Below Min Guideline	-	-
HWA2	n	142	142
	Min	0	0
	Median	0	0.2
	Max	0.3	0.7
	Above Max Guideline	1	1
	Below Min Guideline	-	-
PWFP10	n	118	118
	Min	0	0
	Median	0	0.1
	Max	0.4	0.3
	Above Max Guideline	2	6
	Below Min Guideline	-	-

## 2. Upper Nepean System

**Table A12 Upper Nepean system – catchments – benchmarked characteristics**

Station Code	Statistic	Dissolved Oxygen (mg/L)	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)
E6006	n	12	12	12	12	12	12	12	12
	Min	65.8	5	1	0.01	0.01	0.005	0.002	0.001
	Median	83.3	5.4	2.7	0.065	0.03	0.005	0.002	0.001
	Max	94	6	9.1	0.69	0.06	0.21	0.06	0.004
	Above Max Guideline	0	0	0	1	7	2	1	0
	Below Min Guideline	10	12	-	-	-	-	-	-
E601	n	12	12	12	12	12	12	12	12
	Min	82.5	7	1.7	0.01	0.005	0.005	0.008	0.001
	Median	97.6	7.3	2.9	0.13	0.007	0.005	0.08	0.003
	Max	103.2	7.6	3.6	0.67	0.01	0.04	0.6	0.009
	Above Max Guideline	0	0	0	4	0	1	10	0
	Below Min Guideline	1	0	-	-	-	-	-	-
E602	n	12	12	12	12	12	12	12	12
	Min	88.8	6.3	1.1	0.01	0.005	0.005	0.002	0.001
	Median	99.6	6.6	2	0.04	0.007	0.005	0.002	0.002
	Max	105.6	7.6	5.2	0.08	0.01	0.01	0.02	0.004
	Above Max Guideline	0	0	0	0	0	0	1	0
	Below Min Guideline	1	6	-	-	-	-	-	-
E604	n	12	12	12	12	12	12	12	12
	Min	42.2	6.2	0.3	0.12	0.005	0.005	0.002	0.001
	Median	87.2	6.8	1	0.245	0.005	0.005	0.2	0.002
	Max	100.2	7	6.7	0.38	0.01	0.01	0.2	0.003
	Above Max Guideline	0	0	0	5	0	0	11	0
	Below Min Guideline	7	1	-	-	-	-	-	-
E608	n	12	12	12	12	12	12	12	12
	Min	67.7	6	1.8	0.05	0.005	0.005	0.04	0.001
	Median	83.8	7.2	3.1	0.18	0.008	0.005	0.1	0.003
	Max	95.2	7.4	7.8	0.28	0.02	0.007	0.2	0.005
	Above Max Guideline	0	0	0	1	0	0	12	0

	Below Min Guideline	9	1	-	-	-	-	-	-
E609	n	12	12	12	12	12	12	12	12
	Min	68.4	6.1	3.9	0.02	0.005	0.012	0.01	0.001
	Median	82.4	6.7	6.1	0.07	0.01	0.02	0.03	0.002
	Max	99.9	7.1	14.6	0.24	0.02	0.03	0.1	0.007
	Above Max Guideline	0	0	0	0	0	10	11	0
	Below Min Guideline	8	5	-	-	-	-	-	-
E610	n	12	12	12	12	12	12	12	12
	Min	79.6	6.6	0.8	0.01	0.005	0.005	0.002	0.001
	Median	90.7	7.1	1.9	0.04	0.007	0.005	0.003	0.002
	Max	95.7	7.3	5.6	0.15	0.01	0.005	0.02	0.003
	Above Max Guideline	0	0	0	0	0	0	0	0
	Below Min Guideline	5	0	-	-	-	-	-	-
E680	n	12	12	12	12	12	12	12	12
	Min	60.3	6.4	0.3	0.07	0.005	0.005	0.009	0.001
	Median	85.5	6.8	1.8	0.13	0.008	0.01	0.07	0.002
	Max	99.3	7.2	5.4	0.4	0.02	0.04	0.2	0.005
	Above Max Guideline	0	0	0	1	1	3	10	0
	Below Min Guideline	9	1	-	-	-	-	-	-
E697	n	12	12	12	12	12	12	12	12
	Min	70.4	6.6	2.6	0.06	0.005	0.005	0.006	0.001
	Median	91.1	7.2	3.2	0.19	0.01	0.006	0.08	0.001
	Max	98.1	7.8	7.8	0.78	0.02	0.04	0.8	0.006
	Above Max Guideline	0	0	0	5	0	3	8	0
	Below Min Guideline	4	0	-	-	-	-	-	-

Station Code	Statistic	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Conductivity Field (mS/cm)
E6006	n	12	12	12	12	1	0	1	12
	Min	0.05	0.14	0.068	0.3	0	-	0	0.1
	Median	0.09	0.73	0.33	1.2	0	-	0	0.12
	Max	0.25	2.79	0.64	6.8	0	-	0	0.15
	Above Max Guideline	11	-	0	1	0	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E601	n	12	12	12	12	0	0	0	12
	Min	0.02	0.54	0.007	0.2	-	-	-	0.1
	Median	0.04	0.81	0.018	0.5	-	-	-	0.14
	Max	0.08	1.08	0.067	3.1	-	-	-	0.17
	Above Max Guideline	4	-	0	0	0	0	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E602	n	12	12	12	12	0	0	0	12
	Min	0.02	0.62	0.016	0.2	-	-	-	0.09
	Median	0.04	0.85	0.04	0.6	-	-	-	0.1
	Max	0.08	2.48	0.08	1.9	-	-	-	0.13
	Above Max Guideline	2	-	0	0	0	0	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E604	n	12	12	12	12	1	0	1	12
	Min	0.01	0.02	0.001	0.2	0	-	0	0.12
	Median	0.02	0.055	0.007	0.9	0	-	0	0.15
	Max	0.12	0.74	0.09	14.2	0	-	0	0.17
	Above Max Guideline	2	-	0	1	0	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E608	n	12	12	12	12	1	0	1	12
	Min	0.04	0.12	0.007	0.2	0	-	0.07	0.16
	Median	0.07	0.24	0.013	0.6	0	-	0.07	0.21
	Max	0.11	0.35	0.03	15.2	0	-	0.07	0.25
	Above Max Guideline	9	-	0	1	0	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E609	n	12	12	12	12	0	0	0	12
	Min	0.04	0.61	0.044	0.2	-	-	-	0.11
	Median	0.09	1.4	0.089	0.6	-	-	-	0.13
	Max	0.17	1.79	0.14	2	-	-	-	0.16
	Above Max Guideline	10	-	0	0	0	0	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-

E610	n	12	12	12	12	0	0	0	12
	Min	0.01	0.13	0.01	0.2	-	-	-	0.09
	Median	0.02	0.215	0.016	0.4	-	-	-	0.14
	Max	0.09	0.36	0.026	1.5	-	-	-	0.16
	Above Max Guideline	1	-	0	0	0	0	-	0
E680	n	12	12	12	12	0	0	0	12
	Min	0.02	0.14	0.027	0.5	-	-	-	0.09
	Median	0.03	0.37	0.06	0.9	-	-	-	0.11
	Max	0.25	0.87	0.2	3	-	-	-	0.12
	Above Max Guideline	2	-	0	0	0	0	-	0
E697	n	12	12	12	12	1	0	1	12
	Min	0.04	0.58	0.016	1	0	-	0.004	0.11
	Median	0.07	0.95	0.038	2.7	0	-	0.004	0.12
	Max	0.19	2.3	0.17	5.4	0	-	0.004	0.16
	Above Max Guideline	10	-	0	1	0	0	0	0
Below Min Guideline	-	-	-	-	-	-	-	-	

**Table A13 Upper Nepean system –storages – benchmarked characteristics**

Station Code	Statistic	Dissolved Oxygen (mg/L)	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)
DAV1	n	12	12	12	12	12	12	12	12
	Min	87.5	6	0.2	0.11	0.005	0.005	0.006	0.001
	Median	103.6	6.4	1	0.16	0.005	0.007	0.019	0.001
	Max	111.7	7.1	2.1	0.34	0.008	0.041	0.034	0.002
	Above Max Guideline	2	0	0	0	0	5	8	-
DAV7	n	12	12	12	12	12	12	12	12
	Min	91.4	6.4	0.3	0.077	0.005	0.005	0.002	0.001
	Median	104.4	6.7	1	0.17	0.005	0.005	0.005	0.001
	Max	111.3	7.6	1.2	0.22	0.008	0.019	0.032	0.004
	Above Max Guideline	2	0	0	0	0	2	4	-
DCA1	n	12	12	12	12	12	12	12	12
	Min	88.1	6.3	0	0.065	0.005	0.005	0.002	0.001
	Median	101.4	6.8	1.3	0.17	0.006	0.005	0.006	0.001
	Max	106.6	8	3.1	0.29	0.009	0.049	0.028	0.004
	Above Max Guideline	0	0	0	0	0	4	5	-
DCO1	n	12	12	12	12	12	12	12	12
	Min	87	6.6	1.1	0.11	0.005	0.005	0.002	0.001
	Median	100.3	7.1	1.8	0.2	0.005	0.005	0.003	0.001
	Max	108.8	7.8	3.1	0.3	0.013	0.03	0.03	0.005
	Above Max Guideline	0	0	0	0	1	3	3	-
DNE2	n	12	12	12	12	12	12	12	12
	Min	68.1	6	1.1	0.15	0.005	0.005	0.002	0.001
	Median	99.5	7.2	2.1	0.28	0.0068	0.006	0.059	0.001
	Max	109.3	7.7	3.7	0.44	0.015	0.046	0.23	0.003
	Above Max Guideline	0	0	0	2	3	3	8	-
Below Min Guideline	3	3	-	-	-	-	-	-	

Station Code	Statistic	Total Manganese (mg/L)	Total Aluminium (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Temperature (° C)	Conductivity Field (mS/cm)
DAV1	n	12	12	12	0	0	0	12	12
	Min	0.004	0.01	1.4	-	-	-	12.2	0.06
	Median	0.015	0.01	2.225	-	-	-	16.4	0.07
	Max	0.071	0.02	5.1	-	-	-	22.3	0.08
	Above Max Guideline	0	0	1	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DAV7	n	12	12	12	12	0	12	12	12
	Min	0.004	0.01	2.5	0	-	0	12	0.06
	Median	0.016	0.013	4.28	0	-	0.004	19.1	0.07
	Max	0.027	0.023	7.83	87	-	0.104	23.3	0.08
	Above Max Guideline	0	0	4	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DCA1	n	12	12	12	3	0	4	12	12
	Min	0.019	0.035	1	0	-	0	11.5	0.07
	Median	0.037	0.068	2.9	0	-	0.003	19.4	0.08
	Max	0.073	0.11	8.75	71	-	0.01	25.5	0.1
	Above Max Guideline	0	6	4	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DCO1	n	12	12	12	10	0	11	12	12
	Min	0.0115	0.015	2.9	0	-	0	11.1	0.09
	Median	0.028	0.02	6.75	0	-	0.07	19.1	0.09
	Max	0.16	0.045	20.35	0	-	0.17	25.1	0.15
	Above Max Guideline	0	0	9	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	0
DNE2	n	12	12	12	33	21	33	12	12
	Min	0.012	0.015	0.7	0	LOR	0	11.3	0.07
	Median	0.016	0.033	3.125	0	-	0.02	17.1	0.09
	Max	0.11	0.13	7.95	0	LOR	0.4	26.3	0.1
	Above Max Guideline	0	4	5	0	0	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-

**Table A14 Upper Nepean system – water filtration plants – benchmarked characteristics**

Station Code	Statistic	Alkalinity (CaCO <sub>3</sub> mg/L)	Total Hardness (CaCO <sub>3</sub> mg/L)	True Colour at 400 nm	Turbidity (NTU)	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Areal Standard Unit (ASU)
HNED	n	12	12	12	12	12	12	12	12
	Min	8	13	13	0.9	0.04	0.43	0.01	6
	Median	10	13	22	1.4	0.075	0.49	0.039	56
	Max	12	13	28	2.6	0.13	0.64	0.21	1176
	Above Max Guideline	0	0	0	0	0	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-
IWFP-R	n	12	12	12	12	12	12	12	12
	Min	1	1	3	0.6	0.01	0.05	0.008	110
	Median	5	7	4	1.5	0.02	0.08	0.022	1030
	Max	6	11	6	3.4	0.03	0.21	0.05	8104
	Above Max Guideline	0	0	0	0	0	0	0	1
	Below Min Guideline	-	-	-	-	-	-	-	-
HMAC1	n	12	12	12	12	12	12	12	12
	Min	5	11	7	0.1	0.02	0.24	0.016	14
	Median	7	13	12	1.1	0.06	0.33	0.021	83
	Max	8	13	19	1.7	0.09	0.5	0.026	585
	Above Max Guideline	0	0	0	0	0	0	0	0
	Below Min Guideline	-	0	-	-	-	-	-	-

**Table A15 Upper Nepean system – water filtration plants – cyanobacteria**

Station Code	Statistic	Algal Total Count (cells/mL)	Algal Biovolume (mm <sup>3</sup> /mL)	Total Cyanobacterial cell count (cells/mL)	Total Cyanobacterial biovolume (mm <sup>3</sup> /L)	Microcystin LR + RR + YR (µg/L)	Toxic Cyanobacterial cell count (cells/mL)	Toxic Cyanobacterial biovolume (mm <sup>3</sup> /L)
HNED	n	12	12	12	12	0	12	12
	Min	28	0.008	0	0	-	0	0
	Median	902	0.08	132	0	-	0	0
	Max	5920	2.04	2060	0.008	-	0	0.007
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-
IWFP-R	n	12	12	12	12	1	12	12
	Min	2100	0.2	556	0	LOR	0	0
	Median	10895	2	5630	0.003	LOR	0	0
	Max	31330	13	27830	0.1	LOR	3790	0.05
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-
HMAC1	n	12	12	12	12	0	12	12
	Min	69	0.01	0	0	-	0	0
	Median	1565	0.1	564	0.0002	-	0	0
	Max	67540	0.8	65350	0.03	-	229	0.03
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-

**Table A16 Upper Nepean system – water filtration plants – indicator bacteria**

Station Code	Statistic	<i>Clostridium perfringens</i> (cfu/100 mL)	<i>E. coli</i> (orgs/100mL)	Enterococci (cfu/100ml)
HMAC1	n	12	12	12
	Min	LOR	4	8
	Median	LOR	18	49
	Max	4	100	320
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
IWFP-R	n	12	12	12
	Min	LOR	LOR	LOR
	Median	LOR	LOR	LOR
	Max	2	LOR	4
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
HNED	n	14	14	14
	Min	LOR	LOR	LOR
	Median	LOR	LOR	LOR
	Max	LOR	2	10
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-

**Table A17 Upper Nepean system – water filtration plants – health related physical chemical**

Station Code	Statistic	Arsenic Total (mg/L)	Barium Total (mg/L)	Beryllium-Total (mg/L)	Boron Total (mg/L)	Mercury Total (mg/L)	Molybdenum Total (mg/L)	Selenium Total (mg/L)	Silver Total (mg/L)	Tin Total (mg/L)	Iodide (mg/L)
HMAC1	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.01	LOR	0.01	LOR	LOR	LOR	LOR	0.002	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-
IWFP-R	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.007	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.007	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.08	LOR	0.03	LOR	LOR	LOR	LOR	0.002	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-
HNED	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.009	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-

**Table A18 Upper Nepean system – water filtration plants – pesticides**

Station Code	Statistic	2,4-D (ug/L)	Amitrole (ug/L)	Atrazine (ug/L)	Chlorfenvinphos (E) (ug/L)	Chlorpyrifos (ug/L)	Clopyralid (ug/L)	Dichlobenil (ug/L)	Dimethoate (ug/L)	Diuron (ug/L)	Fluroxypyr (ug/L)	Glyphosate (ug/L)	Hexazinone (ug/L)	MCPA (ug/L)
HMAC1	n	4	4	12	12	4	12	4	12	4	4	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-

WFP-R	n	4	4	12	12	4	12	4	12	4	4	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
HNED	n	4	4	12	12	4	12	4	12	4	4	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
Station Code	Statistic	Azinphos-methyl (ug/L)	Picloram (ug/L)	Triclopyr (ug/L)	Trifluralin (ug/L)	Metsulfuron Methyl (ug/L)	Chlorothaloni (ug/L)	Acephate (ug/L)	Aminopyralid (ug/L)	Fluproprate (ug/L)	Simazine (ug/L)	cis-1,3-Dichloropropene (ug/L)	trans-1,3-Dichloropropene (ug/L)	
HMAC1	n	4	12	12	12	5	4	4	4	4	12	4	4	
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
WFP-R	n	4	12	12	12	5	4	4	4	4	12	4	4	
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
HNED	n	4	12	12	12	5	4	4	4	4	12	4	4	
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Max	LOR	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	

**Table A19 Upper Nepean system – water filtration plants – Synthetic organic compounds & radionuclides**

Station Code	Statistic	Gross Alpha	Gross Beta	1,1-Dichloroethane (ug/L)	1,2-Dichloroethane (ug/L)	cis-1,2-Dichloroethene (ug/L)	trans-1,2-Dichloroethene (ug/L)	Benzene (ug/L)	Hexachlorobutadiene (ug/L)	Trichloroethene (ug/L)
HMAC1	n	1	1	4	12	12	12	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
WFP-R	n	1	1	4	12	12	12	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HNED	n	1	1	4	12	12	12	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-

**Table A20 Upper Nepean, Woronora, Illawarra, Blue Mountains systems – water filtration plants – *Cryptosporidium* and *Giardia***

Station Code	Station Description	Statistic	<i>Crypto</i> oocysts IFA (Adj for Recovery for 10L)	<i>Giardia</i> cysts IFA (Adj for Recovery to 10L)
MACSP1A	Macarthur WFP raw water	n	50	50
		Min	0	0
		Median	0.06	0.05
		Max	1.71	1.02
		Above Max Guideline	3	6
		Below Min Guideline	-	-
HNED	Nepean Raw Water	n	147	147
		Min	0	0
		Median	0	0
		Max	0	0
		Above Max Guideline	-	-
		Below Min Guideline	-	-
IWFP-R	Illawarra Raw Water	n	147	147
		Min	0	0
		Median	0.002	0.003
		Max	0.22	0.29
		Above Max Guideline	1	2
		Below Min Guideline	-	-
HCSR	Cascades Raw Water	n	101	101
		Min	0	0
		Median	0.03	0.03
		Max	0.58	0.72
		Above Max Guideline	9	10
		Below Min Guideline	-	-
HWO1-A	Woronora Raw Water	n	98	98
		Min	0	0
		Median	0	0.006
		Max	0	0.26
		Above Max Guideline	-	3
		Below Min Guideline	-	-

### 3. Woronora system

**Table A21 Woronora system – catchments**

Station Code	Statistic	Dissolved Oxygen (mg/L)	pH Lab/Field	Turbidity Lab/Field (NTU)	Temperature (°C)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)
E6131	n	12	12	12	12	12	12	12	12	12
	Min	87.6	6.9	2.9	8.6	0.01	0.005	0.005	0.002	0.001
	Median	91.3	7.4	4.4	17.5	0.05	0.006	0.005	0.003	0.002
	Max	102.6	7.7	6.7	24.6	0.18	0.02	0.019	0.06	0.005
	Above Max Guideline	0	0	0	-	0	0	1	2	0
	Below Min Guideline	3	0	-	-	-	-	-	-	-
E677	n	12	12	12	12	12	12	12	12	12
	Min	64.7	5.6	0.9	6.6	0.03	0.005	0.005	0.002	0.001
	Median	78.4	6.4	2.6	16.2	0.1	0.005	0.005	0.003	0.001
	Max	92.9	6.7	4.8	24.6	0.2	0.02	0.02	0.06	0.004
	Above Max Guideline	0	0	0	-	0	1	3	1	0
	Below Min Guideline	9	9	-	-	-	-	-	-	-

Station Code	Statistic	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Conductivity Field (mS/cm)
E6131	n	12	12	12	12	0	0	0	12
	Min	0.01	0.3	0.032	0.2	-	-	-	0.2
	Median	0.01	0.3	0.05	0.8	-	-	-	0.27
	Max	0.03	0.5	0.09	1.3	-	-	-	0.32
	Above Max Guideline	0	-	0	0	-	-	-	0
	Below Min Guideline	-	-	-	-	-	-	-	-
E677	n	12	12	12	12	2	0	2	12
	Min	0.04	0.2	0.008	0.2	0	-	0	0.18
	Median	0.08	0.5	0.02	1.4	0	-	0.002	0.2
	Max	0.1	1.8	0.06	6.4	0	-	0.004	0.25
	Above Max Guideline	7	-	0	2	0	-	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-

**Table A22 Woronora system – storage**

Station Code	Statistic	Dissolved Oxygen (mg/L)	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)
DWO1	n	12	12	12	12	12	12	12	12
	Min	91	6.3	0.4	0.16	0.005	0.005	0.05	0.001
	Median	107.5	7	1	0.21	0.005	0.007	0.06	0.002
	Max	120.1	7.2	3.1	0.26	0.02	0.03	0.08	0.003
	Above Max Guideline	4	0.00	0.00	0	2	4	12	0
	Below Min Guideline	0	1	-	-	-	-	-	-

Station Code	Statistic	Total Manganese (mg/L)	Total Aluminium (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Conductivity Field (mS/cm)	Temperature (° C)
DWO1	n	12	12	12	0	0	0	12	12
	Min	0.006	0.02	0.6	-	-	-	0.1	13.5
	Median	0.008	0.04	1.4	-	-	-	0.11	18.8
	Max	0.01	0.08	3	-	-	-	0.12	23.8
	Above Max Guideline	0	4	0	-	-	-	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-

**Table A23 Woronora system – water filtration plant – physicochemical**

Station Code	Statistic	Alkalinity (CaCO <sub>3</sub> mg/L)	Total Hardness (CaCO <sub>3</sub> mg/L)	True Colour at 400 nm	Turbidity (NTU)	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Areal Standard Unit (ASU)
HWO1-A	n	12	12	12	12	12	12	12	12
	Min	4	7	4	0.4	0.02	0.08	0.007	9.1
	Median	5	13	7.5	1	0.045	0.14	0.008	42
	Max	8	13	12	1.4	0.08	0.16	0.016	421
	Above Max Guideline	0	0	0	0	0	0	0	0
	Below Min Guideline	-	0	-	-	-	-	-	-

**Table A24 Woronora system – water filtration plant - cyanobacteria**

Station Code	Statistic	Algal Total Count (cells/mL)	Algal Biovolume (mm <sup>3</sup> /mL)	Total Cyanobacterial cell count (cells/mL)	Total Cyanobacterial biovolume (mm <sup>3</sup> /L)	Microcystin LR + RR + YR (µg/L)	Toxic Cyanobacterial cell count (cells/mL)	Toxic Cyanobacterial biovolume (mm <sup>3</sup> /L)
HWO1-A	n	12	12	12	12	0	12	12
	Min	238	0.008	0	0	-	0	0
	Median	2460	0.06	1925	0	-	0	0
	Max	7990	4.1	6480	0.002	-	0	0
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-

**Table A25 Woronora system – water filtration plant - indicator bacteria**

Station Code	Statistic	<i>Clostridium perfringens</i> (cfu/100 mL)	<i>E. coli</i> (orgs/100mL)	Enterococci (cfu/100ml)
HWO1-A	n	13	13	13
	Min	LOR	LOR	LOR
	Median	LOR	LOR	LOR
	Max	2	LOR	LOR
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-

**Table A26 Woronora system – water filtration plant – health related physical chemical**

Station Code	Statistic	Arsenic Total (mg/L)	Barium Total (mg/L)	Beryllium-Total (mg/L)	Boron Total (mg/L)	Mercury Total (mg/L)	Molybdenum Total (mg/L)	Selenium Total (mg/L)	Silver Total (mg/L)	Tin Total (mg/L)	Iodide (mg/L)
HWO1-A	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.012	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.012	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.013	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
Below Min Guideline	-	-	-	-	-	-	-	-	-	-	

**Table A27 Woronora system – water filtration plant - pesticides**

Station Code	Statistic	2,4-D (ug/L)	Amitrole (ug/L)	Atrazine (ug/L)	Chlorfenvinphos (E) (ug/L)	Chlorpyrifos (ug/L)	Clopyralid (ug/L)	Dichlobenil (ug/L)	Dimethoate (ug/L)	Diuron (ug/L)	Fluroxypyr (ug/L)	Glyphosate (ug/L)	Hexazinone (ug/L)	MCPA (ug/L)
HWO1-A	n	4	4	12	12	4	12	4	12	4	4	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-	
Station Code	Statistic	Azinphos-methyl (ug/L)	Picloram (ug/L)	Triclopyr (ug/L)	Trifluralin (ug/L)	Metsulfuron Methyl (ug/L)	Chlorothalonil (ug/L)	Acephate (ug/L)	Aminopyralid (ug/L)	Fluproprate (ug/L)	Simazine (ug/L)	cis-1,3-Dichloropropene (ug/L)	trans-1,3-Dichloropropene (ug/L)	
HWO1-A	n	4	12	12	12	5	4	4	4	4	12	4	4	
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-		

**Table A28 Woronora system – water filtration plant – synthetic organic compounds & radionuclides**

Station Code	Statistic	Gross Alpha	Gross Beta	1,1-Dichloroethane (ug/L)	1,2-Dichloroethane (ug/L)	cis-1,2-Dichloroethene (ug/L)	trans-1,2-Dichloroethene (ug/L)	Benzene (ug/L)	Hexachlorobutadiene (ug/L)	Trichloroethene (ug/L)
HWO1-A	n	1	1	4	12	12	12	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	0.27	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
Below Min Guideline	-	-	-	-	-	-	-	-	-	

## 4. Blue Mountains System

Table A29 Blue Mountains system – storages

Station Code	Statistic	Dissolved Oxygen (mg/L)	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)	Conductivity Field (mS/cm)
DGC1	n	12	12	12	12	12	12	12	12	12
	Min	83.2	5.3	0.9	0.13	0.005	0.005	0.007	0.001	0.03
	Median	87	5.7	1.4	0.21	0.008	0.04	0.08	0.002	0.03
	Max	95.4	6.7	3.2	0.28	0.01	0.1	0.17	0.006	0.03
	Above Max Guideline	0	0	0	0	3	10	11	1	-
Below Min Guideline	9	11	-	-	-	-	-	-	-	-
DLC1	n	6	6	6	6	6	6	6	6	6
	Min	85.2	7.4	0.3	0.2	0.005	0.005	0.02	0.001	0.07
	Median	88.1	7.7	0.5	0.26	0.005	0.02	0.06	0.001	0.09
	Max	92.3	7.8	0.6	0.29	0.006	0.034	0.11	0.001	0.09
	Above Max Guideline	0	0	0	0	0	4	6	0	-
Below Min Guideline	4	0	-	-	-	-	-	-	-	-
DTC1	n	12	12	12	12	12	12	12	12	12
	Min	83.1	7.2	0.3	0.23	0.005	0.005	0.006	0.001	0.059
	Median	88.4	7.4	0.4	0.37	0.006	0.01	0.04	0.001	0.077
	Max	96.4	7.6	0.6	0.51	0.009	0.02	0.07	0.002	0.086
	Above Max Guideline	0	0	0	7	0	5	10	0	-
Below Min Guideline	7	0	-	-	-	-	-	-	-	-

Station Code	Statistic	Total Manganese (mg/L)	Total Aluminium (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Temperature (° C)
DGC1	n	12	12	12	12	12	12	12
	Min	0.015	0.08	1.5	0	LOR	0	7
	Median	0.02	0.12	3	0	LOR	-	15
	Max	0.05	0.19	11.7	0	LOR	0.5	22.3
	Above Max Guideline	0	12	4	0	0	0	-
Below Min Guideline	-	-	-	-	-	-	-	-
DLC1	n	6	6	6	2	0	2	6
	Min	0.02	0.01	1.6	0	-	0.001	8.7
	Median	0.03	0.01	2.2	0	-	-	15.9
	Max	0.04	0.02	5.4	0	-	0.001	22.7
	Above Max Guideline	0	0	1	0	-	0	-
Below Min Guideline	-	-	-	-	-	-	-	-
DTC1	n	12	12	12	12	12	12	12
	Min	0.008	0.01	2	0	LOR	0	7.6
	Median	0.013	0.01	3.2	0	LOR	0.003	15.5
	Max	0.028	0.04	6.7	477	LOR	0.2	22.2
	Above Max Guideline	0	0	3	0	0	0	-
Below Min Guideline	-	-	-	-	-	-	-	-

**Table A30 Blue Mountains system – water filtration plant – benchmarked characteristics**

Station Code	Statistic	Alkalinity (CaCO3 mg/L)	Total Hardness (CaCO3 mg/L)	True Colour at 400 nm	Turbidity (NTU)	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Areal Standard Unit (ASU)
HCSR	n	12	12	12	12	12	12	12	12
	Min	10	12	5	0.3	0.01	0.03	0.008	63
	Median	21.5	21	6	0.6	0.01	0.06	0.013	342
	Max	29	27	10	1.1	0.09	0.14	0.019	1865
	Above Max Guideline	0	0	0	0	0	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-

**Table A31 Blue Mountains system – water filtration plants – cyanobacteria**

Station Code	Statistic	Algal Total Count (cells/mL)	Algal Biovolume (mm3/mL)	Total Cyanobacterial cell count (cells/mL)	Total Cyanobacterial biovolume (mm3/L)	Microcystin LR + RR + YR (µg/L)	Toxic Cyanobacterial cell count (cells/mL)	Toxic Cyanobacterial biovolume (mm3/L)
HCSR	n	12	12	12	12	0	12	12
	Min	322	0.069	119	0	-	0	0
	Median	4545	0.555	2530	0.007	-	0	0
	Max	25930	3.01	22130	0.09	-	1610	0.02
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-

**Table A32 Blue Mountains system – water filtration plant - indicator bacteria**

Station Code	Statistic	<i>Clostridium perfringens</i> (cfu/100 mL)	<i>E. coli</i> (orgs/100mL)	Enterococci (cfu/100ml)
HCSR	n	13	13	13
	Min	LOR	LOR	LOR
	Median	LOR	4	6
	Max	2	19	32
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-

**Table A33 Blue Mountains system – water filtration plant – health related physical chemical**

Station Code	Statistic	Arsenic Total (mg/L)	Barium Total (mg/L)	Beryllium-Total (mg/L)	Boron Total (mg/L)	Mercury Total (mg/L)	Molybdenum Total (mg/L)	Selenium Total (mg/L)	Silver Total (mg/L)	Tin Total (mg/L)	Iodide (mg/L)
HCSR	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR

	Max	LOR	0.008	LOR								
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-

**Table A34 Blue Mountains system – water filtration plant - pesticides**

Station Code	Statistic	2,4-D (ug/L)	Amitrole (ug/L)	Atrazine (ug/L)	Chlorfenvinphos (E) (ug/L)	Chlorpyrifos (ug/L)	Clopyralid (ug/L)	Dichlobenil (ug/L)	Dimethoate (ug/L)	Diuron (ug/L)	Fluroxypyr (ug/L)	Glyphosate (ug/L)	Hexazinone (ug/L)	MCPA (ug/L)
HCSR	n	4	4	12	12	4	12	4	12	4	4	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	0.005	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	0.08	LOR
	Above Max	-	-	-	-	-	-	-	-	-	-	-	-	-
Below Min	-	-	-	-	-	-	-	-	-	-	-	-	-	
Station Code	Statistic	Azinphos-methyl (ug/L)	Picloram (ug/L)	Triclopyr (ug/L)	Trifluralin (ug/L)	Metsulfuron Methyl (ug/L)	Chlorothalonil (ug/L)	Acephate (ug/L)	Aminopyralid (ug/L)	Fluproprate (ug/L)	Simazine (ug/L)	cis-1,3-Dichloropropene (ug/L)	trans-1,3-Dichloropropene (ug/L)	
HCSR	n	4	12	12	12	5	4	4	4	4	12	4	4	
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	0.018	LOR	LOR	
	Above Max	-	-	-	-	-	-	-	-	-	-	-	-	
Below Min	-	-	-	-	-	-	-	-	-	-	-	-		

**Table A35 Blue Mountains system – water filtration plant – synthetic organic compounds & radionuclides**

Station Code	Statistic	Gross Alpha	Gross Beta	1,1-Dichloroethane (ug/L)	1,2-Dichloroethane (ug/L)	cis-1,2-Dichloroethene (ug/L)	trans-1,2-Dichloroethene (ug/L)	Benzene (ug/L)	Hexachlorobutadiene (ug/L)	Trichloroethene (ug/L)
HCSR	n	1	1	4	12	12	12	12	12	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
Below Min Guideline	-	-	-	-	-	-	-	-	-	

## 5. Shoalhaven system

**Table A36 Shoalhaven system – catchments – benchmarked characteristics**

Station Code	Statistic	Dissolved Oxygen (mg/L)	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)
E300	n	12	12	12	12	12	12	12	12
	Min	35.7	6.1	3.1	0.39	0.005	0.008	0.3	0.001
	Median	73.3	6.5	5.5	0.84	0.02	0.03	0.8	0.002
	Max	104	7.7	28.5	2.21	0.06	0.5	1.3	0.006

	Above Max Guideline	0	0	1	12	5	10	12	0
	Below Min Guideline	10	6	-	-	-	-	-	-
E301	n	12	12	12	12	12	12	12	12
	Min	80.2	6.6	1.5	0.21	0.005	0.005	0.03	0.001
	Median	94.3	7	4.8	0.7	0.02	0.009	0.5	0.003
	Max	122.2	8	10.7	0.95	0.05	0.025	0.9	0.01
	Above Max Guideline	1	0	0	11	5	2	12	0
	Below Min Guideline	3	0	-	-	-	-	-	-
E520	n	12	12	12	12	12	12	12	12
	Min	102.5	7.1	0.3	0.07	0.005	0.005	0.009	0.001
	Median	106.4	7.4	2.4	0.19	0.01	0.005	0.04	0.002
	Max	108.8	7.7	6.1	0.26	0.02	0.012	0.1	0.004
	Above Max Guideline	0	0	0	1	0	0	10	0
	Below Min Guideline	0	0	-	-	-	-	-	-
E7021	n	12	12	12	12	12	12	12	12
	Min	57.5	5.6	1.8	0.12	0.01	0.005	0.002	0.001
	Median	93.3	6.7	3.4	0.22	0.02	0.01	0.02	0.005
	Max	105.5	7.2	9.9	0.41	0.034	0.03	0.1	0.01
	Above Max Guideline	0	0	0	5	6	3	8	0
	Below Min Guideline	5	5	-	-	-	-	-	-
E706	n	12	12	12	12	12	12	12	12
	Min	44.5	6.4	2.9	0.15	0.005	0.01	0.03	0.007
	Median	88.8	6.9	5.2	0.49	0.067	0.1	0.05	0.02
	Max	104.6	7.3	10.5	0.97	0.11	0.43	0.3	0.04
	Above Max Guideline	0	0	0	10	9	11	12	8
	Below Min Guideline	6	1	-	-	-	-	-	-
E7061	n	12	12	12	12	12	12	12	12
	Min	62.2	6.4	2.2	0.09	0.008	0.005	0.002	0.001
	Median	90.5	7	3.1	0.16	0.0165	0.005	0.03	0.003
	Max	102.5	7.3	9.9	0.62	0.023	0.02	0.08	0.008
	Above Max Guideline	0	0	0	1	3	3	8	0
	Below Min Guideline	6	1	-	-	-	-	-	-
E822	n	12	12	12	12	12	12	12	12
	Min	63.6	6.6	1.9	0.04	0.008	0.005	0.002	0.002
	Median	85.5	7.3	2.8	0.155	0.0135	0.008	0.006	0.004
	Max	95.7	8.1	11.5	0.37	0.034	0.03	0.06	0.006
	Above Max Guideline	0	3	0	1	2	4	3	0
	Below Min Guideline	8	0	-	-	-	-	-	-
E8311	n	12	12	12	12	12	12	12	12
	Min	74.8	5	1	0.06	0.005	0.005	0.002	0.001
	Median	93.7	7.2	1.5	0.16	0.006	0.005	0.002	0.001
	Max	99.8	8.5	3.9	0.45	0.018	0.01	0.008	0.002
	Above Max Guideline	0	2	0	3	0	0	0	0
	Below Min Guideline	3	2	-	-	-	-	-	-
E847	n	12	12	12	12	12	12	12	12
	Min	94.4	7.3	1	0.09	0.005	0.005	0.002	0.001
	Median	101.8	7.8	3.1	0.175	0.0105	0.005	0.007	0.003
	Max	108.4	7.9	18.4	0.35	0.016	0.007	0.05	0.009
	Above Max Guideline	0	0	0	3	0	0	5	0
	Below Min Guideline	0	0	-	-	-	-	-	-
E860	n	12	12	12	12	12	12	12	12
	Min	87.3	6.8	1.1	0.06	0.01	0.005	0.002	0.002
	Median	92.1	7.6	2.8	0.22	0.0215	0.005	0.005	0.006
	Max	100.2	7.9	10.8	0.68	0.085	0.01	0.06	0.01
	Above Max Guideline	0	0	0	5	7	1	2	0
	Below Min Guideline	1	0	-	-	-	-	-	-
E861	n	11	11	11	11	11	11	11	11
	Min	89.7	7.1	1.7	0.1	0.005	0.005	0.002	0.001
	Median	102.8	7.7	3	0.28	0.013	0.005	0.003	0.003
	Max	107.9	8.2	43.1	0.71	0.04	0.01	0.18	0.005
	Above Max Guideline	0	3	1	6	1	0	4	0
	Below Min Guideline	1	0	-	-	-	-	-	-
E890	n	12	12	12	12	12	12	12	12
	Min	35.8	6.1	5.1	0.08	0.019	0.005	0.002	0.001
	Median	68.2	6.7	6.3	0.28	0.028	0.008	0.006	0.006
	Max	86.9	7.7	28.1	0.83	0.096	0.03	0.034	0.01
	Above Max Guideline	0	0	1	6	10	4	4	0
	Below Min Guideline	12	5	-	-	-	-	-	-
E891	n	12	12	12	12	12	12	12	12
	Min	49.1	7	2.7	0.2	0.012	0.005	0.002	0.004
	Median	75.3	7.4	5.1	0.42	0.023	0.011	0.02	0.009
	Max	90.1	7.7	24	0.87	0.18	0.03	0.42	0.02
	Above Max Guideline	0	0	0	11	8	5	7	3
	Below Min Guideline	11	0	-	-	-	-	-	-

Station Code	Statistic	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin Variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Conductivity Field (mS/cm)	Temperature (°C)
E300	n	12	12	12	12	4	0	4	12	12
	Min	0.12	0.3	0.02	1.7	0	-	0	0.03	8.7
	Median	0.15	0.9	0.06	3.1	0	-	0	0.08	13.6
	Max	0.7	1.9	0.2	8.5	752	-	0.01	0.09	21.2
	Above Max Guideline	12	-	0	4	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E301	n	12	12	12	12	2	0	2	12	12
	Min	0.05	0.3	0.02	0.8	0	-	0	0.08	8.1
	Median	0.095	0.5	0.04	1.7	0	-	0	0.09	14.6
	Max	0.48	1.2	0.2	21.8	0	-	0	0.1	22.2
	Above Max Guideline	10	-	0	2	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E520	n	12	12	12	12	0	0	0	12	12
	Min	0.02	0.2	0.004	0.2	-	-	-	0.12	6.6
	Median	0.04	0.4	0.01	0.4	-	-	-	0.16	18.1
	Max	0.09	0.5	0.01	1.2	-	-	-	0.19	23
	Above Max Guideline	3	-	0	0	-	-	-	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E7021	n	12	12	12	13	2	0	2	12	12
	Min	0.05	0.3	0.01	0.5	0	-	0	0.07	7.8
	Median	0.1	0.5	0.02	1.3	0	-	0	0.11	17.4
	Max	0.6	0.8	0.05	25.1	0	-	0	0.13	21.6
	Above Max Guideline	11	-	0	2	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E706	n	12	12	12	12	7	0	7	12	12
	Min	0.05	0.4	0.02	1.9	0	-	0	0.1	8.3
	Median	0.1	0.8	0.04	6.1	0	-	0.04	0.1	17.5
	Max	0.2	1.1	0.09	51.6	0	-	2.1	0.2	24.8
	Above Max Guideline	11	-	0	7	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E7061	n	12	12	12	12	3	0	3	12	12
	Min	0.04	0.3	0.01	0.3	0	-	0	0.09	8.1
	Median	0.07	0.4	0.02	2	0	-	0	0.1	18.5
	Max	0.1	0.7	0.05	15	0	-	0.121	0.13	22.4
	Above Max Guideline	8	-	0	3	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E822	n	12	12	12	12	1	0	1	12	12
	Min	0.05	0.2	0.005	0.9	0	-	0.017	0.045	4.4
	Median	0.08	0.5	0.02	1.8	0	-	0.017	0.06	14.1
	Max	0.4	0.9	0.04	11.5	0	-	0.017	0.3	24.1
	Above Max Guideline	11	-	0	1	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E8311	n	12	12	12	12	1	0	1	12	12
	Min	0.05	0.2	0.003	0.9	0	-	0	0.05	5.6
	Median	0.1	0.3	0.01	1.6	0	-	0	0.07	15.4
	Max	0.5	0.8	0.03	5.1	0	-	0	0.3	25.3
	Above Max Guideline	11	-	0	1	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E847	n	12	12	12	12	1	0	1	12	12
	Min	0.03	0.1	0.006	1.3	0	-	0	0.08	6.6
	Median	0.07	0.3	0.02	2.7	0	-	0	0.1	21
	Max	0.3	0.7	0.04	5.5	0	-	0	0.2	26.8
	Above Max Guideline	6	-	0	1	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E860	n	12	12	12	12	3	0	3	12	12
	Min	0.03	0.3	0.01	1.8	0	-	0	0.08	5
	Median	0.09	0.5	0.03	3.7	0	-	0	0.1	15.5
	Max	0.3	0.9	0.06	8.8	0	-	0	0.3	24
	Above Max Guideline	8	-	0	3	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E861	n	11	11	11	11	3	0	3	11	11
	Min	0.02	0.2	0.02	1.5	0	-	0.001	0.09	7.2
	Median	0.06	0.3	0.03	3.4	0	-	0.028	0.1	17.6
	Max	0.9	1.1	0.06	15.1	1050	-	0.15	0.35	26.5

	Above Max Guideline	7	-	0	3	0	-	0	0	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E890	n	12	12	12	12	5	0	5	12	12
	Min	0.08	0.5	0.02	3.2	0	-	0	0.08	6.3
	Median	0.28	1.1	0.08	4.5	0	-	0.003	0.1	14.9
	Max	1	2	0.3	10.9	0	-	0.02	0.35	23.6
	Above Max Guideline	12	-	0	5	0	-	0	1	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
E891	n	12	12	12	12	8	0	8	12	12
	Min	0.01	0.4	0.05	4.1	0	-	0	0.5	3.5
	Median	0.02	0.9	0.1	6.9	0	-	0	0.54	13
	Max	0.93	11.1	0.9	68	912	-	0.007	0.7	21.9
	Above Max Guideline	2	-	0	8	0	-	0	12	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-

**Table A37 Shoalhaven system – storages – benchmarked characteristics**

Station Code	Statistic	Dissolved Oxygen (mg/L)	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Ammoniacal Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Filtered Reactive Phosphorus (mg/L)
DBP1	n	6	6	6	6	6	6	6	6
	Min	80.7	7.0	3.9	0.2	0.01	0.01	0.01	0.001
	Median	93.4	7.3	5.6	0.4	0.02	0.01	0.09	0.002
	Max	106.3	7.4	6	0.6	0.03	0.07	0.28	0.004
	Above Max Guideline	0	0	0	5	6	4	5	0
	Below Min Guideline	2	0	-	-	-	-	-	-
DFF6	n	12	12	12	12	12	12	12	12
	Min	85.5	7.2	4	0.5	0.01	0.02	0.01	0.001
	Median	97.0	7.5	7.3	0.7	0.02	0.08	0.23	0.001
	Max	108.9	8.6	9.9	0.8	0.02	0.20	0.37	0.002
	Above Max Guideline	0	1	0	11	10	10	10	0
	Below Min Guideline	1	0	-	-	-	-	-	-
DTA1	n	12	12	12	12	12	12	12	12
	Min	60.9	6.5	1.00	0.2	0.01	0.01	0.00	0.001
	Median	91.4	7.3	3.2	0.3	0.01	0.01	0.03	0.001
	Max	114.9	8.1	7.8	0.5	0.02	0.17	0.22	0.006
	Above Max Guideline	1	1	0	2	3	4	7	1
	Below Min Guideline	5	0	-	-	-	-	-	-
DTA5	n	12	12	12	12	12	12	12	12
	Min	70.2	6.5	1.1	0.2	0.01	0.01	0.00	0.001
	Median	85.4	7.5	3.6	0.3	0.01	0.01	0.04	0.002
	Max	114.4	7.8	23.6	0.5	0.02	0.14	0.21	0.007
	Above Max Guideline	1	0	1	4	3	7	9	1
	Below Min Guideline	9	1	-	-	-	-	-	-
DTA8	n	12	12	12	12	12	12	12	12
	Min	59.3	6.6	3.3	0.2	0.01	0.01	0.00	0.001
	Median	85.6	7.1	5.5	0.4	0.02	0.04	0.05	0.002
	Max	96.8	8.0	6.2	0.6	0.03	0.13	0.27	0.013
	Above Max Guideline	0	1	0	10	12	10	10	2
	Below Min Guideline	7	0	-	-	-	-	-	-
DWI1	n	12	12	12	12	12	12	12	12
	Min	88.0	7.0	5.7	0.3	0.01	0.01	0.00	0.001
	Median	96.5	7.4	7.2	0.5	0.01	0.03	0.08	0.001
	Max	101.0	7.7	11.6	0.6	0.02	0.06	0.22	0.001
	Above Max Guideline	0	0	0	10	9	8	10	0
	Below Min Guideline	1	0	-	-	-	-	-	-

Station Code	Statistic	Total Manganese (mg/L)	Total Aluminium (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	Total Cyanobacteria (mm <sup>3</sup> /L)	Conductivity Field (mS/cm)	Temperature (° C)
DBP1	n	6	6	39	39	39	39	6	6
	Min	0.02	0.05	2.9	0	0.3	0.00	0.10	9.6
	Median	0.04	0.09	13.4	421	0.3	0.08	0.11	17.8
	Max	0.07	0.13	26.2	2950	0.4	0.43	0.13	24.7
	Above Max Guideline	0	5	38	0	0	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DFF6	n	12	12	12	9	1	9	12	12
	Min	0.01	0.05	6.5	0	0.4	0.03	0.09	7.5
	Median	0.02	0.16	11.1	140	0.4	0.14	0.10	18.4
	Max	0.03	0.50	13.7	2440	0.4	1.31	0.15	23.4
	Above Max Guideline	0	9	11	0	0	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DTA1	n	12	12	12	5	0	5	12	12
	Min	0.01	0.02	1.9	0	-	0.00	0.11	10.7
	Median	0.02	0.05	5.0	0	-	0.02	0.13	19.5
	Max	0.14	0.20	9.1	0	-	0.05	0.14	26.0
	Above Max Guideline	0	6	6	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DTA5	n	12	12	12	9	0	9	12	12
	Min	0.01	0.03	3.4	0	-	0.00	0.11	10.1
	Median	0.03	0.08	5.9	0	-	0.01	0.13	17.8
	Max	0.10	0.27	8.8	70	-	0.12	0.15	25.8
	Above Max Guideline	0	8	9	0	-	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DTA8	n	12	12	39	39	39	39	12	12
	Min	0.03	0.06	2.3	0	0.3	0.00	0.11	9.3
	Median	0.06	0.09	14.7	274	0.3	0.04	0.12	20.0
	Max	0.07	0.15	29.5	2580	0.5	0.87	0.13	26.0
	Above Max Guideline	0	12	35	0	0	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-
DW11	n	12	12	43	43	43	43	12	52
	Min	0.01	0.04	4.6	286	0.3	0.02	0.07	7.7
	Median	0.02	0.12	9.9	9210	0.4	0.26	0.08	16.7
	Max	0.05	0.21	26.7	78600	2.7	1.60	0.10	22.3
	Above Max Guideline	0	11	43	3	0	0	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-

**Table A38 Shoalhaven system – storages – *Cryptosporidium* and *Giardia***

Station Code	Statistic	<i>Cryptosporidium</i> oocysts IFA (Adj for Recovery for 10L)	<i>Giardia</i> cysts IFA (Adj for Recovery for 10L)
DW11	n	51	51
	Min	0	0
	Median	0	0
	Max	0	0
	Above Max Guideline	-	-
	Below Min Guideline	-	-

**Table A39 Shoalhaven system – water filtration plants – benchmark characteristics**

Station Code	Statistic	Alkalinity (CaCO3 mg/L)	Total Hardness (CaCO3 mg/L)	True Colour at 400 nm	Turbidity (NTU)	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Areal Standard Unit (ASU)	pH Lab/Field
HKV1	n	12	12	12	12	12	12	12	12	12
	Min	15	18	8	2.4	0.02	0.25	0.017	552.1	6.9
	Median	19.5	23.5	11	5.25	0.1	0.35	0.038	1647.5	7.2
	Max	28	27	18	6.2	0.16	0.58	0.078	4236	8
	Above Max Guideline	0	0	0	0	0	0	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HW11	n	12	12	12	12	12	12	12	12	12
	Min	11	13	6	4.8	0.08	0.14	0.012	1090	7
	Median	13	13	10	6.8	0.13	0.37	0.025	2076.5	7.4
	Max	31	16	18	7.3	0.2	0.9	0.062	3466	7.8
	Above Max Guideline	0	0	0	0	-	0	0	0	0
	Below Min Guideline	-	-	-	-	-	-	-	-	-

**Table A40 Shoalhaven system – water filtration plants – cyanobacteria**

Station Code	Statistic	Algal Total Count (cells/mL)	Algal Biovolume (mm3/mL)	Total Cyanobacterial cell count (cells/mL)	Total Cyanobacterial biovolume (mm3/L)	Microcystin LR + RR + YR (µg/L)	Toxic Cyanobacterial cell count (cells/mL)	Toxic Cyanobacterial biovolume (mm3/L)
HKV1	n	12	12	12	12	0	12	12
	Min	7360	0.736	2610	0.003	-	0	0
	Median	31105	2.24	17540	0.039	-	105.5	0.0016
	Max	230900	11.14	223400	0.143	-	1570	0.023
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-
HW11	n	12	12	12	12	10	12	12
	Min	32130	1.02	12490	0.03	LOR	488	0.007
	Median	69795	2.145	56475	0.153	0.6	4620	0.069
	Max	258800	4.07	246500	0.644	1.2	34580	0.518
	Above Minor Guideline	-	-	-	-	-	-	-
	Below Major Guideline	-	-	-	-	-	-	-

**Table A41 Shoalhaven system – water filtration plants - indicator bacteria**

Station Code	Statistic	<i>Clostridium perfringens</i> (cfu/100 mL)	<i>E. coli</i> (orgs/100mL)	Enterococci (cfu/100ml)
HW11	n	12	12	12
	Min	LOR	LOR	LOR
	Median	LOR	LOR	2
	Max	4	7	13
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
HKV1	n	13	13	13
	Min	LOR	LOR	LOR
	Median	3	8	6
	Max	12	140	57
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-

**Table A42 Shoalhaven system – water filtration plants – health related physical chemical**

Station Code	Statistic	Arsenic Total (mg/L)	Barium Total (mg/L)	Beryllium- Total (mg/L)	Boron Total (mg/L)	Mercury Total (mg/L)	Molybdenum Total (mg/L)	Selenium Total (mg/L)	Silver Total (mg/L)	Tin Total (mg/L)	Iodide (mg/L)
HW11	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.007	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.0085	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-
HKV1	n	4	4	4	4	4	4	4	1	4	1
	Min	LOR	0.012	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.014	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.015	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-

**Table A43 Shoalhaven system – water filtration plants - pesticides**

Station Code	Statistic	2,4-D (ug/L)	Amitrole (ug/L)	Atrazine (ug/L)	Chlorfenvinphos (E) (ug/L)	Chlorpyrifos (ug/L)	Clopyralid (ug/L)	Dichlobenil (ug/L)	Dimethoate (ug/L)	Diuron (ug/L)	Fluroxypyr (ug/L)	Glyphosate (ug/L)	Hexazinone (ug/L)	MCPA (ug/L)
HW11	n	4	4	11	11	4	11	4	11	4	4	11	11	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
HKV1	n	5	5	12	12	5	12	5	12	5	5	12	12	5
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	-
Station Code	Statistic	Azinphos-methyl (ug/L)	Picloram (ug/L)	Triclopyr (ug/L)	Trifluralin (ug/L)	Metsulfuron Methyl (ug/L)	Chlorothalonil (ug/L)	Accephate (ug/L)	Aminopyralid (ug/L)	Fluproprionate (ug/L)	Simazine (ug/L)	cis-1,3-Dichloropropene (ug/L)	trans-1,3-Dichloropropene (ug/L)	
HW11	n	4	11	11	11	5	4	4	4	4	11	4	4	
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Median	LOR	LOR	LOR	0.04	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Max	LOR	LOR	LOR	0.1	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
HKV1	n	5	12	12	12	5	5	5	5	5	12	5	5	
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	
	Above Max Guideline	-	-	-	-	-	-	-	-	-	-	-	-	
	Below Min Guideline	-	-	-	-	-	-	-	-	-	-	-	-	

**Table A44 Shoalhaven system – water filtration plants – synthetic organic compounds & radionuclides**

Station Code	Statistic	Gross Alpha	Gross Beta	1,1-Dichloroethane (ug/L)	1,2-Dichloroethane (ug/L)	cis-1,2-Dichloroethene (ug/L)	trans-1,2-Dichloroethene (ug/L)	Benzene (ug/L)	Hexachlorobutadiene (ug/L)	Trichloroethene (ug/L)
HW11	n	1	1	4	11	11	11	11	11	4
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HKV1	n	1	1	5	12	12	12	12	12	5
	Min	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-

## 6. Picnic Areas

**Table A45 Picnic areas – reportable benchmarks**

Station Code	Statistic	pH Lab/Field	Turbidity Lab/Field (NTU)	Total Manganese (mg/L)	Total Aluminium (mg/L)	Total Iron (mg/L)	Free Chlorine residuals (mg/L)	Chlorophyll-a (µg/L)	Toxic Cyanobacteria (cells/mL)	Microcystin variants (µg/L)	E. coli (orgs/100 mL)
HAV3	n	52	52	52	12	52	52	12	0	0	52
	Min	6.8	0	0.002	0.01	0.09	0	0.2	-	-	LOR
	Median	7.6	1	0.005	0.02	0.14	0.05	0.2	-	-	-
	Max	8.5	3.2	0.018	0.02	0.33	1.54	0.2	-	-	LOR
	Above Max Guideline	0	0	0	0	1	-	0	-	-	-
	Below Min Guideline	0	-	-	-	-	49	-	-	-	-
HBPP1	n	1	1	1	1	1	0	1	0	0	1
	Min	7.4	1	0.004	0.04	0.04	-	0.2	-	-	LOR
	Median	7.4	1	0.004	0.04	0.04	-	0.2	-	-	-
	Max	7.4	1	0.004	0.04	0.04	-	0.2	-	-	LOR
	Above Max Guideline	0	0	0	0	0	-	0	-	-	-
	Below Min Guideline	0	-	-	-	-	-	-	-	-	-
HCA1	n	52	52	52	12	52	52	12	0	0	52
	Min	6.4	0.5	0.006	0.04	0.33	0	0.2	-	-	LOR
	Median	7	1.2	0.026	0.08	0.44	0.45	0.2	-	-	-
	Max	7.6	2.9	0.106	0.12	2.15	1.8	0.5	-	-	LOR
	Above Max Guideline	0	0	1	0	52	-	0	-	-	-
	Below Min Guideline	1	-	-	-	-	27	-	-	-	-
HCO6	n	52	52	52	12	52	52	12	0	0	52
	Min	6.7	0.4	0.008	0.01	0.13	0	0.2	-	-	LOR
	Median	7.3	1.3	0.023	0.02	0.27	0.07	0.2	-	-	-
	Max	7.9	6.9	0.23	0.05	1.04	0.69	0.5	-	-	LOR
	Above Max Guideline	0	2	8	0	19	-	0	-	-	-
	Below Min Guideline	0	-	-	-	-	49	-	-	-	-
HFFR2	n	52	52	52	12	52	52	12	0	0	52
	Min	7.1	0.4	0.002	0.06	0.02	0.38	0.2	-	-	LOR
	Median	7.9	1	0.017	0.075	0.07	0.8	0.2	-	-	-
	Max	8.3	5.4	0.078	0.19	0.34	1.23	0.24	-	-	LOR
	Above Max Guideline	0	1	0	0	1	-	0	-	-	-
	Below Min Guideline	0	-	-	-	-	3	-	-	-	-
HNEP1	n	1	1	1	1	1	0	1	0	0	1
	Min	7.8	1	0.006	0.04	0.13	-	0.2	-	-	LOR
	Median	7.8	1	0.006	0.04	0.13	-	0.2	-	-	-
	Max	7.8	1	0.006	0.04	0.13	-	0.2	-	-	LOR

	Above Max Guideline	0	0	0	0	0	-	0	-	-	-
	Below Min Guideline	0	-	-	-	-	-	-	-	-	-
HWAP1	n	1	1	1	1	1	1	1	0	0	1
	Min	7.3	0.12	0.001	0.01	0.01	0.77	0.2	-	-	LOR
	Median	7.3	0.12	0.001	0.01	0.01	0.77	0.2	-	-	-
	Max	7.3	0.12	0.001	0.01	0.01	0.77	0.2	-	-	LOR
	Above Max Guideline	0	0	0	0	0	-	0	-	-	-
	Below Min Guideline	0	-	-	-	-	0	-	-	-	-
HWIP1	n	1	1	1	1	1	0	1	0	0	1
	Min	7.8	1.5	0.016	0.06	0.15	-	0.2	-	-	LOR
	Median	7.8	1.5	0.016	0.06	0.15	-	0.2	-	-	-
	Max	7.8	1.5	0.016	0.06	0.15	-	0.2	-	-	LOR
	Above Max Guideline	0	0	0	0	0	-	0	-	-	-
	Below Min Guideline	0	-	-	-	-	-	-	-	-	-
HWOP1	n	1	1	1	1	1	0	1	0	0	1
	Min	9.1	1	0.001	0.04	0.02	-	0.2	-	-	LOR
	Median	9.1	1	0.001	0.04	0.02	-	0.2	-	-	-
	Max	9.1	1	0.001	0.04	0.02	-	0.2	-	-	LOR
	Above Max Guideline	1	0	0	0	0	-	0	-	-	-
	Below Min Guideline	0	-	-	-	-	-	-	-	-	-

**Table A46 Picnic areas - health related physical chemical**

Station Code	Statistic	Arsenic Total (mg/L)	Barium Total (mg/L)	Beryllium-Total (mg/L)	Mercury Total (mg/L)	Molybdenum Total (mg/L)	Selenium Total (mg/L)	Silver Total (mg/L)	Tin Total (mg/L)	Iodide (mg/L)
HFFR2	n	12	12	12	12	12	12	12	12	12
	Min	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	0.002	0.01	LOR	LOR	LOR	LOR	LOR	LOR	0.001
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HBPP1	n	1	1	1	1	1	1	1	1	1
	Min	LOR	0.009	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.009	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.009	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HWIP1	n	1	1	1	1	1	1	1	1	1
	Min	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HCO6	n	12	12	12	12	12	12	12	12	12
	Min	LOR	0.011	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.02	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.023	LOR	LOR	LOR	LOR	LOR	LOR	0.002
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HCA1	n	12	12	12	12	12	12	12	12	12
	Min	LOR	0.003	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.007	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	0.001	0.008	LOR	LOR	LOR	LOR	LOR	LOR	0.034
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HAV3	n	12	12	12	12	12	12	12	12	12
	Min	LOR	0.005	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.0075	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.01	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HNEP1	n	1	1	1	1	1	1	1	1	1
	Min	LOR	0.005	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Median	LOR	0.005	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Max	LOR	0.005	LOR	LOR	LOR	LOR	LOR	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HWAP1	n	1	1	1	1	1	1	1	1	1
	Min	LOR	0.019	LOR	LOR	LOR	LOR	LOR	LOR	LOR

	Median	LOR	0.019	LOR						
	Max	LOR	0.019	LOR						
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-
HWOP1	n	1	1	1	1	1	1	1	1	1
	Min	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	0.02
	Median	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	0.02
	Max	LOR	0.008	LOR	LOR	LOR	LOR	LOR	LOR	0.02
	Above Max Guideline	-	-	-	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-	-	-	-

**Table A47 Picnic areas – additional health related physical chemical**

Station Code	Statistic	Antimony Total (mg/L)	Cadmium Total (mg/L)	Chromium VI Total (mg/L)	Copper Total (mg/L)	Lead Total (mg/L)	Nickel Total (mg/L)
HFFR2	n	12	12	12	12	12	12
	Min	LOR	LOR	LOR	0.006	LOR	LOR
	Median	LOR	LOR	LOR	0.008	LOR	LOR
	Max	LOR	0.0001	LOR	0.03	0.003	0.004
	Above Max Guideline	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-
HBPP1	n	1	1	1	1	1	1
	Min	LOR	LOR	LOR	0.014	LOR	LOR
	Median	LOR	LOR	LOR	0.014	LOR	LOR
	Max	LOR	LOR	LOR	0.014	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-
HWIP1	n	1	1	1	1	1	1
	Min	LOR	LOR	LOR	0.181	0.003	LOR
	Median	LOR	LOR	LOR	0.181	0.003	LOR
	Max	LOR	LOR	LOR	0.181	0.003	LOR
	Above Max Guideline	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-
HCO6	n	12	12	12	12	12	12
	Min	LOR	LOR	LOR	0.084	LOR	LOR
	Median	LOR	LOR	LOR	0.21	LOR	LOR
	Max	LOR	LOR	LOR	1.12	0.002	0.008
	Above Max Guideline	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-
HCA1	n	12	12	12	12	12	12
	Min	LOR	LOR	LOR	0.048	LOR	LOR
	Median	LOR	LOR	LOR	0.2215	LOR	LOR
	Max	LOR	LOR	LOR	1.45	0.003	0.011
	Above Max Guideline	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-
HAV3	n	12	12	12	12	12	12
	Min	LOR	LOR	LOR	0.081	0.001	LOR
	Median	LOR	LOR	LOR	0.1495	0.001	LOR
	Max	LOR	LOR	LOR	0.618	0.002	0.0005
	Above Max Guideline	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-
HNEP1	n	1	1	1	1	1	1
	Min	LOR	LOR	0.005	0.06	LOR	LOR
	Median	LOR	LOR	0.005	0.06	LOR	LOR
	Max	LOR	LOR	0.005	0.06	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-
HWAP1	n	1	1	1	1	1	1
	Min	LOR	LOR	LOR	0.049	LOR	LOR
	Median	LOR	LOR	LOR	0.049	LOR	LOR
	Max	LOR	LOR	LOR	0.049	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-
	Below Min Guideline	-	-	-	-	-	-
HWOP1	n	1	1	1	1	1	1
	Min	LOR	LOR	LOR	0.035	LOR	LOR
	Median	LOR	LOR	LOR	0.035	LOR	LOR
	Max	LOR	LOR	LOR	0.035	LOR	LOR
	Above Max Guideline	-	-	-	-	-	-

	Below Min Guideline	-	-	-	-	-	-
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**Table A48 Picnic areas – indicator bacteria**

Station Code	Statistic	Clostridium perfringens (cfu/100 mL)	E. coli (orgs/100mL)
HFFR2	n	0	55
	Min	-	LOR
	Median	-	LOR
	Max	-	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-
HBPP1	n	1	1
	Min	LOR	LOR
	Median	LOR	LOR
	Max	LOR	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-
HWIP1	n	1	1
	Min	LOR	LOR
	Median	LOR	LOR
	Max	LOR	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-
HCO6	n	0	52
	Min	-	LOR
	Median	-	LOR
	Max	-	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-
HCA1	n	0	52
	Min	-	LOR
	Median	-	LOR
	Max	-	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-
HAV3	n	0	52
	Min	-	LOR
	Median	-	LOR
	Max	-	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-
HNEP1	n	1	1
	Min	LOR	LOR
	Median	LOR	LOR
	Max	LOR	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-
HWAP1	n	1	1
	Min	LOR	LOR
	Median	LOR	LOR
	Max	LOR	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-
HWOP1	n	1	1
	Min	LOR	LOR
	Median	LOR	LOR
	Max	LOR	LOR
	Above Max Guideline	-	-
	Below Min Guideline	-	-

## 7. Downstream of storages

Table A49 Downstream of storages – physicochemical

Station Code	Statistic	pH Lab/Field	Turbidity Lab/Field (NTU)	Dissolved Oxygen (%Sat)	Total Nitrogen(mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (µg/L)
E303	n	12	12	12	12	12	12
	Min	6.9	1	91.1	0.32	0.012	6
	Median	7.6	8.9	99.1	0.52	0.017	9
	Max	8.2	12.8	103.1	0.58	0.032	18.5
	Above Max Guideline	0	0	0	7	0	12
Below Min Guideline	0	-	0	-	-	-	
E851	n	12	12	12	12	12	12
	Min	7	1.6	100.4	0.2	0.006	3.6
	Median	7.4	3.8	104.8	0.355	0.012	6.8
	Max	8	7.7	109.8	0.43	0.016	10.2
	Above Max Guideline	0	0	0	0	0	8
Below Min Guideline	0	-	0	-	-	-	
G0515	n	12	12	12	12	12	12
	Min	5.9	1.2	29	0.11	0.005	0.5
	Median	6.3	2.7	56.9	0.175	0.007	4.85
	Max	6.8	9.5	94.5	0.35	0.045	11.1
	Above Max Guideline	0	0	0	0	0	5
Below Min Guideline	9	-	11	-	-	-	
N44	n	12	12	12	12	12	12
	Min	7.3	1.6	89.8	0.43	0.006	3.4
	Median	7.8	2.7	96.6	0.64	0.011	7.9
	Max	8.2	7.47	112.8	1.1	0.026	11.3
	Above Max Guideline	0	0	1	11	0	8
Below Min Guideline	0	-	0	-	-	-	
N57	n	12	12	12	12	12	12
	Min	7.3	1.1	87.5	0.28	0.005	3.1
	Median	7.8	3.3	104.1	0.43	0.007	5.4
	Max	9.1	5.2	135.1	0.9	0.018	22.4
	Above Max Guideline	2	0	3	5	0	7
Below Min Guideline	0	-	0	-	-	-	
N64	n	12	12	12	12	12	12
	Min	7.4	1.2	96.2	0.42	0.005	3
	Median	7.7	3.4	101.2	0.64	0.007	4.7
	Max	8.3	4.8	114.4	0.98	0.014	36.3
	Above Max Guideline	0	0	3	9	0	5
Below Min Guideline	0	-	0	-	-	-	
N641	n	12	12	12	12	12	12
	Min	7	1.4	90	0.22	0.005	0.8
	Median	7.4	2.1	104.6	0.38	0.005	1
	Max	7.8	6.2	124.3	0.8	0.009	2.9
	Above Max Guideline	0	0	3	1	0	0
Below Min Guideline	0	-	0	-	-	-	
N67	n	12	12	12	12	12	12
	Min	7.2	3.2	80.6	0.41	0.008	4.2
	Median	7.5	6	102.3	0.72	0.0175	7.1
	Max	8.6	8.5	130.7	1.08	0.034	56.6
	Above Max Guideline	1	0	3	11	0	11
Below Min Guideline	0	-	2	-	-	-	
N75	n	12	12	12	12	12	12
	Min	7.2	1.9	91.7	0.43	0.008	3
	Median	7.5	3.5	97.2	0.765	0.014	6.7
	Max	7.7	6.1	105.8	1.76	0.02	21.2
	Above Max Guideline	0	0	0	11	0	9
Below Min Guideline	0	-	0	-	-	-	
N85	n	12	12	12	12	12	12
	Min	7.2	0.9	86.6	0.06	0.007	1.7
	Median	7.4	2.4	95.6	0.22	0.009	5.5
	Max	7.9	5.4	101.5	0.36	0.023	22
	Above Max Guideline	0	0	0	0	0	6
Below Min Guideline	0	-	0	-	-	-	

N86	n	12	12	12	12	12	12
	Min	6.6	1	102.9	0.12	0.005	0.2
	Median	7.2	1.8	105.8	0.21	0.0055	1.3
	Max	7.4	5.8	110.4	0.37	0.013	9.4
	Above Max Guideline	0	0	1	0	0	1
	Below Min Guideline	0	-	0	-	-	-
N881	n	12	12	12	12	12	12
	Min	6.6	0.1	103.3	0.1	0.005	0.3
	Median	7.2	1.2	104.6	0.205	0.005	1.05
	Max	7.7	2	107.6	0.24	0.008	6.2
	Above Max Guideline	0	0	0	0	0	1
	Below Min Guideline	0	-	0	-	-	-
N92	n	12	12	12	12	12	12
	Min	7.9	0.3	57.7	0.03	0.005	1.7
	Median	8.4	1	100.5	0.25	0.01	6.9
	Max	9.2	2.1	141	0.48	0.054	16.8
	Above Max Guideline	3	0	2	0	1	7
	Below Min Guideline	0	-	2	-	-	-

**Table A50 Downstream of storages – indicator bacteria**

Station Code	Statistic	<i>Clostridium perfringens</i> (cfu/100 mL)	<i>E. coli</i> (orgs/100mL)	Enterococci (cfu/100ml)
E303	n	11	11	11
	Min	LOR	LOR	LOR
	Median	9	5	10
	Max	28	28	140
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
E851	n	12	12	12
	Min	1	1	11
	Median	1	2	72
	Max	8	19	670
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
G0515	n	12	12	12
	Min	LOR	5	LOR
	Median	6.5	52	14.5
	Max	22	1000	54
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N44	n	12	12	12
	Min	LOR	12	12
	Median	3.5	52	46.5
	Max	11	170	68
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N57	n	12	12	12
	Min	LOR	5	5
	Median	LOR	50.5	38.5
	Max	5	610	410
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N64	n	12	12	12
	Min	LOR	LOR	2
	Median	1	3.5	7
	Max	3	20	63
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N641	n	12	12	12
	Min	LOR	LOR	LOR
	Median	LOR	3.5	1.5
	Max	3	9	14
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N67	n	12	12	12
	Min	1	8	8
	Median	1	31	34.5
	Max	15	210	330

	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N75	n	12	12	12
	Min	LOR	18	18
	Median	3	57	30
	Max	16	110	80
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N85	n	12	12	12
	Min	1	6	12
	Median	1.5	35	22.5
	Max	5	99	77
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N86	n	12	12	12
	Min	LOR	LOR	4
	Median	LOR	7.5	26
	Max	LOR	26	98
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N881	n	12	12	12
	Min	LOR	2	4
	Median	LOR	17.5	49
	Max	4	140	290
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-
N92	n	12	12	12
	Min	LOR	LOR	LOR
	Median	LOR	1.5	4
	Max	3	15	18
	Above Max Guideline	-	-	-
	Below Min Guideline	-	-	-

## Appendix B Wet Weather Auto-Samples

**Table B1: Number of wet-weather samples and events from Type 1 auto-samplers 2017–18**

Station Code	System	Number of samples	Number of events
E0321	Warragamba	1	1
E046	Warragamba	3	1
E306	Warragamba	4	1
E3151	Warragamba	1	1
E409	Warragamba	8	2
E4122	Warragamba	4	1
E457	Warragamba	4	1
E6131	Woronora	6	1
E680	Cordeaux	14	1
E7021	Shoalhaven	1	1
E847	Shoalhaven	9	1

\* Refer to catchment maps in Section 5 in report for location of auto-sampler sites.

\*\* An event is classed as successive samples being less than two days apart.

**Table B2: Wet-weather samples analysed for *Cryptosporidium* and *Giardia* from Type 2 auto-samplers and grab samples during 2017-18**

Station Code	System	Auto-sampler Type 2 and wet weather grab samples		Positive Pathogen Results	
		Number of samples	Number of events	<i>Cryptosporidium</i>	<i>Giardia</i>
E3151	2	1	1	1	0
E409	14	3	2	1	2
E4122	7	2	1	2	2
E457	7	2	1	0	1
E706	0	1	1	0	0
DDUC01	1	1	1	0	0
HPR1	6	5	3	0	0

## Appendix C Incidents

Date	Sub-type	Location	Details	Potential Consequences	Root Cause Analysis	Actions Taken
<b>MAJOR</b>						
Aug-2017	Algae	Wingecarribee WFP	An algal sample collected from 0-6m depth at Wingecarribee dam wall on 14 August 2017 recorded elevated counts and biovolume for potentially toxic algae <i>Nostocaceae</i> and <i>Microcystis</i> (14,690 cells/mL and biovolume of 1.579 mm <sup>3</sup> /L). This exceeds the major incident trigger level of 0.6mm <sup>3</sup> /L	Potential to produce the toxin microcystin. Long term health impacts of microcystin intake can include liver damage and is possibly carcinogenic.  Adverse health impacts are unlikely from short term exposure at levels below the ADWG health guideline.	Wingecarribee Reservoir has long been known to experience blooms of toxic cyanobacteria which often result in concentrations of cyanotoxins above the drinking water guidelines. These blooms are generally driven by the toxin producing cyanobacteria <i>Microcystis</i> , though other toxin producing species such as <i>Dolichospermum</i> , <i>Nostocaceae</i> and <i>Phormidium</i> also regularly appear in the counts in much fewer numbers. The Wingecarribee Water Filtration Plant is capable of treating algal toxins using powdered activated carbon.	Sampling was increased to twice weekly.  NSW Health and Wingecarribee Shire Council notified as per protocol.  Wingecarribee Shire Council continued to dose with Powdered Activated Carbon (PAC) to remove algal cells and toxins.  NSW Health advised that they were satisfied with the actions taken.
Feb-2018	Algae	Wingecarribee WFP	An algal sample collected from 0-6m depth at Wingecarribee dam wall on 20 February 2018 recorded elevated counts and biovolume for potentially toxic algae <i>Radiocystis</i> and <i>Microcystis</i> (61,832 cells/mL and biovolume of 0.961 mm <sup>3</sup> /L). This exceeds the major incident trigger level of 0.6mm <sup>3</sup> /L	Treatment of water at Wingecarribee WFP is expected to remove any toxins.		Results provided to Wingecarribee Shire Council and NSW Health. The plant continues to dose with PAC and is able to treat the water effectively, removing toxins. NSW Health consulted with the Council regarding plant performance and treated water sampling.
Nov-2017	Supply Agreement	Illawarra WFP	Filter clogging algae in the raw water to Illawarra WFP have increased to 11,760 ASU/mL. This is the highest result of this season's bloom and is largely attributable to the <i>Urosolenia</i> population.	Potential to clog filters in the Water Filtration Plant, impacting plant performance  Aesthetic water quality issue, No health guideline set.	Escalation of minor incident recorded in September 2017. The elevated algal ASU was mainly due to the presence of diatoms (especially <i>Urosolenia</i> ).	Ongoing weekly discussions with water Filtration Plant to share sampling results and forecast conditions. No treatment issues reported
<b>SIGNIFICANT</b>						
Nov-2017	Supply Agreement	Nepean WFP	Results from samples taken on 9 November 2017 showed algal ASU above the minor incident level	Potential to clog filters in the Water Filtration Plant, impacting plant performance	Naturally occurring algae, dominated by diatoms including the genus <i>Urosolenia</i>	WaterNSW notified Sydney Water plant operator who stated that the WFP is not having any difficulty treating the raw water to appropriate standards. WaterNSW

Date	Sub-type	Location	Details	Potential Consequences	Root Cause Analysis	Actions Taken
			according to the Water Quality Incident Response Plan.	Aesthetic water quality issue, No health guideline set.		recommended changing offtake to a lower outlet but Sydney Water preferred to remain at current level in the short term due to increased colour at depth
Nov-2017	Supply Agreement	Cascades WFP	Algal monitoring undertaken in the raw water to Cascades WFP on 9 November recorded 1,865 ASU/mL. This is above the minor incident trigger for Cascade WFP of 1,000 ASU. Increases were also recorded in Top Cascade Lake (1,938 ASU/mL) and Lake Greaves (1,134 ASU/mL).	Potential to clog filters in the Water Filtration Plant, impacting plant performance  Aesthetic water quality issue, No health guideline set.	Naturally occurring algae. Algal ASU dominated by diatoms including the genus <i>Urosolenia</i>	Sydney Water advise that Cascades WFP is not having any issues treating water to the required standards. Contingency plan developed to provide an alternative source via direct supply of water from Fish River Water Supply if required.

Date	Sub-type	Location	Details	Potential Consequences	Root Cause Analysis	Actions Taken
<b>MINOR</b>						
Sep-2017	Supply Agreement	Illawarra WFP	Algal sampling in the raw water to Illawarra WFP recorded 3,564 ASU/mL on 6 September 2017, which is above the minor incident level of 3,000 ASU as per Water Quality Incident Response Plan.	Potential to clog filters in the Water Filtration Plant, impacting plant performance  Aesthetic water quality issue, No health guideline set.	The elevated result was mainly due to the presence of diatoms. ASU is also slightly elevated in the lake, but lower than results from the raw water.	Discussed with WFP operator, who hasn't seen any perceivable impacts on filter performance. They have also conducted additional jar testing, which has provided ideas and potential options if they do experience any treatment problems.
Sep-2017	Supply Agreement	Macarthur WFP	Filter clogging algae in the raw water to Macarthur WFP recorded a rise to 329 ASU/mL from a sample collected on 19 September. This result is above the WaterNSW minor incident trigger of 100 ASU, for the average of the last three samples. In this case, the last three monthly samples resulted in an average of 146 ASU. This result remains below the 500 ASU target	Potential to clog filters in the Water Filtration Plant, impacting plant performance  Aesthetic water quality issue, No health guideline set.	Monitoring conducted at Broughtons Pass a few days prior did not indicate any issues with algae. The largest contributor to the ASU was the diatom <i>Urosolenia</i> . Increases and fluctuations in diatoms are expected this time of year.	Water Filtration Plant notified as per Raw Water Quality Incident Response Plan. Plant reported no issues treating the water.

			during low flows (<125 MLD), as outlined in the Raw Water Supply Agreement			
Oct-2017	Contamination	Nepean Picnic Area	The contractor installing fibre optic cable to the Sydney Water Filtration Plant noticed a hydraulic line had leaked prior to start of work on Saturday 14/10. Initial indication showed it to be minor, and the hydraulic line was replaced. The following day, it was observed that the leak was more significant and the contractor undertook more rigorous investigation and documented in accordance with their processes.	Potential contamination of raw water supply	Defective hydraulic hose line	Initial leak controlled and hoses replaced. Spill/Absorbent material placed below the boring machine. Clean up with chemical degreaser, pump out truck and removal of soil undertaken on Sunday.No runoff into the special area, no contamination to supply.
Dec-2017	Alarm	Upper Canal	At 1423 Hrs on Saturday 2/12/17, the duty PINO received an SCADA alarm for high hydrocarbon from the sensor in the Upper Canal at Prospect. On checking the SCADA it was noted that the reading was 35.8 ppm, well above the background (~2 ppm).	Detection of hydrocarbons in raw water supply may indicate a spill (such as fuel from a motor vehicle)	Likely instrument error. The hydrocarbon meter reading dropped back down to 2.6 ppm (background level) at about 14:40pm. Prospect WFP have not observed any oil in the sample from the turbidity sampling line.	WaterNSW advised Prospect WFP immediately and requested diversion of Upper Canal flow to Prospect Reservoir. The plant had no treatment issues and sampling found no indication of contamination. Supply was resumed after two hours.  WaterNSW has installed an auto sampler at the site to provide the ability to capture samples whenever the instrument goes into alarm
Dec-2017	Alarm	Upper Canal	Hydrocarbon alarm in SCADA at 1945 on 14/12/17.		WaterNSW has inspected the canal several times with no sign of a source of contamination.  Results from sampling did not detect any contaminants.  Other than these two spikes, the hydrocarbon meter has been reading background levels  Other water quality parameters are stable.	
Jan-2018	Algae	Wingecarribee WFP	A sample taken from Wingecarribee Reservoir on the 15th January returned a potentially toxin producing cyanobacteria biovolume of 0.288mm <sup>3</sup> /L, which is above the	Potential to produce the toxin microcystin. Long term health impacts of microcystin intake can include liver damage and is possibly carcinogenic.	Wingecarribee Reservoir has long been known to experience blooms of toxic cyanobacteria which often result in concentrations of cyanotoxins above the drinking water	Results provided to Wingecarribee WFP. Plant continues to dose with PAC in response to elevated algal counts (major incident levels reported in August 2017)

			minor incident trigger of 0.2 mm <sup>3</sup> /L. Dominant algae are Microcystis (species unknown) and Radiocystis	Adverse health impacts are unlikely from short term exposure at levels below the ADWG health guideline. Treatment of water at Wingecarribee WFP is expected to remove any toxins.	guidelines. The Wingecarribee Water Filtration Plant is capable of treating algal toxins using powdered activated carbon.	
Feb-2018	Supply Agreement	Cascades WFP	Sampling on 1 February recorded a total algae ASU at 1,568 ASU/mL in the raw water (HCSR). This is at the minor incident trigger level outlined in the Raw Water Quality Incident Response Plan. This is a significant rise since last sampling on 4 January which recorded only 158 ASU/mL in the raw water.	Potential to cause inconvenience to water filtration plant, reducing filter run times	Algae occur naturally in all waterways. Dominant organism is the large diatom <i>Urosolenia</i> .	Results and speciation reported to WFP. No impact on plant performance reported.
Mar-2018	Wildlife	Cascades WFP	Large population of jelly fish (millions) were observed by WaterNSW sampler during routine sampling at Upper Cascades Dam on 29/03/18	No health risk to water supply but possibility of filter clogging at water filtration plant	Upstream phytoplankton bloom and transfer of jellyfish down the supply. Jellyfish ( <i>Craspedacusta sowerbii</i> ) is not a native species but are known to be living in Australia and have been sighted in this lake in previous years.	Teleconference held between WaterNSW, Sydney Water and NSW Health. No health risk identified but additional sampling arranged to determine biomass of jellyfish. No impact on plant performance reported.
May-2018	Supply Agreement	Macarthur WFP	Routine sampling undertaken on 6 and 7 June 2018 returned results of 523.5 and 631.6mg/L of Algal ASU in the raw water supply to Macarthur WFP, exceeding the minor incident level (75mg/L) in the Raw Water Quality Incident Response Plan.	Potential to cause inconvenience to water filtration plant, reducing filter run times	Algae occur naturally in all waterways. Dominant organism is the large diatom <i>Synedra</i> . Sampling from upstream storages show slight elevation in Lake Cataract but more likely a local issue in the Broughtons Pass area	Macarthur WFP notified of results and speciation. No issues with operation of the treatment plant. No issues with supply to consumers but plant to monitor filter performance.
Jun-2018	Supply Agreement	Cascades WFP	A sample of raw water supplied to Cascades WFP on 7 June 2018 recorded alkalinity of 28mg CaCO <sub>3</sub> /L. Minor incident level is 22.5mg/L	Changes in alkalinity can affect performance of water filtration plant	Elevated alkalinity in water transferred from Oberon Dam	Results reported to Water Filtration Plant. Noted that alkalinity will remain elevated while transfers from Oberon continue
Jun-2018	Supply agreement	Cordeaux Picnic Area	Turbidity	Elevated turbidity may indicate inadequate disinfection	Possible suspension of biofilm from reservoir tank	Taps at picnic area flushed