ACT WATER REPORT 2008–2009

ACT GOVERNMENT

FOR THE QUEEN, THE LAW, AND THE PEOPLE

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MINISTERIAL FOREWORD ACT WATER REPORT 2008–2009

Canberra's continued health and prosperity depends on the sustainable management of our water resources. It is vital we continue to manage successfully the waterways and aquifers in the ACT.

The ***ACT Water Report 2008–2009*** provides important information about our waterways and the impact of the urban, rural, forestry and conservation land practices in the ACT.

The report provides comment on the way in which we use our waterways, from recreation to irrigation. Water access entitlements and licences to take water for the period 2008–2009 are recorded in the report.

This year the report continues an examination of the way our catchments and waterways are responding to the ongoing impacts of drought and recovery following fire damage. Ongoing stewardship in line with the ACT government policy *Think water, act water* is the responsibility of us all. Nevertheless, the quality of water leaving the Territory is at least as good as that entering it.

This year has seen sustained blooms of various algal kinds in our lakes, indicating just how deep the drought has impacted. These blooms were fed by the gradual concentration of nutrients seeping into the lakes in the low drought flows. Even so, the indication from a review of the long-term trends in parameter values, the condition of our urban water is positive with no parameter showing a trend away from expected standards.

In non-urban areas, streams that deteriorated post-bushfire have stabilised and are maintaining moderate to good condition under drought stress. Fish stocks and diversity have been reviewed in the Murrumbidgee, Cotter and Queanbeyan rivers in the last year. Macquarie perch are now at their highest density in the Cotter since 1997, and recruitment of many other species (including trout cod and two spined blackfish) has increased in the Cotter and the Murrumbidgee.

In addition to the monitoring undertaken by the government, many community organisations are making significant contributions to care for our waterways. Community monitoring programs focus on water quality, and assess aquatic fauna, such as frogs and macroinvertebrates, and riparian condition. Such community groups should be commended for their ongoing dedication to our precious waterways.

Think water, act water now shapes the format of the report. The report provides data to demonstrate that water quality in the region is meeting acceptable standards, and there is ongoing efficient use of that resource. The report recognises the need for cross-border water management, and includes information on waterway health in relation to the demands of both the local and downstream users. The data presented in the report commends the efforts towards water sensitive urban design where such planning delivers improved data for urban waterways.

I welcome this report and look forward to following the continued improvement of our catchments and waterways as they recover from the difficulties of drought and storms.

Simon Corbell
Minister for the Environment, Climate Change and Water

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EXECUTIVE SUMMARY

The Department of the Environment, Climate Change, Energy and Water (DECCEW) manages a water monitoring and assessment program for the Australian Capital Territory that includes water quality, streamflow, and biological monitoring. This program is part of maintaining up-to-date information on the water resources of the ACT, a statutory requirement of the *Water Resources ACT 2007*. Additionally this information is used to assist in determining whether management strategies used to achieve or maintain the aquatic values set for ACT waters are appropriate.

The report is intended to provide the community with information regarding the state of water resource management in the ACT, including quality and quantity. The assessment approach adopted is designed to move towards a more holistic ecosystem health monitoring system as advocated by the Murray-Darling Basin Commission's Sustainable Rivers Audit. It uses biological data to ascertain ecosystem diversity, and water quality data to determine trends that may be present, and compares these results with the designated environmental and use values and standards set in the Territory Plan, the *Environment Protection Act 1997* and its regulations, the *Environment Protection Regulation 2005* and the *Water Resources Act 2007*.

Streamflow monitoring provides contextual information and is used to gauge the impact of removing water from the environment for other uses and , more recently, of the drought. Water quality is monitored in the major urban lakes (with the exception of Lake Burley Griffin, a Commonwealth responsibility) and Burrinjuck Reservoir (a NSW responsibility) the first major water body downstream of the ACT. The major rivers and some urban streams are also monitored. River flow is measured at a number of sites throughout the ACT. The report uses AUSRIVAS biological information to report the biodiversity in the rivers and streams (see p. 37). The individual data points and mean values of water quality parameters for the year are considered with reference made to the standards set out in the Territory Plan and *Environment Protection Regulation 2005*.

Results for the 12-month reporting period (July 2008–June 2009) showed that rainfall in the urban area was almost the same as 2007–2008 and below the long-term average. Rainfall in the water supply catchments was close to but below the long-term average with peak stream flow coincident with rain in September, November and December. The good rain in April was mostly absorbed in the catchment.

Environmental conditions in urban waterways remain at the degraded condition of previous years, continuing to suffer stress from drought induced low flows and development disturbances. Environmental conditions in non-urban waterways occasionally vary from reference conditions following storm events. Examination of the long-term trends in turbidity and suspended solids indicate that the Murrumbidgee catchment remains fragile after the 2003 bushfire and the potential for major sedimentation events is ongoing.

All the urban lakes are now showing water quality close to or within recommended limits. All of the urban lakes have shown high readings for chlorophyll 'a' for much of the year. Phytoplankton numbers have been high and have included green and golden-green algae as well as blue-green algae (cyanobacteria). The long lake closures (from February to May in Lake Tuggeranong) were precautionary and the longest periods for many years. Point Hut Pond water quality has improved so that in the reporting period most water quality indicators were within limits although turbidity remains high because of fine bottom sediments.

The *Water Resources ACT 2007* came into full effect in August 2007 and required assessment of river flows, and licensing of water abstractions. In recent years, particularly since the recent drought, the demand for surface and groundwater has risen considerably. Consequently the water abstracted in some subcatchments has reached the sustainable limit. Holders of Water Access Entitlements under this Act are issued with licences to extract water within regularly sustainable volumes.

The ACT Government has 14 groundwater monitoring bores in high demand areas within the ACT and monitoring continues to assess the aquifer response to abstraction and rainfall. Research continues on catchment processes and threatened fishes. Water related community programs, such as Waterwatch (including Frogwatch), continue to attract a high level of interest and support from the community.

INTRODUCTION

Purpose

The *ACT Water Report 2008–2009* is intended to provide the Australian Capital Territory community with information on the state of the ACT's water resources for the year 1 July 2008 to 30 June 2009.

The report is divided into three sections. Section 1 examines the water resources in the ACT, including the amount of water and its use. Section 2 discusses water quality condition including the type of indicators used for assessing water quality and biological condition. Results for lakes and rivers are given in the context of water quality standards. Section 3 outlines research and community activities taking place throughout waterways in the ACT.

Scope

The report focuses on the waterways of the ACT with the exception of Lake Burley Griffin. It will cover the past year's water conditions and the long-term trends for the period 2002–2003 to 2008–2009.

Lake Burley Griffin is a Commonwealth responsibility and the condition of the lake is presented in an annual report produced by the National Capital Authority. For information relating to Lake Burley Griffin, contact the National Capital Authority on 6271 2888 or at www.nationalcapital.gov.au.

Information relating to drinking water quality of the mains water supply is the responsibility of ACTEW and the Chief Health Officer, and is not included in this report. For information relating to mains water supply, contact ActewAGL on 13 14 93 or at www.actewagl.com.au.

Land Use

Land use is an important consideration for water quality because different land uses have different impacts on water quality (because of rates of soil erosion and sediment transport) and hydrology (impervious surfaces in urban areas increase storm water runoff and may reduce groundwater recharge). There are four major land uses in the ACT (see Figure 1). In normal circumstances, conservation land use tends to have a minimal negative impact on water quality. However, as a result of the January 2003 bushfires and the ongoing drought, soil erosion and sediment movement continue to have the potential to impact on the water quality of waterways in ***conservation land use*** areas. ***Plantation forestry*** and ***rural use*** can have significant impacts on water bodies where these activities result in soil erosion, on-farm water retention, or the release of agricultural chemicals and animal waste. ***Urban use*** has the greatest potential for negative impact on local water quality. Materials entering urban waterways, which include fertilisers and other chemicals, organic matter, soil, oil, and small amounts of sewage effluent, are likely to impact on the health of our waterways. During drought periods the impact of pollutants on waterways can be inflated as there will be less flow to dilute the pollutants. Run-off from sudden storms after long dry periods can deposit very high levels of soil, organic matter and rubbish in waterways. Riparian condition for urban waterways is usually severely modified to park-like conditions. This can reduce biodiversity markedly and unfavourably promote conditions suitable for aquatic weeds and nuisance algae.

Rivers in the ACT Region

The Murrumbidgee River is the major river flowing through the ACT; originating in the alpine area to the south of the ACT. However, the headwaters of the Murrumbidgee are largely diverted to the Snowy River Scheme from Tantangara Reservoir for irrigation and power generation purposes. Murrumbidgee River waters that do flow through the ACT are further regulated downstream of the ACT border at Burrinjuck Reservoir. All rivers and creeks in the ACT drain to the Murrumbidgee River (see Figure 1). For example, the Molonglo and Queanbeyan Rivers, which originate to the southeast of the ACT, together drain through Lake Burley Griffin before flowing into the Murrumbidgee River.

Bushfires

The fires of January 2003 (see Figure 1) continue to be a major influencing factor on the condition of the ACT's waterways. The fires had a significant effect on a large proportion of the water catchments in the ACT, including the areas around and in our reservoirs. Monitoring and research into various ecosystem components, such as riparian vegetation and sediment transport, highlighted in the Environment ACT Bushfire Recovery Plan (www.environment.act.gov.au/Files/bushfirerecoveryplan.pdf) is continuing.

Protection of Water Resources

The ACT Government seeks to manage catchments and waterways so that sustainable and appropriate water conditions are attained. This includes an integrated catchment approach to planning, development controls, controls on water abstracted, the licensing of end of pipe discharges and regulation of non-point source discharges through the requirements of erosion and sediment control plans. There is an increasing emphasis on improved design and management of urban stormwater systems to reduce urban impacts on water quality. Urban stormwater infrastructure such as gross pollutant traps, water quality control ponds, wetlands and vegetated floodways are designed and managed to ensure that water quality is suitable for designated uses. The 'WaterWays: Water Sensitive Urban Design General Code' in the Territory Plan (www.actpla.act.gov.au/tools_resources/legislation_plans_registers/plans/territory_plan) will help ensure that urban development is consistent with sound water resource management.

The Territory Plan Environmental and Use Values

Volume 2 of the Territory Plan, General Code 1.8 'Water Use and Catchment General Codes', sets the permitted uses and protected environmental values for the waterways in the ACT. The plan identifies three types of catchments: drainage and open space, water supply and conservation. For streams, lakes and rivers within each of these catchment types, the Territory Plan also identifies a set of values e.g. maintenance of ecosystems, recreation and water supply. This set includes a primary value and a range of other permitted uses, which are generally compatible with, but secondary to, the primary value. These permitted uses specified in the Territory Plan can then be used, with the water quality standards, to determine the water quality required for each water body.

Water Quality Standards

Water quality standards are listed in Schedule 4 of the *Environment Protection Regulation 2005*. These tables list the necessary water quality to support each of the water uses referred to in the Territory Plan. Table 1 provides examples of some of the water quality standards for certain water uses.

Figure 1. Land Use and Main Rivers of the ACT

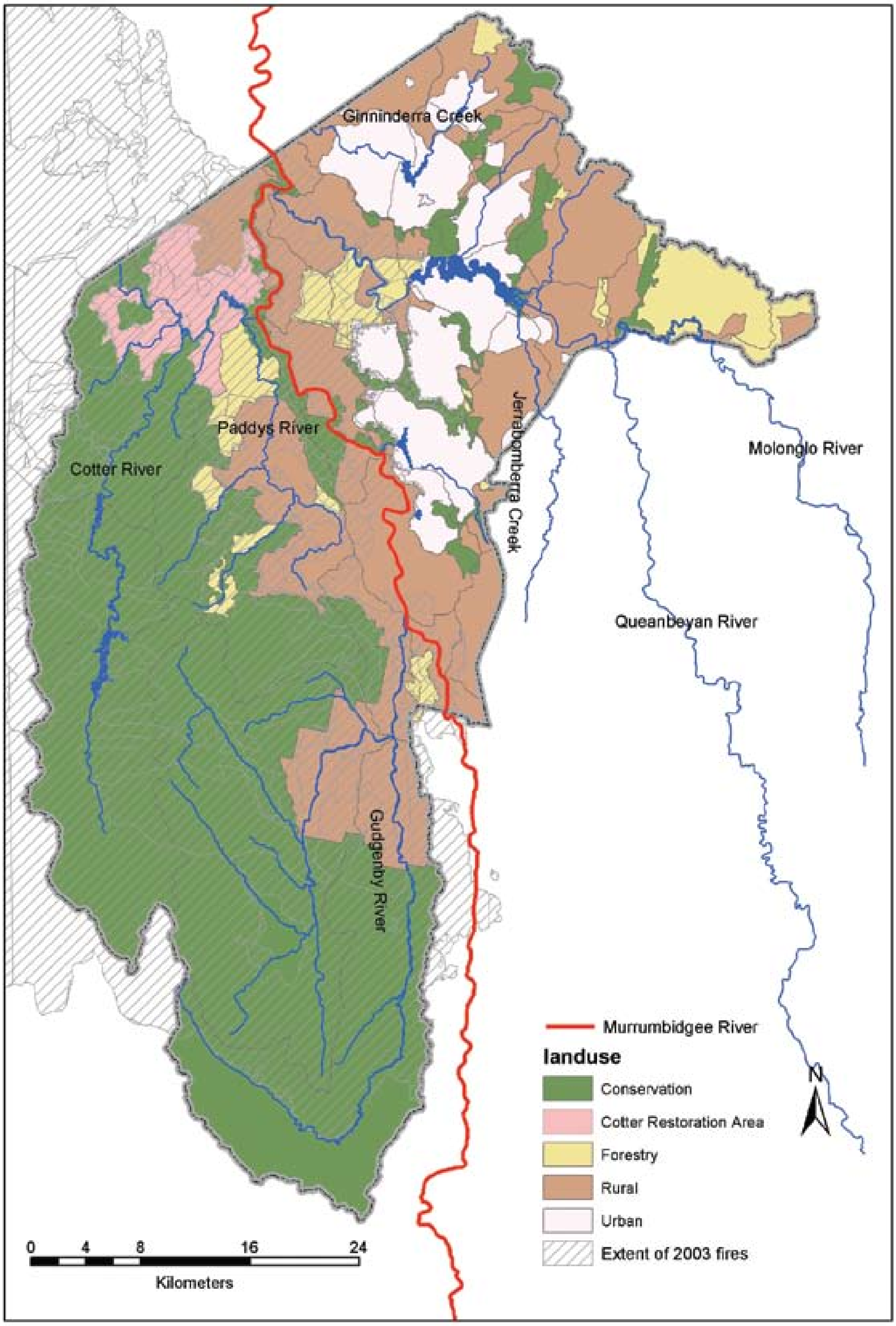


Table 1. Water Quality Standards (*Environment Protection Regulation 2005*)

Indicator	Water Use				
	Water-based recreation		Water supply		Aquatic habitat
	Swimming (REC/1)	Boating (REC/2)	Stock (STOCK)	Irrigation (IRRIG)	Wetland (AQUA/1 to AQUA/6)
Total Phosphorus (mg/L)	< 0.1	< 0.1			< 0.1
Turbidity (NTU)	Not objectionable	Not objectionable			<10 – <30
Suspended Solids (mg/L)					<12.5 – <25
Chlorophyll 'a' (µg/L)	< 10	< 10	< 10		<2 – <10
Faecal coliforms (cfu/100mL)	≤ 150	≤ 1,000	≤ 1,000	≤ 1,000	
Dissolved Oxygen (mg/L)					>4
Acidity (pH)	6.5–8.5	6.5–8.5	6.5–9.2	4.5–9.0	6–9
Total Dissolved Solids (mg/L)			< 3,000	< 500	

SECTION 1: WATER RESOURCES

Water Resource Use

The Act. The *Water Resources Act 2007* (the Act) provides a framework for the sustainable management of ACT water resources. The Act is the law that controls how people living and working in the ACT use water directly from water bodies including groundwater aquifers. The Act aims to balance present day household, industrial and agricultural use of water with protection of local ecosystems while conserving the resource to meet the reasonable future needs of the community. The Act endeavours to protect aquatic ecosystems and aquifers from damage and, where possible, reverse damage already done. The *Water Resources Act 2007* replaced the *Water Resources Act 1998.*

The Act and its regulations contain arrangements for the management of the Territory's water resources. They identify, for each water management area in the ACT, how much water is required to maintain river systems and associated ecosystems and how much is available for entitlements for off-stream use.

The Instruments. Under the Act, the document *Water Resources (Water management areas) Determination 2007* (No 1) details the water management areas which include one or more of the previously recognised sub-catchment areas, as provided for by the former water resources management plan (see Volume 3 *Think water, act water* www.thinkwater.act.gov.au/more_information/publications.shtml). *Water Resources (Water available from areas) Determination 2007* (No. 1) details the surface water and groundwater available for taking from each water management area and includes water reserved for future use. These measures ensure the Territory's water resources are managed appropriately. Water management area boundaries used for this purpose are set out in Figure 2.

Environmental Flows. The Act requires that water needed to maintain river systems and associated ecosystems is identified and reserved for that purpose. These requirements are generally referred to as environmental flows. Environmental flow requirements apply to all Territory water resources including water in rivers, streams, dams, lakes and groundwater aquifers. The Environmental Flow Guidelines can be accessed at www.environment.act.gov.au/water/act_water_resources.

Extraction Regulations. The Act makes it clear that control of all water use in the Territory, including from streams, dams or groundwater, is vested in the Territory. Under the Act it is a requirement to hold a **Water Access Entitlement** (WAE) before a **Licence to Take Water** can be issued. A WAE is a right to an amount of surface water or groundwater within a Water Management Area. A Licence to Take Water is required to physically extract the water specified by a WAE. The Licence to Take Water states the location and conditions from which water can be taken and used.

ACTEW holds a licence to take water and so customers of ACTEW are not required to hold a licence to take water when using water supplied by ACTEW. The taking of surface water for stock and domestic purposes, where water is collected from the lessee's property or where their property directly abuts a waterway, does not require a licence. Nor does the Act require a licence for the use of water collected in rainwater tanks, or the on-site use of waste water.

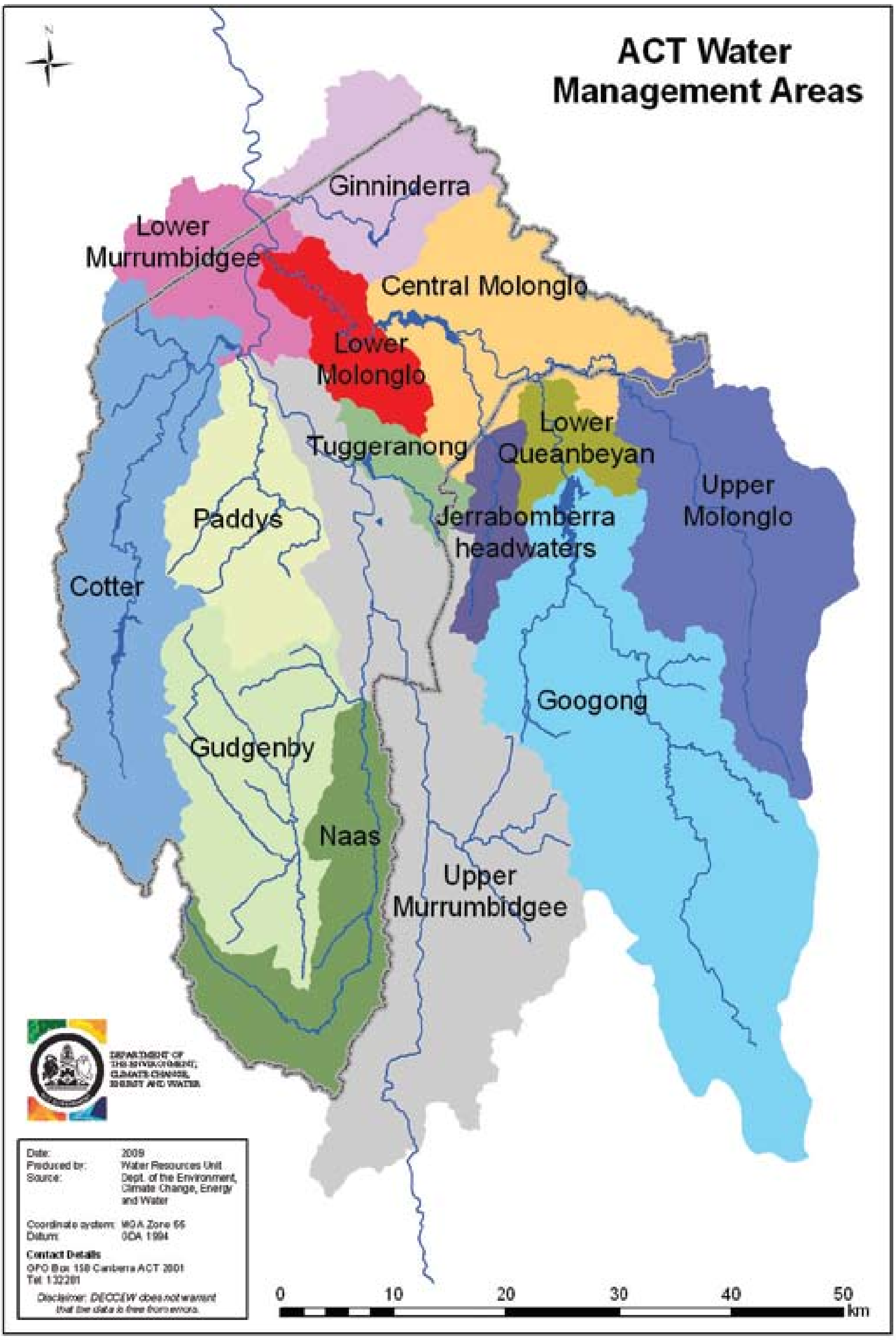
Information. Details of legislation, environmental flows and fact sheets on specific water allocation uses can be obtained from the DECCEW website (www.environment.act.gov.au) or by calling Canberra Connect on 13 22 81.

Fostering Sustainable Water Resource Use Through Regulation

The Minister for the Environment, Climate Change and Water generally issues Water Access Entitlements (Table 2) and the Environment Protection Authority (EPA) issues Licences to Take Water (Table 3a and b) Bore Works Licences and Waterway Works Licences (needed for construction of dams), subject to conditions and volume considerations. Together these controls allow the EPA to manage the use of water resources in an environmentally sensitive manner.

Full details of water-related entitlements and licences issued by the EPA are available for inspection in the Water Resource Act Register. Appointments for inspection can be made by contacting the EPA on 13 22 81.

Figure 2. Boundaries of Water Management Areas under the Water Resources Act 2007



Water Allocations

A Water Access Entitlement (WAE) is an entitlement to the volume of surface water or ground water stated in the entitlement. Under the present Act there are fourteen Water Management Areas in which WAEs may be held. All 149 WAEs (or surviving allocations) are listed below in Table 2. Whilst some of the allocations issued under the 1998 Act remain as surviving allocations and have not been replaced by WAEs under the existing Act, for the purposes of reporting, they are all referred to as WAEs.

Table 2. The number of WAEs and related water volume within ACT water management areas

Water Management Area	Number of WAEs	Related Water Volume (ML)
Cotter	3	58,000
Googong	7	12,812
Total (urban water supply)	**10**	**70,812**
Central Molonglo	11	2,226
Ginninderra	45	2,041
Upper Murrumbidgee	36	1,893
Lower Molonglo	19	1,906
Tuggeranong	9	853
Lower Murrumbidgee	7	139
Paddys	7	104
Gudgenby	2	24
Upper Molonglo	1	-
Naas	2	6
Jerrabomberra Headwaters	-	-
Lower Queanbeyan	-	-
Total (other)	**139**	**9,192**

Licences to Take Water

Among the 193 licences to take water issued or renewed this year following the implementation of the new Act, seven were wholly new licences (Table 3a). A license holder must have a WAE and may hold multiple WAEs, but not all WAEs may have active licenses in the reporting period. The ACT government does not control water extraction at sites other than the Reservoir in Googong, in Jerrabomberra Headwaters or Lower Queanbeyan or Googong WMAs as these areas are under New South Wales jurisdiction.

Table 3a. Licences issued in reporting period, 2008–2009

Licence Type	Licences issued
Waterway Works Licence	37
Bore Works Licence	9
Driller's Licence	7
New Licence to Take Water	7
Current Licences	193*

*This figure includes all licences, newly issued or renewal of existing licences.

Table 3b. The number of Licences to Take Water by Water Management Area and water type, including volumes from ACTEW's licence for potable water supply

Water Management Area	Number of Licences to Take Water			Total Licenced Volume (ML)
	Groundwater (only)	Surface Water (only)	Surface and Groundwater (only)	
Cotter		1		58,000
Googong		1		12,000
Total (urban water supply)		**2**		**70,000**
Central Molonglo	95	15	6	2,388
Ginninderra	8	8	3	1,461
Upper Murrumbidgee	12	5	2	559
Lower Molonglo	12	1		213
Tuggeranong	3	1		110
Lower Murrumbidgee		2	1	133
Paddys	3	2	1	114
Gudgenby	1			9
Upper Molonglo	1			2
Naas				2
Jerrabomberra Headwaters				-
Lower Queanbeyan				-
Total (other)	**136**	**36**	**13**	**4,990**

While the table above is definitive in its depiction of total licensed volume of water in the ACT, it is recognised that there may still be unlicensed bores in use and existing licence holders may exceed their licensed volume. The EPA conducts a compliance program to monitor volumes extracted by licensed extractors and detect unlicensed extraction.

Climate and Water Resources

The availability of the ACT's water resources is strongly influenced by rainfall. Groundwater recharge in the ACT's low yield fractured rock aquifers is closely linked to recent rainfall history, unlike some other groundwater sources that contain stored rainfall from millions of years ago. In 2008–2009 stream flow in waterways arising within the ACT has often been negligible as most of the rainfall has been absorbed directly into the catchment. Stream flow in the Murrumbidgee and Molonglo Rivers crossing the ACT includes additional contributions from substantial areas of their catchment outside the ACT.

Rainfall in the ACT is strongly affected by the landform. In the mountainous region to the west of the Murrumbidgee River, annual average rainfall ranges from 800–1,000 mm. In the flatter tablelands on which Canberra the annual rainfall reaches 600–700 mm. In the present 12-month reporting period Canberra's annual rainfall was 524 mm, 3 mm below the 527 mm in 2007–2008 and once again only 85 per cent of (91.4 mm less than) the long-term average for Canberra Airport of 615.4 mm.

Rainfall in an urban area (Charnwood Road in Belconnen) and in a water supply catchment area (Cotter Hut, above Corin Reservoir) is depicted in Figure 3. These are two sites where rainfall measured is directly correlated with stream flow in the ACT, and so demonstrate the rainfall and landform interaction. Both the long-term average monthly rainfall from data collected since 1990, and the monthly rainfall for the 2008–2009 reporting period are presented.

Figure 3. Comparison of 2008–2009 monthly rainfalls in Belconnen near Charnwood Road and Cotter Hut in the Corin Reservoir Catchment with the long-term average monthly rainfall

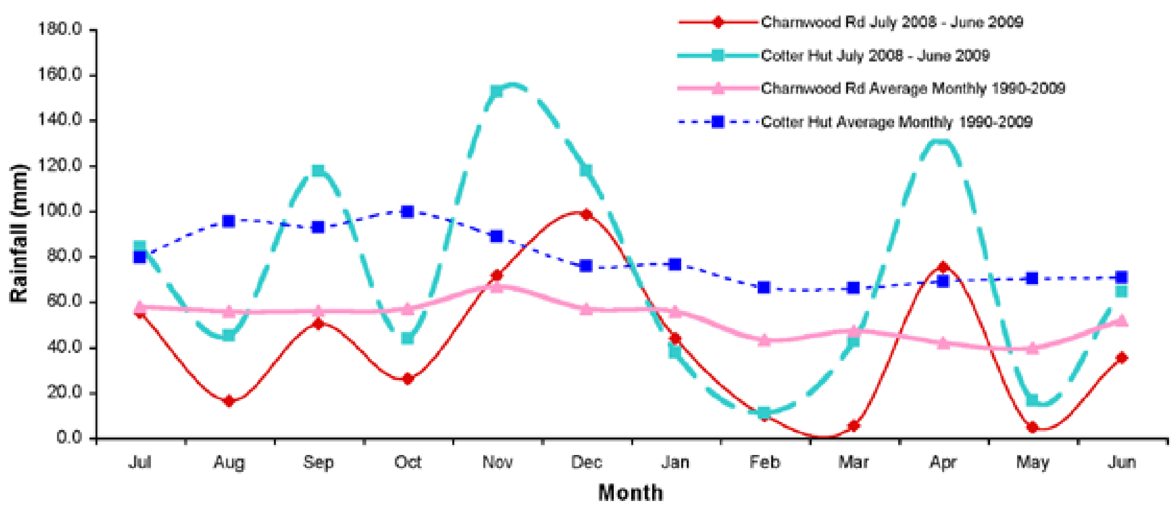


Figure 4. Comparison of average monthly flow (July 2008–June 2009) in Ginninderra Creek upstream of Charnwood Road compared with the long-term average monthly flow for that site

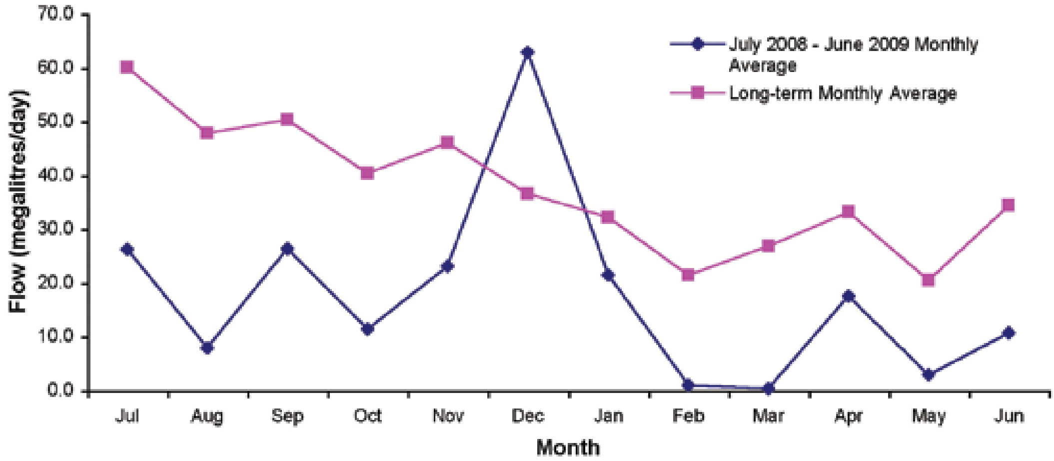
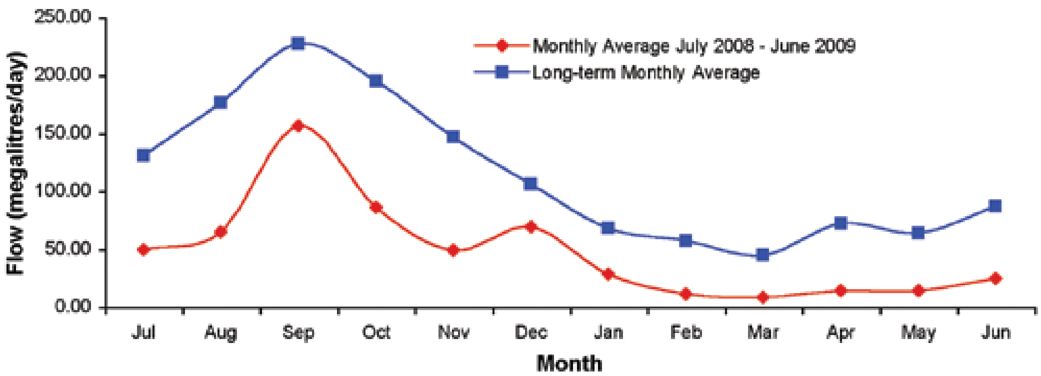


Figure 5. Comparison of average monthly flow (July 2008–June 2009) in Cotter River with the long-term average monthly flow for a site upstream of Corin Reservoir

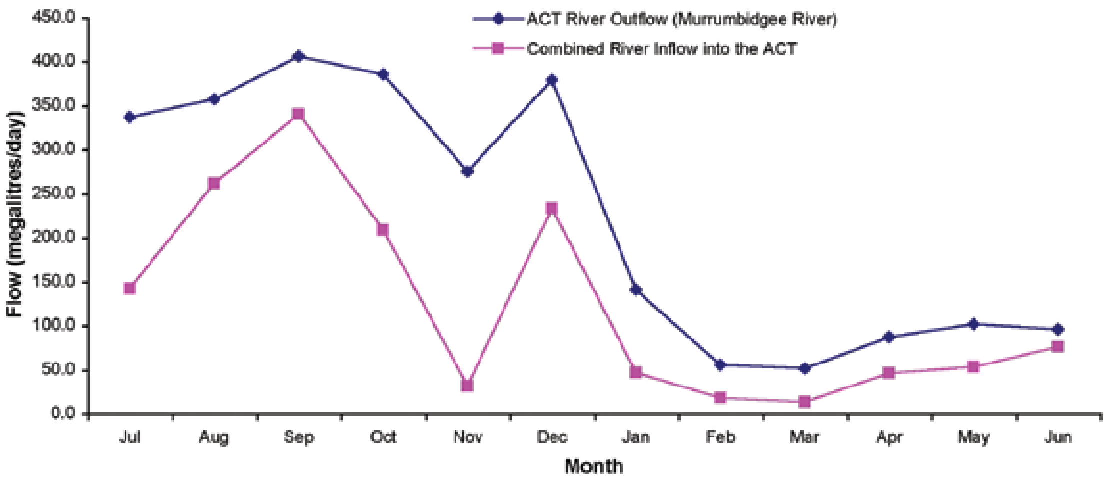


The long-term average annual rainfall since 1990 in Belconnen at the Charnwood Road site is 628 mm and the annual rainfall for this reporting period, 1 July 2007 to 30 June 2008, was 78 per cent of the long-term average at 490 mm. This is a little lower than 2007–2008 and the main falls were in November, December and April. The site at Cotter Hut has a long-term annual rainfall of 948 mm and for this reporting period the total rainfall was 863 mm, 91 per cent of average rainfall with above average rain in September, November and December 2008 and good falls in April 2009. This is the fourth year running of below average rainfall. The early summer rain did maintain reservoir levels but sustained above average rainfall would be needed to refill the water supply reservoirs.

Patterns in the stream hydrograph for the urban area (Figure 4) closely reflected rainfall patterns at Belconnen (Figure 3). Ginninderra Creek, which drains a highly urbanised catchment with large areas of impervious surfaces, showed quick response to the high rainfalls occurring in December (Figure 4). Through the rest of the year stream flow for the urban area was well below the long-term average. The very low flow in February, March, and May to June reflects the pattern of light showers linked with high evaporation in the 'Indian Summer' of 2009. Although only half to two thirds of the long-term average, the monthly flow above Corin Reservoir follows the established pattern of high spring flows gradually easing in summer to low flows through autumn (Figure 5).

The ACT remains a net exporter of water into the Murrumbidgee River. A comparison of the volume of water flowing (in the case of the Queanbeyan River water that would flow if not for Googong Dam) into the ACT with the volume of water leaving the ACT is shown in Figure 6. The Molonglo River contribution was very small with only one month (December 2008) having an average daily flow of greater than 10 ML per day and minimal flow recorded from February to June. In the same period the Murrumbidgee River at the Lobbs Hole gauge experienced average daily flows of greater than 100 ML/day in July, September, October and December. For the remainder of the reporting period average daily flows in the Murrumbidgee fell below 50 ML/day. This is demonstrated in the flow-based Water Quality sampling for the period, where no sampling was possible in the first half of 2009. The low flows in the Murrumbidgee were supplemented by the returns from sewage treatment.

Figure 6. Comparison of the average monthly inflows into the ACT with the average monthly outflows from the ACT July 2008 – June 2009



SECTION 2: WATER QUALITY CONDITION

Water Quality Monitoring Program

The Environment Protection Authority (EPA) manages a monitoring program for the Australian Capital Territory's water resources that includes the collection of water quality, stream flow and biological data. The monitoring program is based on regular sampling of lakes and rivers. Such information is used to determine whether waters in the ACT are of appropriate quality and if the management strategies used to achieve or maintain such water quality are adequate. The information is not intended to identify specific pollution incidents but rather provide information about changes to water quality over time. Data for long-term trends have been compiled by comparing the annual mean parameter values for each reporting period between 2002–2003 and 2008–2009.

Water quality data are collected by other government agencies, research institutions and authorised dischargers such as ACTEW (Lower Molonglo Water Quality Control Centre and Water Supply Reservoirs) and the Queanbeyan City Council (Queanbeyan Sewage Treatment Plant). Although the EPA may use such data for assessing compliance with licence conditions and the *Environment Protection Regulation 2005*, the data collected by those organisations are not reported in this document.

Sampling Sites

Sites are located so as to be representative of stream and lake conditions in the ACT (Figure 7). It is not possible to monitor all sites and all parameters of interest; consequently those considered most representative of environmental conditions are selected as examples for similar areas.

Lakes

The major urban lakes (with the exception of Lake Burley Griffin which is a Commonwealth responsibility are sampled eight months of the year during August, October to March, and May. The ACT Government also monitors Burrinjuck Reservoir as activities in the ACT could potentially impact on this reservoir. Monitoring of blue-green algae in Canberra's lakes is undertaken mostly but not exclusively during the summer months by EPA officers and encompasses the recreation zones of the lakes and the Molonglo River. The ACT Health Protection Service undertakes bacterial monitoring of lake and river recreation areas during peak use times.

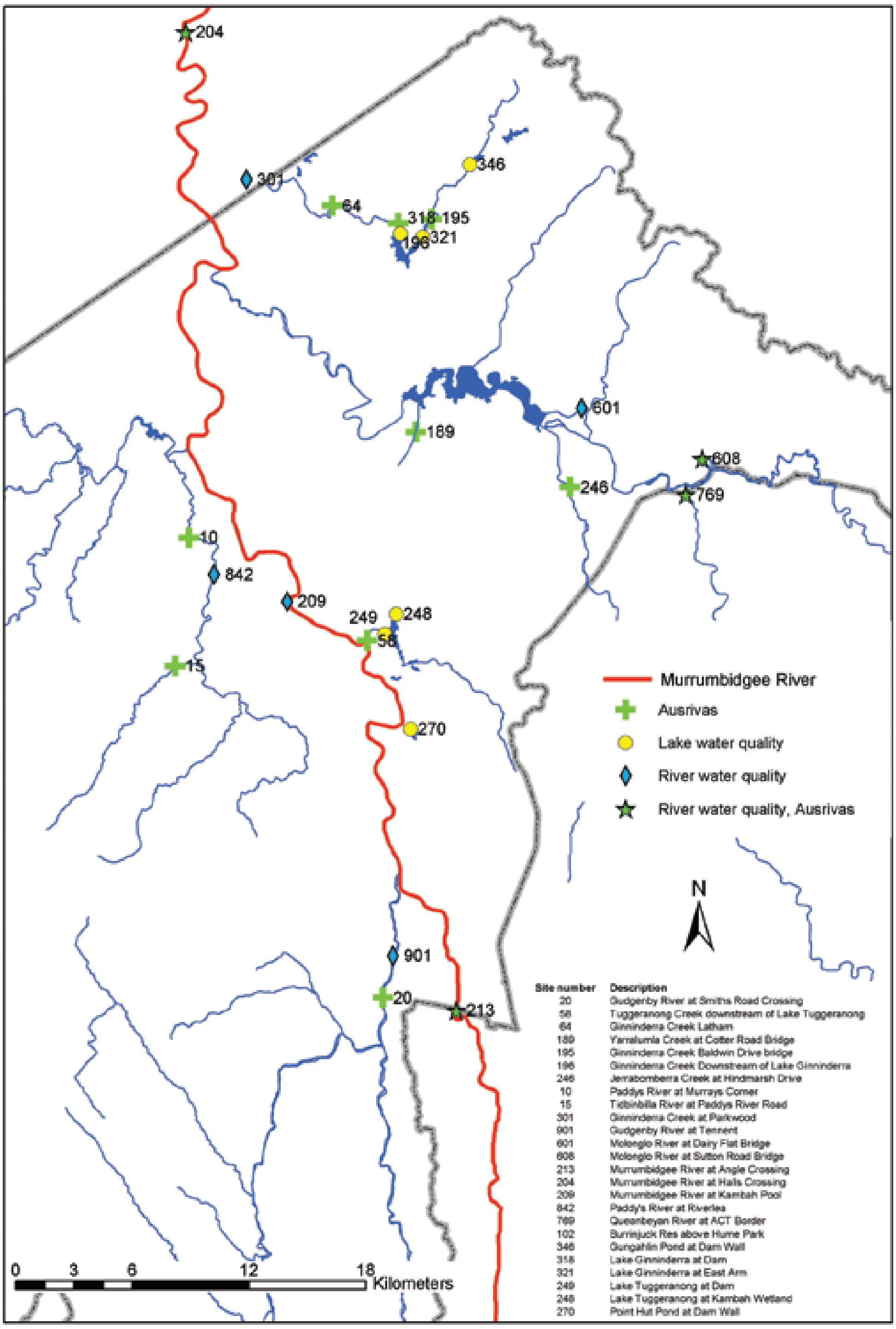
Rivers

Stream-flow is measured continuously at a number of sites throughout the ACT at hydrographic stations. This information is valuable for interpreting water quality data as most of the pollutants that enter our waterways do so during storms. Consequently streams are sampled for water quality at different flow levels, rather than at fixed times, to better characterise the pollutant loads. The aim of the sampling strategy is to provide a fully representative assessment of river health over time by taking account of the impact of flow on water quality. Samples are collected within four flow levels, measured by the flow percentile (5–29 per cent, 30–49 per cent, 50–69 per cent and 70–89 per cent). The 5th percentile flow is the flow exceeded only 5 per cent of the time and represents very high flow; conversely the 90th percentile flow indicates very low flow.

Table 4. Flow Percentiles for River Sampling

Flow Percentile Group	Description	Number of Samples
0–4	Very high flow	-
5–29	High flow	2
30–49	Moderate increasing flow	2
50–69	Moderate decreasing flow	2
70–89	Low to basal flow	2
90–100	Negligible flow	-

Figure 7. Locations of Water Quality and Biological (AUSRIVAS) Sampling Sites in the ACT Water Quality Monitoring Program



Flow-based sampling operates well in years of average rainfall with rain and run-off at well spaced intervals across the whole year. Rivers were sampled three times during this reporting period. In 2008–2009 suitable flow occurred in August, September and December. The optimum number of samples, two at each percentile band, was not reached again this year. The gradual decline in opportunities to sample across the range of flow percentiles, and the consequent drop in number of samples taken annually reflect the long period of drought in the catchment (Table 5). A review of sampling frequency may be required in the future, based on climate change scenarios and related observations.

Table 5. Flow-based samples taken since 2001

Sampling period	2001–2002	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009
No. Samples	10	6	5	5	5	4	4	3

In this reporting period we have supplemented the flow-based data with date based data (February and May) collected by Waterwatch volunteers for sites 209, 213, 601, 769 and 842. These data, while not as comprehensive (no nitrogen, suspended solids, faecal coliforms or chlorophyll 'a' data) are more than adequate to indicate trends. In periods of low flow, fewer run-off or flow-driven processes occur in the catchment. At such times a narrower range of indicators should provide sufficient information to characterise riverine processes and water condition.

Biological Assessment of Ecosystem Condition

In addition to monitoring the physical and chemical condition of the ACT's waters, an assessment of the status of the aquatic ecosystem is undertaken. Assessment of ecosystem health is based on the macroinvertebrate monitoring undertaken using the AUSRIVAS protocol (see p.37). It involves collecting samples of stream invertebrates from stream edge sites in the ACT region during spring and autumn. An AUSRIVAS predictive model is used to assess these sites. The condition of the site, as determined by the model, provides a measure of a stream's biological health. Thirteen sites are sampled and are selected as either reference or test sites. The selection of test sites was based on potential and known impacts from rural degradation, urban runoff, discharge of treated sewage effluent, trace metal contamination, habitat degradation, sedimentation events and river regulation. The three reference sites were selected from those sampled during development of the ACT component of the National River Health Program. The 10 test sites and three reference sites were sampled in November 2008 and April–May 2009.

Condition of ACT Waters

Over the long-term the water quality in ACT streams and lakes has tended to be good as assessed against the water quality standards (Table 1). However in recent years rivers and streams have been stressed by the extreme events of drought and fire. Sites outside the urban area have displayed resilience to these events; they appear to have recovered from the impacts of the 2003 bushfires and are accommodating the ongoing periods of low flow. Sites in urban and peri-urban areas appear to be faring worse than non-urban sites. Urban sites are commonly impacted by human actions such as altered flow regimes, nutrient enrichment, weed infestation and increased pollutants. Recently urban water quality is thought to have remained poor because, with drought conditions, stream flows are generally low and any pollutants entering waterways are not diluted and frequently do so as part of storm events. Long dry periods combined with sudden storm events can allow the development of heavy silt loads in runoff water from urban areas under development. This year rains in early and late spring, bringing in nutrients from the catchments, followed by long periods of warm, dry weather have encouraged the growth of phytoplankton in all the lakes. The chlorophyll 'a' readings have consistently stayed at or above reference levels, and the lakes, ponds and the Dairy Flat Rd reach of the Molonglo River have all supported large volumes of phytoplankton, including both cyanobacteria and green algae. Algal blooms are the natural way of mopping up nutrients and distributing them down stream. In the absence of flows, the dispersal of the bloom may not occur, and no such dispersal happened in Canberra's urban lakes last autumn.

The condition of water quality at the monitoring sites may be assessed by comparison of actual concentrations with concentrations listed in the water quality standards (Table 1).

Summary of Water Quality Observations for Reporting Period 2008–2009

Table 6. Summary of Water Quality in the ACT, 2008–2009

Parameter	Reg. Limit	Sources	Consequences of exceeding limits	Incidents in reporting period
Total Phosphorus	<0.1mg/mL	Soil and humus	With high TN, turbidity, water temperature and low flow, may lead to cyanobacterial bloom.	Minor spring fluctuations.
Total Nitrogen	N/A. [<150 µg/L]	Organic matter breakdown, + biological Nitrogen fixation.	With high TP, turbidity, water temperature and low flow, may lead to cyanobacterial bloom.	Halls Crossing; Dairy Flat Rd.
Suspended Solids	<25mg/L	Disturbance of soil by storm damage, human activity causing catchment disturbance, and in upland river, watercourse creep.	Silt slugs; bank scouring; burial of riffles or aquatic vegetation; increased (long-term) turbidity.	Localised rain associated events
Turbidity	<10 NTU, flowing <30 NTU, standing	Soil and country rock clay fraction; humic 'tea'.	Modification of biological light regime; poor aesthetics.	Spring and summer storms; slug at Angle Crossing in January
Faecal Coliforms	<150 cfu (swimming) 1000 cfu / mL	Rural and urban animal waste, fertilizers [sewage]	Closure of recreational waters because of health risk from associated (hard to monitor) pathogens.	Localised events associated with low flow.
Conductivity	N/A.	Salts in country rock and ground water; sewage treatment plants.	Salinity or corrosion problems, where water is used.	N/A
pH	6–9	Catchment geology	Changes to biodynamics; may release toxic metals.	N/A
Dissolved Oxygen	> 4.0 mg/L	Normal plant (including algal) activity and physical exchange with atmosphere through wind and water movement.	Hot weather and low flows drive O_2 out of water, leading to biological stress, with fish kills being the worst outcome.	Summer lows at Point Hut Pond, Queanbeyan River at the cemetery.
Chlorophyll 'a'	< 10 µg/L	Phytoplankton	Poor aesthetics; scums; unpleasant smells (geosmin); blooms outside of normal population fluctuation.	Lakes and ski reach closed February–May 2009

Indicators

Nutrient Levels (Phosphorus and Nitrogen)

Nutrients are a natural component of all water bodies, but increases in their supply often have undesirable effects, including the eutrophication of aquatic ecosystems. Eutrophication is the presence of an abnormally high quantity of plant nutrients and can lead to excess algal growth including toxic algal blooms. This can also produce other unwanted side effects e.g. low dissolved oxygen levels in the water with dire consequences for aquatic organisms of all sizes. The two most important plant nutrients for aquatic ecosystems are phosphorus and nitrogen.

Total Phosphorus

Total phosphorus is the sum of dissolved and particulate phosphorus in the water. The standard is 0.1 mg/L for both aquatic health and recreational use. In ACT water bodies total phosphorus availability is what commonly determines planktonic algal activity.

Nutrients such as phosphorus are bound within soil/sediment particles and the movement of phosphorus through the landscape and waterways is closely linked to soil erosion and sediment transport dynamics.

Phosphorus levels in Burrinjuck Dam (site 102) had elevated phosphorous levels in February 2009, and the Gudgenby River (site 901) had elevated levels in September 2008. The southern lakes, fed by urban run-off, frequently reach or slightly exceed regulation expectations. All these events are correlated with rainfall events. The other waterways have phosphorous levels generally within regulation limits.

Long-term trends. Phosphorous readings at all sites have remained at much the same mean level from 2002 to the present.

Table 7. Total Phosphorus (mg/L) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	0.04	0.11	0.06	0.02	0.10
248	Lake Tuggeranong at Kambah Wetland	0.06	0.12	0.09	0.02	0.10
249	Lake Tuggeranong at Dam	0.06	0.16	0.10	0.03	0.10
270	Point Hut Pond at Dam Wall	0.07	0.13	0.09	0.02	0.10
318	Lake Ginninderra at Dam	0.02	0.04	0.03	0.01	0.10
321	Lake Ginninderra at East Arm	0.025	0.08	0.05	0.02	0.10
346	Gungahlin Pond at Dam Wall	0.02	0.05	0.03	0.01	0.10
204	Murrumbidgee River at Halls Crossing	0.07	0.07	0.07	0.00	0.10
209	Murrumbidgee River at Kambah Pool	0.04	0.07	0.05	0.01	0.10
213	Murrumbidgee River at Angle Crossing	0.03	0.04	0.04	0.01	0.10
301	Ginninderra Creek at Parkwood	0.02	0.05	0.04	0.02	0.10
601	Molonglo River at Dairy Flat Bridge	0.03	0.07	0.05	0.02	0.10
608	Molonglo River at Yass Road Bridge	0.03	0.04	0.04	0.00	0.10
769	Queanbeyan River at ACT Border	0.01	0.05	0.03	0.02	0.10
842	Paddy's River at Riverlea	0.02	0.05	0.04	0.02	0.10
901	Gudgenby River at Tennent	0.02	0.10	0.07	0.03	0.10

Total Nitrogen

There is no regulation limit for total nitrogen for the ACT. Nitrogen is not generally a limiting factor in algal growth in regional waters and it is non toxic to organisms. Nitrogen values are normally consistently highest at two sampling sites (601 and 204), which are downstream of the Queanbeyan and Canberra sewage treatment plants. These high levels generally decrease rapidly along the stream. International standards for discharged wastewater recommend 15 mg/L or less. Research into nitrogen fixing blue-green algae, including potentially toxic Anabaena species, indicates that low or limiting concentrations of nitrogen favour their growth over other, more benign phytoplankton. In such situations the discharge of nitrogen in sewage effluent may discourage nitrogen fixers. For these reasons management and discharge authorisation arrangements in the ACT concentrate on minimising the input of phosphorus to waterways as a priority, with nitrogen reduction encouraged as a second priority.

There were the usual slightly elevated levels at sites 204 and 601 associated with the sewage treatment discharge. Burrinjuck Reservoir (site 102) which acts as a vast nutrient and sediment sink had regular small fluctuations in nitrogen measurements throughout the year with its most elevated reading in May 2009. These variations are not solely because of loading from the ACT but involve other processes such as reservoir draw-down during irrigation supply and internal reservoir circulation dynamics.

Long-term trends. Nitrogen readings at all sites have remained at much the same mean level from 2002 to the present.

Table 8. Total Nitrogen (mg/L) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	1.20	11.0	3.80	3.09	N/A
248	Lake Tuggeranong at Kambah Wetland	0.75	1.10	0.93	0.15	N/A
249	Lake Tuggeranong at Dam	0.69	1.40	1.01	0.22	N/A
270	Point Hut Pond at Dam Wall	0.79	1.40	1.08	0.19	N/A
318	Lake Ginninderra at Dam	0.49	0.60	0.55	0.04	N/A
321	Lake Ginninderra at East Arm	0.48	0.83	0.68	0.12	N/A
346	Gungahlin Pond at Dam Wall	0.36	0.66	0.53	0.10	N/A
204	Murrumbidgee River at Halls Crossing	1.30	4.50	2.47	1.77	N/A[15]
209	Murrumbidgee River at Kambah Pool	0.30	0.56	0.41	0.14	N/A
213	Murrumbidgee River at Angle Crossing	0.21	0.36	0.28	0.08	N/A
301	Ginninderra Creek at Parkwood	0.53	0.61	0.58	0.04	N/A
601	Molonglo River at Dairy Flat Bridge	1.10	5.60	4.00	2.52	N/A[15]
608	Molonglo River at Yass Road Bridge	0.42	0.55	0.48	0.07	N/A
769	Queanbeyan River at ACT Border	0.32	0.56	0.41	0.13	N/A
842	Paddy's River at Riverlea	0.19	0.42	0.33	0.12	N/A
901	Gudgenby River at Tennent	0.42	0.78	0.65	0.20	N/A

Suspended Solids

All streams and rivers naturally carry some suspended material as organic and inorganic particles of varying sizes. Most land uses and activities have the potential to increase the concentrations of suspended solids in streams. An increase in the concentration of suspended solids can have two major impacts on aquatic ecosystems. First, higher concentrations of suspended solids reduce the light penetration of water, slowing plant growth and changing the type of algae present. Second, increases in suspended solids concentrations ultimately result in increased sedimentation in streams and lakes, choking habitats for bottom dwelling organisms with sediment while increasing the potential for elevated phosphorus levels as indicated above.

In general the suspended sediment concentrations in ACT waterways were within the water quality standard in this reporting period. The exceptions were sporadic elevated readings in Ginninderra Ck and ponds associated with urban development, with one high reading at Angle Crossing in August 2009. Flow based sampling highlights storm effects, while the long-term average may indicate closer general conformity to regulation limits. High concentrations continue to occur in some waterways downstream of current areas of urban development, for example Lake Ginninderra and Gungahlin Pond. Point Hut Pond, with a long standing elevated suspended solids load, again showed elevations in three of the eight samples. It is expected that these urban sites will continue to show fluctuating levels until most building and landscaping in their catchments ceases.

Long-term trends. The lakes and the streams in the Molonglo system have shown little change in levels of Suspended Solids from 2002 to the present. The rivers in the Murrumbidgee system, all affected by the 2003 bushfire, show an elevated mean in the 2003/2004 period and mean figures at a new, slightly increased level from then on. The 2006 New Year's Eve storm inflated the 2006-2007 data (Figure 9).

Table 9. Suspended Solids (mg/L) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	13.00	28.00	18.63	6.00	25
248	Lake Tuggeranong at Kambah Wetland	12.00	24.00	18.50	4.21	25
249	Lake Tuggeranong at Dam	11.00	26.00	17.88	5.11	25
270	Point Hut Pond at Dam Wall	13.00	72.00	34.13	20.73	25
318	Lake Ginninderra at Dam	5.00	15.00	8.38	3.02	25
321	Lake Ginninderra at East Arm	11.00	84.00	28.00	24.31	25
346	Gungahlin Pond at Dam Wall	3.00	36.00	13.88	11.36	25
204	Murrumbidgee River at Halls Crossing	18.00	23.00	21.33	2.89	25
209	Murrumbidgee River at Kambah Pool	17.00	23.00	20.33	3.06	25
213	Murrumbidgee River at Angle Crossing	17.00	32.00	23.67	7.64	25
301	Ginninderra Creek at Parkwood	8.00	29.00	19.00	10.54	25
601	Molonglo River at Dairy Flat Bridge	8.00	17.00	11.00	5.20	25
608	Molonglo River at Yass Road Bridge	8.00	11.00	9.67	1.53	25
769	Queanbeyan River at ACT Border	3.00	9.00	5.33	3.21	25
842	Paddy's River at Riverlea	6.00	10.00	7.67	2.08	25
901	Gudgenby River at Tennent	5.00	18.00	12.33	6.66	25

Turbidity

Turbidity or opacity of a water body is related to the suspended solids concentration but also includes colouration. A stream may have very low levels of suspended material but be strongly coloured, for example the tannin rich streams in Namadgi National Park. Turbidity has an important ecological effect in determining the depth to which light penetrates the water, affecting plant growth and changing the kinds of algae present.

Canberra has soils with very fine clay particles that can cause high turbidity levels even though the actual amount of material suspended in the water column is not large. Also the small clay particles remain floating in the water long after the heaver sediments have settled on the bottom.

Rivers often experience pulses of high turbidity related to rainfall events that wash soil into the waterway. As the urban lakes are fed by drainage lines they show storm peaks and long periods of turbidity within expected limits. Point Hut Pond fitted that pattern on top of the naturally elevated turbidity of a soft bottomed water body. This year the rivers were all at very low flows with occasional storm based higher flows and the consistently elevated figures reflect the flow regime.

Long-term trends. The new 'post wildfire' level of turbidity in the Murrumbidgee system is similar in pattern to that for suspended solids, although slightly more pronounced. Otherwise there are no clear trends in turbidity levels.

Table 10. Turbidity (NTU) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	7.20	26.00	15.03	6.38	30
248	Lake Tuggeranong at Kambah Wetland	9.40	34.00	20.30	8.16	30
249	Lake Tuggeranong at Dam	13.00	31.00	19.75	5.95	30
270	Point Hut Pond at Dam Wall	36.00	150.00	72.63	38.21	30
318	Lake Ginninderra at Dam	5.30	15.00	8.24	3.06	30
321	Lake Ginninderra at East Arm	11.00	50.00	21.00	12.71	30
346	Gungahlin Pond at Dam Wall	4.30	32.00	13.40	9.47	30
204	Murrumbidgee River at Halls Crossing	15.00	18.00	16.67	1.53	10
209	Murrumbidgee River at Kambah Pool	22.00	24.00	22.67	1.15	10
213	Murrumbidgee River at Angle Crossing	17.00	28.00	23.00	5.57	10
301	Ginninderra Creek at Parkwood	7.50	18.00	12.83	5.25	10
601	Molonglo River at Dairy Flat Bridge	6.00	8.90	7.43	1.45	10
608	Molonglo River at Yass Road Bridge	5.70	15.00	10.57	4.67	10
769	Queanbeyan River at ACT Border	4.00	12.00	6.90	4.43	10
842	Paddy's River at Riverlea	5.30	18.00	11.10	6.42	10
901	Gudgenby River at Tennent	8.30	24.00	16.77	7.92	10

Faecal Coliform Bacteria

Bacteria occur naturally in all water bodies. The presence of faecal coliforms in a water sample may be an indication that human or animal faeces have contaminated the water and that harmful, less easily detectable pathogens such as *Cryptosporidium* or *Giardia* may be present. High levels of faecal coliforms are not necessarily a problem for aquatic ecosystems. Faecal coliforms generally do not infect aquatic organisms, and may serve as a food source.

The presence of high numbers of faecal coliforms is a problem for some human uses of water bodies, particularly water supply and recreation involving bodily contact. This report looks at bacterial levels in water used for primary and secondary contact recreational use, but does not deal with the quality of drinking water.

Results are expressed as colony forming units (cfu) per 100 mL. The standard for water based recreation (swimming) is 150 cfu/100 mL and for boating and secondary contact is 1000 cfu/100ml. These standards apply to individual sites depending on whether they are classed for swimming or secondary contact recreation in the Territory Plan.

Faecal coliform levels in the lakes compared favourably with the standard designated under the *Environment Protection Regulation 2005.*

In the present reporting period faecal coliform levels were elevated in Lake Tuggeranong in August and March, and in the Molonglo in August and Paddys Rivers from August to December. The figures reflect gradual concentration rather than population explosion as flow in both rivers decreased. The likely sources were urban and rural animal and garden manure, and were not associated with human sewage.

Long-term trends. The variation in faecal coliform counts over time does not present a generalised pattern, and is best described for individual sites or groups of sites.

Table 11. Faecal Coliforms (cfu/100mL) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	1.00	350.00	66.63	123.72	N/A
248	Lake Tuggeranong at Kambah Wetland	6.00	300.00	100.00	120.75	1,000
249	Lake Tuggeranong at Dam	1.00	440.00	105.13	163.49	150
270	Point Hut Pond at Dam Wall	2.00	260.00	68.13	82.98	1,000
318	Lake Ginninderra at Dam	1.00	14.00	5.14	4.95	150
321	Lake Ginninderra at East Arm	1.00	29.00	13.71	10.98	1,000
346	Gungahlin Pond at Dam Wall	1.00	12.00	5.13	4.73	1,000
204	Murrumbidgee River at Halls Crossing	2.00	70.00	40.67	34.95	150
209	Murrumbidgee River at Kambah Pool	4.00	20.00	11.33	8.08	150
213	Murrumbidgee River at Angle Crossing	1.00	15.00	7.67	7.02	150
301	Ginninderra Creek at Parkwood	5.00	320.00	208.33	176.38	1,000
601	Molonglo River at Dairy Flat Bridge	1.00	1,100.00	382.00	622.20	1,000
608	Molonglo River at Yass Road Bridge	12.00	75.00	39.00	32.45	1,000
769	Queanbeyan River at ACT Border	47.00	100.00	77.67	27.47	1,000
842	Paddy's River at Riverlea	4.00	280.00	171.33	147.06	150
901	Gudgenby River at Tennent	12.00	520.00	234.00	259.98	1,000

Conductivity

Conductivity – the ability of electricity to pass through water – is a measure of the salts and ions present in the water body. Pure de-ionised water does not conduct electricity; organic compounds like oil, alcohol and charcoal are poor conductors whereas salts (sodium, potassium, calcium ions), and metals (aluminium, iron) conduct electricity well.

Unless there is an unusual occurrence, conductivity measures provide good indication of the amount of salt in the water. Urban runoff can be high in salts as many cleaning agents, fertilisers and surfaces (paint, concrete, road surfaces) contain salts and these salts are washed into streams during rainfall. Salts can also come from naturally occurring salt in soils and be mobilised by erosion and ground water seepages in drought periods.

There continues to be a long-term downward trend in conductivity in the majority of lake sites and some sites on the Murrumbidgee River. Urban sites have little opportunity to contribute in drought, as little run-off reaches drains except in storms. Once again the highest readings for this period were recorded at sites along the Molonglo River, where concentration, as a consequence of drought, from ground water in rural areas, run-off from Queanbeyan industrial sites and old mine tailings may be important, and Halls Crossing (site 204) where the cumulative inputs of the whole catchment, including the sewage treatment plants, are effectively being monitored.

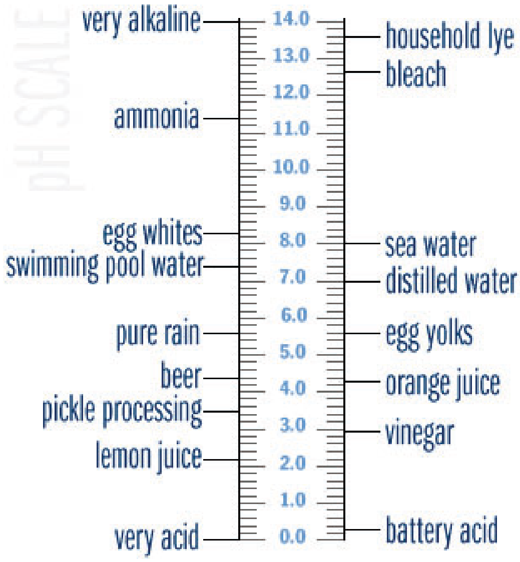
Long-term trends. The conductivity of water in the various lakes has shown a gentle decline from a mean of 200–250 µS/cm to 95–110 µS/cm between 2002 and the present as their catchments have less and less development based disturbance and the lake bottoms stabilise. The river systems show dynamic equilibrium for conductivity.

Table 12. Conductivity (uS/cm) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	190.00	480.00	301.25	91.41	N/A
248	Lake Tuggeranong at Kambah Wetland	87.00	100.00	93.88	4.61	N/A
249	Lake Tuggeranong at Dam	87.00	100.00	93.88	4.58	N/A
270	Point Hut Pond at Dam Wall	110.00	130.00	121.25	8.35	N/A
318	Lake Ginninderra at Dam	190.00	210.00	200.00	9.26	N/A
321	Lake Ginninderra at East Arm	190.00	210.00	201.25	8.35	N/A
346	Gungahlin Pond at Dam Wall	200.00	250.00	227.50	20.53	N/A
204	Murrumbidgee River at Halls Crossing	200.00	240.00	216.67	20.82	N/A
209	Murrumbidgee River at Kambah Pool	57.00	98.00	71.33	23.12	N/A
213	Murrumbidgee River at Angle Crossing	42.00	96.00	65.67	27.61	N/A
301	Ginninderra Creek at Parkwood	210.00	240.00	223.33	15.28	N/A
601	Molonglo River at Dairy Flat Bridge	440.00	520.00	493.33	46.19	N/A
608	Molonglo River at Yass Road Bridge	190.00	390.00	273.33	104.08	N/A
769	Queanbeyan River at ACT Border	190.00	400.00	310.00	108.17	N/A
842	Paddy's River at Riverlea	64.00	85.00	73.67	10.60	N/A
901	Gudgenby River at Tennent	64.00	79.00	69.00	8.66	N/A

pH (Acidity)

The pH refers to the degree of acidity or alkalinity of the water. A pH of 7 is neutral. A value above 7 indicates that the water is alkaline and a pH below 7 indicates acidic conditions (see figure to right).



If the pH of the water is altered substantially then there can be changes to chemical processes, which could release nutrients or toxic metals that were previously bound safely in lake or river sediments. All sites had pH within an acceptable range throughout the year.

The source of run-off may influence the direction that pH takes in relation to rain. Gungahlin Pond (Site 346) as in the last two reporting periods, continues to have slightly more alkaline readings, possibly reflecting the continued construction in the catchment.

Long-term trends. Mean pH levels at all sites have remained at much the same level from 2002 to the present.

Table 13. pH summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	8.00	8.50	8.24	0.23	6–9
248	Lake Tuggeranong at Kambah Wetland	7.10	7.70	7.46	0.19	6–9
249	Lake Tuggeranong at Dam	7.20	8.00	7.55	0.23	6–9
270	Point Hut Pond at Dam Wall	7.40	8.70	7.74	0.42	6–9
318	Lake Ginninderra at Dam	7.80	8.20	8.01	0.15	6–9
321	Lake Ginninderra at East Arm	7.90	8.20	8.04	0.12	6–9
346	Gungahlin Pond at Dam Wall	8.00	9.30	8.43	0.40	6–9
204	Murrumbidgee River at Halls Crossing	8.10	8.40	8.23	0.15	6–9
209	Murrumbidgee River at Kambah Pool	7.50	7.60	7.57	0.06	6–9
213	Murrumbidgee River at Angle Crossing	7.30	7.50	7.40	0.10	6–9
301	Ginninderra Creek at Parkwood	7.40	7.70	7.50	0.17	6–9
601	Molonglo River at Dairy Flat Bridge	7.80	9.20	8.37	0.74	6–9
608	Molonglo River at Yass Road Bridge	7.20	7.30	7.23	0.06	6–9
769	Queanbeyan River at ACT Border	6.90	7.40	7.23	0.29	6–9
842	Paddy's River at Riverlea	7.60	7.70	7.67	0.06	6–9
901	Gudgenby River at Tennent	7.20	7.80	7.50	0.30	6–9

Dissolved Oxygen

Dissolved oxygen is a measure of the oxygen in the water available to aquatic organisms. It is important for the maintenance of aquatic organisms as changes in dissolved oxygen can affect the species present. Low levels of dissolved oxygen can stress fish, which can lead to fungal infections and disease or result directly in fish kills. Levels of dissolved oxygen are affected by turbulence, temperature (colder water can hold more dissolved oxygen), photosynthesis (during periods of sunlight algae and other water plants produce oxygen, while in darkness they consume oxygen) and the level of biological oxygen demand. Biological oxygen demand is an indication the rate of use of oxygen in the system, restricting oxygen availability for fish and other aquatic animals.

Low flows in the rivers combined with other factors such as inputs of sediment and organic material can cause dissolved oxygen concentrations to fall to life threatening levels for fish and gilled macroinvertebrates. For the Queanbeyan River near the ACT border low dissolved oxygen in December, and continuing into the new year may have made the river unfit for survival of aquatic life as a consequence of shallow depth, little water movement and elevated water temperatures. Hot, still conditions, with little or no inflow in Point Hut Pond would account for a crash in dissolved oxygen in February. Other streams throughout the ACT were in the healthy range for dissolved oxygen concentrations.

Long-term trends. Mean dissolved oxygen levels at all sites have fluctuated without clear trends from 2002 to the present.

Table 14. Dissolved Oxygen (mg/L) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	7.90	13.20	8.31	2.45	>4
248	Lake Tuggeranong at Kambah Wetland	6.10	10.90	7.87	1.73	>4
249	Lake Tuggeranong at Dam	4.90	11.00	6.07	2.86	>4
270	Point Hut Pond at Dam Wall	3.40	10.40	7.82	1.92	>4
318	Lake Ginninderra at Dam	5.50	10.90	7.71	2.24	>4
321	Lake Ginninderra at East Arm	6.40	10.80	8.53	1.53	>4
346	Gungahlin Pond at Dam Wall	6.10	14.30	9.10	2.43	>4
204	Murrumbidgee River at Halls Crossing	10.10	11.60	10.70	0.79	>4
209	Murrumbidgee River at Kambah Pool	8.50	11.20	9.87	1.35	>4
213	Murrumbidgee River at Angle Crossing	8.20	14.60	11.47	3.20	>4
301	Ginninderra Creek at Parkwood	7.70	10.10	9.20	1.31	>4
601	Molonglo River at Dairy Flat Bridge	10.50	14.90	12.03	2.48	>4
608	Molonglo River at Yass Road Bridge	6.80	10.00	8.50	1.61	>4
769	Queanbeyan River at ACT Border	4.20	10.90	7.73	3.37	>4
842	Paddy's River at Riverlea	9.40	12.70	11.30	1.71	>4
901	Gudgenby River at Tennent	9.80	12.00	10.90	1.10	>4

Chlorophyll 'a'

Chlorophyll 'a' is the plant pigment that gives algae their green colour, and is commonly used as a measure of the quantity of algae present (algal biomass). This measure can therefore serve as a useful indicator of the extent to which an ecosystem has been affected by nutrient inputs. There is no standard for streams and rivers in the ACT while a standard of less than 10 µg/L applies for urban lakes and ponds. All phytoplanktonic organisms, including cyanobacteria (blue-green algae), use chlorophyll 'a', so that the reading indicates whole population dynamics not any single organism population.

Chlorophyll 'a' is measured in micrograms per litre (µg/L). To provide a sense of scale, water with a chlorophyll 'a' concentration of 1 µg/L will be clear, a concentration of 20 µg/L will be slightly green, and 100 µg/L very green and possibly with algal scums on the surface. There are also normal seasonal fluctuations in planktonic algal biomass that may appear in the figures, independent of flow rates or exceptional nutrient loads.

There is little change in chlorophyll 'a' levels in most waterways from those reported in the previous two reporting periods. Both Lake Tuggeranong sites (248 and 249) show a pattern of consistent slightly elevated readings for chlorophyll 'a' from early spring to early autumn, with peak readings in February and March 2009. These data complement the weekly phytoplankton counts for the lake, which indicate moderate to high populations of *Aphanocapsa*, a cyanobacterium, as part of a more complex bloom of green algae, desmids and dinoflagellates (Figure 8). The Dairy Flat bridge figures (Site 601) indicate the confluence of the river with the lake water and established phytoplankton cycles in Lake Burley Griffin.

Long-term trends. Many of the variations over time in mean chlorophyll 'a' values are site specific, and no pattern can be seen for the ACT.

Table 15. Chlorophyll 'a' (µg/L) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers, 2008–2009

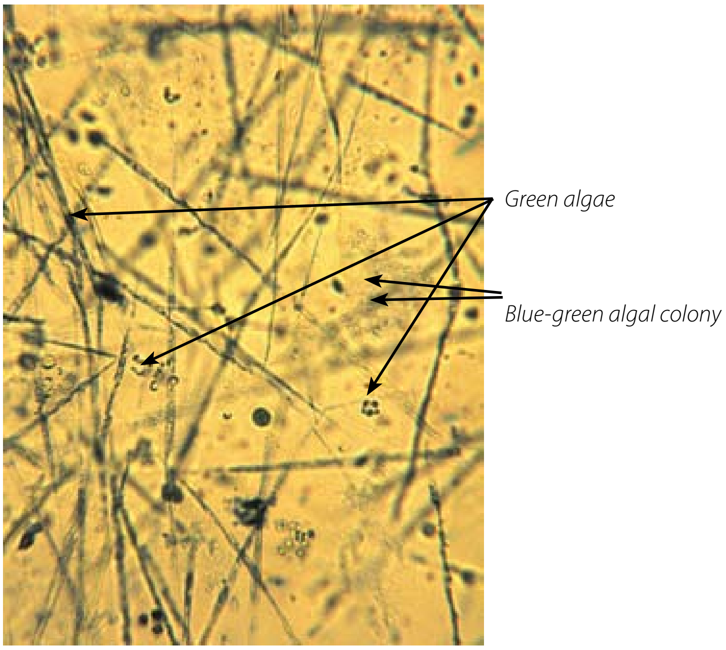
Site number	Site name	Minimum	Maximum	Mean 2008–09	Standard deviation	Regulation limits
102	Burrinjuck Reservoir above Hume Park	7.90	79.00	24.36	23.55	10
248	Lake Tuggeranong at Kambah Wetland	5.10	34.00	18.64	9.92	10
249	Lake Tuggeranong at Dam	9.80	48.00	24.85	14.00	10
270	Point Hut Pond at Dam Wall	0.44	36.00	17.96	13.08	10
318	Lake Ginninderra at Dam	4.70	13.00	7.03	2.54	10
321	Lake Ginninderra at East Arm	2.00	29.00	14.15	8.47	10
346	Gungahlin Pond at Dam Wall	1.00	16.00	6.65	4.98	10
204	Murrumbidgee River at Halls Crossing	14.00	24.00	17.67	5.51	N/A
209	Murrumbidgee River at Kambah Pool	2.80	17.00	9.93	7.10	N/A
213	Murrumbidgee River at Angle Crossing	3.30	5.20	4.53	1.07	N/A
301	Ginninderra Creek at Parkwood	1.00	7.70	5.13	3.61	N/A
601	Molonglo River at Dairy Flat Bridge	7.00	43.00	20.33	19.73	N/A
608	Molonglo River at Yass Road Bridge	3.80	12.00	7.03	4.37	N/A
769	Queanbeyan River at ACT Border	0.96	4.70	2.89	1.87	N/A
842	Paddy's River at Riverlea	1.40	3.00	2.13	0.81	N/A
901	Gudgenby River at Tennent	1.20	3.90	2.10	1.56	N/A

Algal Monitoring of Lake Recreation Areas

Algae are simple, usually microscopic plants that live either in water or damp areas. Dense growths of algae can impact on water quality and aesthetics by causing bad smells, strange colours and forming thick scums. When planktonic algal numbers increase dramatically and change the colour of the water the phenomenon is called an algal bloom. Rotting algae will use up oxygen in the water. Severe blooms also use all available dissolved oxygen. The oxygen drop may cause fish to die as a result. Some members of a certain class of algae, the *Cyanoprokaryota* (cyanobacteria or blue-green algae) in some situations can generate toxins which may be poisonous to animals and people.

Blue-green algae occur naturally in most ACT water bodies, but usually in low numbers in biological balance with other aquatic life. However, given the right environmental conditions, which include warm weather, low rainfall and the right mix of nutrient levels, planktonic blue-green algae, usually *Microcystis, Anabaena* or *Tyconema* in the ACT, may multiply rapidly to high levels, dominate all other algae and pose a health risk. When the total nitrogen over total phosphorus ratio is >10, and turbidity decreases then a blue-green algal bloom becomes likely. The activity of populations of tiny, colonial blue-green algae like the frequently toxic *Microcystis* and the more benign *Aphanocapsa* is best indicated by the space they occupy in the water column. Calculation of biovolume (the displacement caused by the colony) provides a useful tool in both identification and characterisation of blue-green algal bloom formers. In Figure 8 the cyanobacterial colonies are the tiny amorphous masses of spots; the main biovolume in this sample is made by the various needle-like green algae.

Figure 8. Phytoplankton from Lake Tuggeranong, March 2009



Weekly monitoring of visible planktonic algal conditions (especially for blue-green *Anabaena* and *Microcystis*) is performed by EPA officers from September to May and actions on alerts, warnings or lake closures are determined when certain levels of blue-green algae are present (Table 16).

Warm weather combined with other environmental conditions, such as low flows, resulted in high algal levels in Lake Tuggeranong by 5 February 2009 and both Lake Ginninderra and Molonglo River reach above Lake Burley Griffin by 11 February. The lakes remained closed for recreation until 18 May, while the Molonglo River reach remained closed until 18 June 2009. These were the longest closures in recent years.

Table 16. Algae Alert Levels for ACT Urban Lakes

Level	Blue-green algal cells/mL	Biovolume Equivalent	Response
Low	>500 to <5,000	>0.04–<0.4 mm3/L	At this level, there is generally no major health risk. The EPA carries out routine monitoring, which includes weekly visual inspections.
Medium	≥5, 000 to <50,000	≥0.4–<4.0 mm3/L	At this level there is a greater risk of potential health problems. The EPA increases the visual sampling to twice a week and undertakes water sampling weekly.
Medium High	>20,000	>1.6 mm3/L	If algal counts are > 20,000 cells/mL then on-site signs are erected to warn potential water users against risk of skin irritation, headache, nausea, and gastrointestinal illness.
High	≥50,000 or scums are consistently present	≥4.0 mm3/L	At this alert level the EPA maintains a twice-weekly visual inspection and weekly water sampling regime. In addition on-site signs are changed to 'Lake Closed' signs.

AUSRIVAS (Biological assessment using benthic macroinvertebrates)

Water chemistry analysis such as pH, total phosphorus and dissolved oxygen provides a snapshot of the water quality at the time when the sample is taken. Biological assessment, in this case the sampling of waterbugs (benthic macroinvertebrates), can indicate much about the water quality over time and show what kind of environment the water and its waterway provide for animals to live in.

Macroinvertebrate biological assessment is based on a comparison between a tally of the range of waterbugs found at a site with those predicted to occur there. If all those animals expected at a site actually occur there, the site is judged to be in good condition. Conversely the absence of expected animals indicates a site has been disturbed. The rating scale for AUSRIVAS outputs is presented below (Table 17). A full explanation of the AUSRIVAS biological assessment method for the ACT is available from www.ausrivas.canberra.edu.au and the full biological assessment reports are available on request from Water Resources.

Seeing who's home…. Collecting water bugs to assess water quality and habitat conditions

Table 17. AUSRIVAS Bands and their Observed/Expected Taxa Scores for the ACT Autumn Edge Model and Some Interpretations for Reporting (Ball et al. 2001)

Band	Condition	Taxa Interpretations
X	MORE BIOLOGICALLY DIVERSE THAN REFERENCE	More families found than expected. Potential biodiversity 'hot-spot' or mild organic enrichment. Continuous irrigation flow in a normally intermittent stream. Differential loss of pollution-tolerant taxa (potential impact unrelated to water quality).
A	SIMILAR TO REFERENCE	Expected number of families within the range found at 80 per cent of the reference sites.
B	SIGNIFICANTLY IMPAIRED	Fewer families than expected. Potential impact either on water and/or habitat resulting in a loss of families.
C	SEVERELY IMPAIRED	Many fewer families than expected. Loss of families from substantial impairment of expected biota caused by water and/or habitat quality.
D	EXTREMELY IMPAIRED	Few of the expected families and only the hardy, pollution tolerant families remain. Severe impairment.

Table 18. Summary of AUSRIVAS Band Scores for Sites in the ACT from Spring 2004 to Autumn 2009

Site number	Site name	Spring 04	Autumn 05	Spring 05	Autumn 06	Spring 06	Autumn 07	Spring 07	Autumn 08	Spring 08	Autumn 09
213	Murrumbidgee River at Angle Crossing	B	B	B	B	C	A	B	A	A	B
15	Tidbinbilla River at Paddys River Road	A	A	B	B	A	A	A	A	A	A
10	Paddys River at Murray's Corner	A	B	A	B	B	B	B	A	B	A
20	Gudgenby River at Smiths Road	A	A	A	A	A	B	C	B	A	B
58	Tuggeranong Creek D/S of Lake	B	C	C	B	B	B	C	A	C	B
204	Murrumbidgee River at Halls Crossing	C	C	B	A	A	B	B	B	A	B
608	Molonglo River at Yass Road	C	C	B	B	B	B	D	B	A	B
769	Queanbeyan River at ACT border	D	C	C	C	C	C	C	C	D	C
246	Jerrabomberra Creek at Hindmarsh Drive	B	C	D	B	B	C	B	C	C	B
189	Yarralumla Creek at Cotter Road bridge	C	C	C	C	C	C	B	C	C	C
64	Ginninderra Creek at Latham	D	C	D	B	C	B	D	C	D	C
195	Ginninderra Creek Baldwin Drive	C	B	D	C	C	C	C	C	C	C
196	Ginninderra Creek D/S of Lake	C	C	C	B	C	C	C	C	C	C

Note: There is no regulation limit for this parameter (although the ideal would be an A for each site).

Reference sites (10, 15, 213) degraded immediately after the 2003 bushfires, and have fluctuated in macroinvertebrate diversity and complexity ever since. Reference site 15 has remained at reference standard for another year. Reference site 10 dropped to B in spring 2008 with an increase in turbidity and in worms and midge larvae, but regained reference standard in autumn 2009. Reference Site 213 retained reference standard in spring, but dropped to B in autumn 2009 with a decline in macroinvertebrate diversity possibly as flow rates and water levels became and stayed low.

The biological communities in urban sites are under considerable stress from habitat degradation, altered flow regimes, pollutant inputs, or pest species and thus are not as resilient to natural stresses like drought as non-urban sites. The fluctuations in rating for urban sites 58, 64, 769 and 608 illustrate this. One probable impact which may begin as unfavourable but later may promote diversity is willow removal, in the fluctuations in ratings for site 608 the Molonglo River just outside Queanbeyan.

Long-term trends. Site 15 on the Tidbinbilla River has shown the most consistent satisfactory rating of the three reference sites. The other two sites fluctuate between A and B and rarely fall lower.

The test sites reflect the impacts on the ecological systems through which they run. Two of three sites in the Murrumbidgee Corridor (20 and 204) show trends to satisfactory ratings in spring and a drop in autumn. Tuggeranong Creek demonstrates, with the Molonglo catchment sites (769, 608 and 246) the influence of urban and peri-urban development. The highly modified urban ecology around sites 769 (Queanbeyan River) and 189 (Yarralumla Creek) is similar to that for the three Ginninderra Creek sites, where scores rarely improve as ecological influences are static.

Lakes

Lake Tuggeranong

Two sites are monitored in Lake Tuggeranong, one at the Kambah Wetland (Site 248), which is near the northern inflow to the lake, and the other at the dam wall (Site 249).

Data collected since 1992 has indicated decreasing trends in nitrogen, phosphorus and conductivity levels at both sites. High turbidity readings, formerly typical for Lake Tuggeranong, have been replaced by levels well within guidelines. The continued reporting of values within limits for turbidity and suspended solids indicates structural stability of the lake bottom has been achieved. The occasional elevated readings correlate with storm events. High levels of chlorophyll 'a' throughout the year indicate phytoplankton activity. The phytoplankton are more often dominated by green or golden-green algae, *Volvox* and *Synura* colonies among others, rather than cyanobacteria (blue-green algae). The lake closure between February and May 2009 was precautionary in response to large populations of the cyanobacterium *Aphanocapsa*.

Table 19. Site 248 Lake Tuggeranong Kambah Wetland

Indicator	Units	Reg limits	Long-term average	Mean	Aug 08	Oct 08	Nov 08	Dec 08	Jan 08	Feb 08	Mar 08	May 08
Acidity	pH	6–9	7.71	7.46	7.60	7.30	7.70	7.60	7.50	7.40	7.50	7.10
Chlorophyll 'a'	ug/L	10	13.12	18.64	16.00	14.00	34.00	21.00	15.00	32.00	12.00	5.10
Conductivity	uS/cm	N/A	180.47	93.88	98.00	97.00	100.00	87.00	89.00	93.00	96.00	91.00
Dissolved Oxygen	mg/L	>4	7.37	7.87	10.90	6.10	8.00	9.5	6.80	6.80	*	7.00
Faecal Coliforms - Confirmed	cfu/ 100mL	1,000	11,707.12	100.00	6.00	150.00	260.00	30.00	300.00	24.00	14.00	16.00
Suspended Solids	mg/L	25	21.17	18.50	18.00	14.00	22.00	16.00	21.00	21.00	12.00	24.00
Total Nitrogen	mg/L N	N/A	1.06	0.93	0.86	1.10	1.10	0.77	0.75	0.95	0.82	1.10
Total Phosphorus	mg/L P	0.1	0.09	0.09	0.06	0.11	0.12	0.08	0.08	0.09	0.06	0.08
Turbidity	NTU	30	31.86	20.30	18.00	15.00	31.00	18.00	19.00	18.00	9.40	34.00

* Data not available for month

Table 20. Site 249 Lake Tuggeranong Dam Wall

Indicator	Units	Reg limits	Long-term average	Mean	Aug 08	Oct 08	Nov 08	Dec 08	Jan 08	Feb 08	Mar 08	May 08
Acidity	pH	6–9	7.68	7.55	7.70	7.50	7.50	8.00	7.50	7.60	7.20	7.40
Chlorophyll 'a'	ug/L	10	10.65	24.85	16.00	18.00	17.00	28.00	18.00	48.00	44.00	9.80
Conductivity	uS/cm	N/A	173.94	93.88	95.00	98.00	100.00	90.00	87.00	92.00	98.00	91.00
Dissolved Oxygen	mg/L	>4	6.96	6.07	11.00	8.10	7.50	9.50	8.10	4.90	7.90	8.80
Faecal Coliforms - Confirmed	cfu/ 100mL	1,000	273.41	105.13	1.00	36.00	440.00	30.00	20.00	4.00	280.00	30.00
Suspended Solids	mg/L	25	17.37	17.88	17.00	11.00	17.00	21.00	13.00	23.00	26.00	15.00
Total Nitrogen	mg/L N	N/A	1.03	1.01	0.93	0.93	1.20	0.90	0.69	0.96	1.40	1.10
Total Phosphorus	mg/L P	0.1	0.08	0.10	0.06	0.07	0.13	0.10	0.07	0.10	0.16	0.07
Turbidity	NTU	30	30.00	33.48	19.75	20.00	13.00	31.00	16.00	14.00	19.00	25.00

Long-term trends. While turbidity levels fluctuate, the remainder of the parameters have shown no significant trends between 2002 and the present. Mean conductivity levels have gone down gently between 2002 and the present, as the lake floor has stabilised and building construction and road-works have been reduce to a minimum level. Faecal coliform numbers have remained quite high as there have been only occasional bursts of urban run-off strong enough to induce flow through the system.

Point Hut Pond

Water quality in Point Hut Pond (Site 270) has been historically poor compared with the standards set for its designated uses in the Territory Plan and comparison with other lake sites in the ACT. Turbidity remains elevated. Suspended solids loads are now generally close to or within guidelines and related to storm activity in the catchment. Elevated readings will continue while building and infrastructure activity in the catchment continue at the current level. The drop in dissolved oxygen in February is very likely related to the lack of water circulation in the pond at a time of very low rainfall: the Tuggeranong weather station recorded 4.0 mm in February. The elevated chlorophyll 'a' readings are the products of phytoplankton flushes.

Long-term trends. Point Hut Pond parameters have shown little change between 2002 and the present. Turbidity has remained high; faecal coliform counts, while much lower than Lake Tuggeranong, show a similar drought response pattern; and chlorophyll 'a' levels have gradually risen, suggesting increasing dynamic biological stability in the system.

Table 21. Site 270 Point Hut Pond

Indicator	Units	Reg limits	Long-term average	Mean	Aug 08	Oct 08	Nov 08	Dec 08	Jan 08	Feb 08	Mar 08	May 08
Acidity	pH	6–9	7.93	7.74	7.60	7.60	7.60	7.70	8.70	7.40	7.90	7.40
Chlorophyll 'a'	ug/L	10	11.55	17.96	12.00	29.00	28.00	6.60	36.00	6.60	25.00	0.44
Conductivity	uS/cm	N/A	223.98	121.25	130.00	120.00	130.00	110.00	110.00	120.00	130.00	120.00
Dissolved Oxygen	mg/L	>4	8.01	7.82	10.40	8.60	7.10	7.40	9.10	3.40	8.30	8.10
Faecal Coliforms - Confirmed	cfu/ 100mL	1,000	129.25	68.13	2.00	260.00	40.00	60.00	86.00	2.00	65.00	30.00
Suspended Solids	mg/L	25	31.59	34.13	72.00	42.00	24.00	13.00	21.00	27.00	18.00	56.00
Total Nitrogen	mg/L N	N/A	1.16	1.08	1.00	1.20	1.10	0.79	0.88	1.10	1.20	1.40
Total Phosphorus	mg/L P	0.1	0.08	0.09	0.10	0.13	0.10	0.07	0.08	0.08	0.07	0.12
Turbidity	NTU	30	75.93	72.63	110.00	70.00	59.00	55.00	53.00	48.00	36.00	150.00

Gungahlin Pond

Water quality in Gungahlin Pond (Site 346) is now good, and while the water is occasionally slightly more alkaline than guidelines recommend, biological activity, as indicated by faecal coliform counts and chlorophyll 'a' records, is within expectations. The implementation of development controls together with sediment retention ponds upstream of Gungahlin Pond have contributed to the reduction in suspended solids concentrations. The elevated turbidity and suspended solids records for February may reflect the residual levels following a January storm.

Long-term trends. Over the period from 2002 to mid-2009 the mean values for dissolved oxygen, conductivity and faecal coliforms indicate a trend towards improved condition for this water body. Dissolved oxygen levels have shown means well above 6 mg/mL throughout, rising to a healthy 9–9.5 mg/mL in 2008–2009. Both conductivity and faecal coliform mean levels have become very low.

Table 22. Site 346 Gungahlin Pond

Indicator	Units	Reg limits	Long-term average	Mean	Aug 08	Oct 08	Nov 08	Dec 08	Jan 08	Feb 08	Mar 08	May 08
Acidity	pH	6–9	8.21	8.43	9.30	8.20	8.60	8.50	8.40	8.00	8.20	8.20
Chlorophyll 'a'	ug/L	10	5.97	6.65	1.00	2.00	2.00	16.00	6.60	9.00	8.70	7.90
Conductivity	uS/cm	N/A	310.73	227.50	250.00	250.00	250.00	200.00	220.00	210.00	230.00	210.00
Dissolved Oxygen	mg/L	>4	8.13	9.10	14.30	8.80	8.10	10.70	8.50	6.10	8.40	10.50
Faecal Coliforms - Confirmed	cfu/ 100mL	1,000	23.96	5.13	1.00	4.00	10.00	1.00	10.00	12.00	1.00	2.00
Suspended Solids	mg/L	25	17.53	13.88	4.00	3.00	7.00	12.00	8.00	36.00	24.00	17.00
Total Nitrogen	mg/L N	N/A	0.96	0.53	0.36	0.46	0.50	0.58	0.53	0.66	0.66	0.50
Total Phosphorus	mg/L P	0.1	0.04	0.03	0.02	0.02	0.04	0.04	0.03	0.05	0.05	0.02
Turbidity	NTU	30	37.90	13.40	4.30	4.80	7.30	14.00	7.80	32.00	20.00	17.00

Lake Ginninderra

Two sites are monitored in Lake Ginninderra, one near the inflow in the East Arm (Site 321) and the other at the outflow dam wall, or West Arm (Site 318). Water quality in the lake was good and generally better than the other lakes monitored. The presence of moderate quantities of phytoplankton in the East Arm in spring and summer indicates some water column stirring because of rain. High levels of turbidity and suspended solids, again in the East Arm, are probably related to local construction activity.

Long-term trends. All parameters show little change in the period 2002–2003 to the present.

Table 23. Site 318 Lake Ginninderra Dam Wall

Indicator	Units	Reg limits	Long-term average	Mean	Aug 08	Oct 08	Nov 08	Dec 08	Jan 08	Feb 08	Mar 08	May 08
Acidity	pH	6–9	7.93	8.01	8.10	8.20	7.90	7.90	8.00	7.80	8.20	8.00
Chlorophyll 'a'	ug/L	10	5.54	7.03	7.00	4.70	5.90	7.00	13.00	5.70	6.90	6.00
Conductivity	uS/cm	N/A	278.34	200.00	210.00	210.00	210.00	190.00	190.00	190.00	200.00	200.00
Dissolved Oxygen	mg/L	>4	7.24	7.71	10.80	10.00	7.40	7.60	8.50	5.50	8.30	10.10
Faecal Coliforms - Confirmed	cfu/ 100mL	1,000	81.73	5.14	1.00	9.00	6.00	1.00	4.00	*	14.00	1.00
Suspended Solids	mg/L	25	11.72	8.38	7.00	8.00	8.00	7.00	5.00	7.00	10.00	15.00
Total Nitrogen	mg/L N	N/A	0.72	0.55	0.60	0.59	0.58	0.51	0.55	0.49	0.53	0.51
Total Phosphorus	mg/L P	0.1	0.03	0.03	0.02	0.02	0.04	0.03	0.03	0.03	0.03	0.03
Turbidity	NTU	30	14.08	8.24	7.00	7.00	8.60	7.30	5.30	6.00	9.70	15.00

* Data not available for month

Table 24. Site 321 Lake Ginninderra East Arm

Indicator	Units	Reg limits	Long-term average	Mean	Aug 08	Oct 08	Nov 08	Dec 08	Jan 08	Feb 08	Mar 08	May 08
Acidity	pH	6–9	8.00	8.04	8.00	7.90	8.20	8.20	8.00	7.90	8.10	8.00
Chlorophyll 'a'	ug/L	10	9.95	14.15	2.00	11.00	15.00	20.00	29.00	19.00	7.20	10.00
Conductivity	uS/cm	N/A	289.71	201.25	210.00	210.00	210.00	190.00	190.00	200.00	200.00	200.00
Dissolved Oxygen	mg/L	>4	7.97	8.53	10.80	9.30	9.10	9.80	8.30	6.40	8.70	9.90
Faecal Coliforms - Confirmed	cfu/ 100mL	1,000	240.08	13.71	1.00	29.00	10.00	5.00	26.00	*	19.00	6.00
Suspended Solids	mg/L	25	24.08	28.00	16.00	15.00	19.00	84.00	11.00	33.00	34.00	12.00
Total Nitrogen	mg/L N	N/A	0.78	0.68	0.72	0.83	0.60	0.77	0.79	0.63	0.60	0.48
Total Phosphorus	mg/L P	0.1	0.05	0.05	0.05	0.07	0.05	0.08	0.06	0.05	0.05	0.03
Turbidity	NTU	30	26.55	21.00	18.00	14.00	13.00	50.00	11.00	24.00	24.00	14.00

* Data not available for month

Rivers

Murrumbidgee River (Sites 204, 209 and 213)

The Murrumbidgee River flows through the ACT entering at Angle Crossing (213) in the south and is sampled at three locations; Angle Crossing, Kambah Pool (209), and Halls Crossing (204) in NSW just downstream of the ACT. As the main river in the ACT the Murrumbidgee is on the receiving end of most material transported throughout ACT waterways.

There are rarely reports of aberrant reading for any parameter at the Murrumbidgee sites. At Halls Crossing pH is more alkaline, and conductivity and total nitrogen levels are distinctly higher than the two sites upstream of the urban areas and the confluence with the Molonglo River. Urban run-off, return of treated sewage and a change in geology would account for these differences. The small spike in turbidity at Angle Crossing for January 2009 may be coincident with a bank disturbance in the upper catchment at that time.

Table 25. Values of Indicators Sampled on Site 204 on the Murrumbidgee River at Halls Crossing

Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	April 09
Acidity	pH	6–9	8.30	8.23	8.10	8.20	8.40	9.53
Chlorophyll 'a'	ug/L	10	14.59	17.67	15.00	14.00	24.00	
Conductivity	uS/cm	N/A	197.29	216.67	210.00	210.00	240.00	366.60
Dissolved Oxygen	mg/L	>4	10.09	10.70	11.60	10.40	10.10	11.14
Faecal Coliforms - Confirmed	cfu/ 100mL	150	407.37	40.67	2.00	70.00	50.00	
Suspended Solids	mg/L	25	17.12	21.33	23.00	18.00	23.00	
Total Nitrogen	mg/L N	N/A	3.65	2.47	4.50	1.30	1.60	
Total Phosphorus	mg/L P	0.1	0.11	0.07	0.07	0.07	0.07	
Turbidity	NTU	30	13.07	16.67	15.00	18.00	17.00	8.40
		2007–2008					Nov	
AUSRIVAS Score	A,B,C,D	B;B					A	B

Table 26. Values of Indicators Sampled on Site 209 on the Murrumbidgee River at Kambah Pool

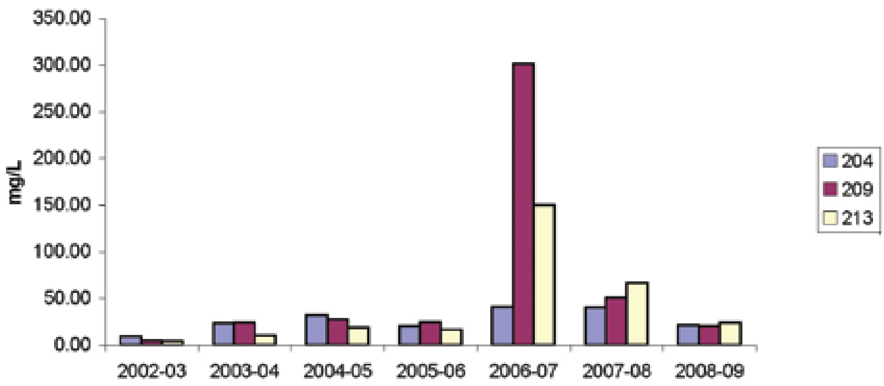
Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	Feb 09	April 09
Acidity	pH	6–9	7.95	7.57	7.50	7.60	7.60	8.90	8.40
Chlorophyll 'a'	ug/L	10	5.85	9.93	2.80	10.00	17.00		
Conductivity	uS/cm	N/A	137.90	71.33	59.00	57.00	98.00	150.00	160.00
Dissolved Oxygen	mg/L	>4	9.45	9.87	11.20	9.90	8.50	6.2	10.00
Faecal Coliforms - Confirmed	cfu/ 100mL	150	291.87	11.33	4.00	10.00	20.00		
Suspended Solids	mg/L	25	20.81	20.33	23.00	21.00	17.00		
Total Nitrogen	mg/L N	N/A	0.56	0.41	0.30	0.36	0.56		
Total Phosphorus	mg/L P	0.1	0.05	0.05	0.04	0.05	0.07	0.01	0.02
Turbidity	NTU	30	17.99	22.67	22.00	22.00	24.00	30.00	30.00

* Data not available for this month

Table 27. Values of Indicators Sampled on Site 213 on the Murrumbidgee River at Angle Crossing

Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	Jan 09	April 09
Acidity	pH	6–9	7.78	7.40	7.40	7.30	7.50	8.60	7.60
Chlorophyll 'a'	ug/L	10	3.91	4.53	5.20	3.30	5.10		
Conductivity	uS/cm	N/A	127.44	65.67	59.00	42.00	96.00	110	104.20
Dissolved Oxygen	mg/L	>4	9.28	11.47	11.60	14.60	8.20	5.50	10.39
Faecal Coliforms - Confirmed	cfu/ 100mL	150	254.92	7.67	1.00	1.00	7.00	15.00	
Suspended Solids	mg/L	25	13.86	23.67	17.00	32.00	22.00		
Total Nitrogen	mg/L N	N/A	0.50	0.28	0.21	0.27	0.36		
Total Phosphorus	mg/L P	0.1	0.05	0.04	0.03	0.04	0.04	-	
Turbidity	NTU	30	9.75	23.00	17.00	28.00	24.00	80.00	-
		2007-2008					Nov		Apr
AUSRIVAS Score	A,B,C,D	B;A					A		B

Figure 9. Annual means (suspended solids) for all sites along the Murrumbidgee River 2002–2003 to 2008–2009



Long-term trends. There are minor fluctuations in most parameter means between 2002 and the present. Figure 9 shows the annual means for suspended solids for all three river sites from 2002–2003 to the present. Prior to 2003–2004 the means for suspended solids generally came in around 10mg/L, with spikes in flood years. Both the suspended solids and turbidity means rise suddenly in 2003–2004, suspended solids to 20 mg/L or higher, and remain at higher levels than before the bushfire. The spike in 2006–2007 reflects the major storm event on New Year's Eve. These data indicate that the catchment has remained fragile after the bushfire and that individual storm events can have dramatic impacts long after the catastrophe has passed.

Murrumbidgee River upstream, Angle Crossing, February 2007

Ginninderra Creek (Site 301 and Sites 195, 196 and 64)

Ginninderra Creek runs through a highly urbanised catchment with intensive development occurring in the upper parts of Gungahlin. The monitoring site for water quality in Ginninderra Creek is at Parkwood (Site 301) below the confluence with Gooromon Ponds Creek downstream of the lake. The biological monitoring sites in Ginninderra Creek are Baldwin Drive bridge (Site 195), downstream of Lake Ginninderra (Site 196) and Latham (Site 64).

While it is expected that willow removal work in the area will eventually make inroads towards improving Ginninderra Creek habitat, the compounding affect of the continued low flows and degraded riparian habitat has resulted in a reduction in AUSRIVAS scores at Site 64. The data for April 2009 are from the AUSRIVAS sites. The Parkwood Rd results, for the first half of the year, indicate that the creek at that time was in generally fair condition.

Table 28. Values of Indicators Sampled at Sites 301, 195, 196 and 64 along Ginninderra Creek

Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	April 09
Acidity	pH	6–9	7.76	7.50	7.40	7.70	7.40	8.07
Chlorophyll 'a'	ug/L	10	14.47	5.13	1.00	7.70	6.70	
Conductivity	uS/cm	N/A	411.35	223.33	240.00	220.00	210.00	18.61
Dissolved Oxygen	mg/L	>4	8.21	9.20	9.80	10.10	7.70	7.73
Faecal Coliforms - Confirmed	cfu/ 100mL	150/1,000	1,343.91	208.33	5.00	300.00	320.00	
Suspended Solids	mg/L	25	15.98	19.00	8.00	20.00	29.00	
Total Nitrogen	mg/L N	N/A	1.15	0.58	0.59	0.53	0.61	
Total Phosphorus	mg/L P	0.1	0.93	0.04	0.02	0.05	0.05	
Turbidity	NTU	30	12.06	12.83	7.50	13.00	18.00	15.80
		2007–2008				Nov 08		
AUSRIVAS Score (195)	A,B,C,D	C;C				B		C
AUSRIVAS Score (196)	A,B,C,D	C;C				C		C
AUSRIVAS Score (64)	A,B,C,D	D;C				D		C

Long-term trends. The fluctuations in mean faecal coliform counts from year to year can be dramatic, the mean Conductivity has gone down a little and the mean turbidity has risen slightly over the period 2002 to 2009. Other parameters have remained relatively static.

Ginninderra Creek is constrained as it flows through urban areas. Poor riparian vegetation encourages compensatory growth of filamentous algae.

Molonglo River (Sites 601 and 608)

The Molonglo River is sampled at two sites above Lake Burley Griffin, near where the river enters the ACT at Dairy Flat (Site 601), and Yass Road bridge (Site 608) downstream of the Molonglo Gorge. The Lower Molonglo Water Quality Control Centre (Canberra's main sewage treatment plant) discharges into the Molonglo River, near its confluence with the Murrumbidgee River. Additional sampling (not reported here) is done by ACTEW as part of monitoring the impact of the discharge may have on downstream waters.

After the Molonglo River leaves the Molonglo Gorge it flows along the periphery of urban/industrial areas of Queanbeyan and continues through intensive land use into Lake Burley Griffin. The conductivity at Dairy Flat Rd is elevated by contributions from the Queanbeyan River (Table 30) and the Queanbeyan Sewage Treatment Plant.

December levels for chlorophyll 'a' in the Molonglo River where it enters Lake Burley Griffin indicates the early stages of the blooms that closed this reach from February to May 2009. Cell counts for the cyanobacterium *Aphanizomenon* sp. had already reached 62,000–70,000/mL in February. Yass Rd bridge AUSRIVAS scores for 2008-2009 are now becoming close to satisfactory. These indicate that riparian restoration works are having a positive effect on water quality at this site.

Table 29. Values of Indicators Sampled on Site 601 on the Molonglo River at Dairy Flat Bridge

Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	Feb 09	April 09
Acidity	pH	6–9	7.58	8.37	7.80	8.10	9.20	7.25	8.15
Chlorophyll 'a'	ug/L	10	14.97	20.33	7.00	11.00	43.00		
Conductivity	uS/cm	N/A	247.50	493.33	520.00	520.00	440.00	348.00	464.00
Dissolved Oxygen	mg/L	>4	7.66	12.03	10.70	10.50	14.90		
Faecal Coliforms - Confirmed	cfu/ 100mL	150	102.98	382.00	1.00	1100.00	45.00		
Suspended Solids	mg/L	25	11.98	11.00	8.00	8.00	17.00		
Total Nitrogen	mg/L N	N/A	1.47	4.00	5.60	5.30	1.10		
Total Phosphorus	mg/L P	0.1	0.10	0.05	0.04	0.03	0.07	*	0.00
Turbidity	NTU	30	12.21	7.43	6.00	7.40	8.90	30.00	30.00

* Data not available for month

Table 30. Values Indicators Sampled on Site 608 (AUSRIVAS 242) on the Molonglo River at Yass Road

Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	April 09
Acidity	pH	6–9	7.31	7.23	7.20	7.30	7.20	7.42
Chlorophyll 'a'	ug/L	10	4.42	7.03	12.00	3.80	5.30	
Conductivity	uS/cm	N/A	348.33	273.33	240.00	190.00	390.00	482.50
Dissolved Oxygen	mg/L	>4	6.80	8.50	10.00	8.70	6.80	6.30
Faecal Coliforms - Confirmed	cfu/ 100mL	150	365.48	39.00	12.00	30.00	75.00	
Suspended Solids	mg/L	25	12.20	9.67	8.00	10.00	11.00	
Total Nitrogen	mg/L N	N/A	0.47	0.48	0.47	0.42	0.55	
Total Phosphorus	mg/L P	0.1	0.04	0.04	0.03	0.04	0.04	
Turbidity	NTU	30	18.94	10.57	5.70	11.00	15.00	10.50
		2007–2008				Nov 08		
AUSRIVAS Score	A,B,C,D	D;B				A		B

Long-term trends. Both the Molonglo River at Yass Road and the Queanbeyan River at the cemetery show fluctuations in the mean dissolved oxygen readings from year to year and this appears to be correlated to mean flow in the two rivers. In years of good rainfall, or well distributed falls, the mean dissolved oxygen levels will be satisfactory (> 4.5 mg/mL) and higher than in years when rainfall is negligible or patchy in the respective catchments and river flow becomes minimal. Other parameters show little variation from year to year.

Queanbeyan River (Site 769)

The Queanbeyan River is sampled at the ACT border. Most indicators for water quality are quite acceptable. Low flow downstream of the town weir associated with hot weather and little rain leads to concerningly low levels of dissolved oxygen at this sampling point. The moderately high conductivity reflects the run-off from urban areas on both sides of the Queanbeyan River.

The AUSRIVAS scores are both well below reference, and may have much to do with the poor quality of riparian bank vegetation (absence of local native plants) and sluggish flows throughout the year.

Table 31. Values Indicators Sampled on Site 769 on the Queanbeyan River at the ACT Border

Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	Feb 09	April 09
Acidity	pH	6–9	7.37	7.23	7.40	7.40	6.90	6.60	8.13
Chlorophyll 'a'	ug/L	10	6.55	2.89	0.96	3.00	4.70		
Conductivity	uS/cm	N/A	216.21	310.00	340.00	400.00	190.00	356.00	218.00
Dissolved Oxygen	mg/L	>4	7.53	7.73	10.90	8.10	4.20		
Faecal Coliforms - Confirmed	cfu/ 100mL	150	665.74	77.67	86.00	47.00	100.00		
Suspended Solids	mg/L	25	8.19	5.33	4.00	9.00	3.00		
Total Nitrogen	mg/L N	N/A	0.53	0.41	0.32	0.34	0.56		
Total Phosphorus	mg/L P	0.1	0.04	0.03	0.01	0.02	0.05	*	0.05
Turbidity	NTU	30	7.27	6.90	4.70	12.00	4.00	10.00	10.00
		2007–2008					Nov 08		
AUSRIVAS Score	A,B,C,D	C;C					D		C

* Data not available for month

Long-term trends. As noted above, dissolved oxygen is the only parameter with significant variation from year to year.

Paddys River (Site 842 and Site 10)

Paddys River catchment has a combination of rural, forestry and conservation land uses. It was affected directly by the January 2003 bushfires. This was reflected in the AUSRIVAS data at Murray's Corner (Site 10), which was below reference for some time after the bushfires. It has now returned to reference condition for autumn.

Sampling results for Paddy's River for this year are similar to the last three years, with good water quality and biological condition at reference or just below reference condition. The elevation in conductivity in 2009 is probably a reflection of the very low or absent flows at this time. Murray's Corner is a popular summer picnic spot, hence the faecal coliform limit of 150 cfu/100mL. Faecal coliform figures indicate both rural activities in the catchment and slow post-fire stabilisation of former forested areas.

Long-term trends. Apart from minor variations, probably attributable to post-fire or persistent drought effects, none of the parameters show any trends between 2002 and the present.

Table 32. Values of Indicators Sampled on Sites 842 and 10 along Paddys River

Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	Feb 09	April 09
Acidity	pH	6–9	7.62	7.67	7.70	7.70	7.60	8.18	7.07
Chlorophyll 'a'	ug/L	10	2.15	2.13	2.00	3.00	1.40		
Conductivity	uS/cm	N/A	87.95	73.67	72.00	64.00	85.00	182.00	155.30
Dissolved Oxygen	mg/L	>4	10.54	11.30	11.80	12.70	9.40	6.80	8.57
Faecal Coliforms - Confirmed	cfu/ 100mL	150	637.98	171.33	4.00	280.00	230.00		
Suspended Solids	mg/L	25	11.91	7.67	7.00	10.00	6.00		
Total Nitrogen	mg/L N	N/A	0.45	0.33	0.19	0.38	0.42		
Total Phosphorus	mg/L P	0.1	0.05	0.04	0.02	0.05	0.05	0.02	
Turbidity	NTU	30	14.79	11.10	5.30	18.00	10.00	21.00	7.40
		2007–2008					Nov 08		
AUSRIVAS band (10)	A,B,C,D	B;A					B		A

Gudgenby River (Site 901 and Site 20)

The Gudgenby River drains a rural catchment dominated by native forest, and the water testing site is a fire affected site. Nevertheless, water quality at this site was close to standard condition. The biological condition of the site at Smiths Road Crossing (20) reached reference in spring, and slipped to significant impairment in autumn. Grazing disturbance and low rainfall are probably involved in the fluctuations in biological condition.

Long-term trends. In another river severely affected by the 2003 wildfire, the suspended solids and turbidity means rise suddenly in 2003–2004 and then drop back to a higher level than before the fire, and remain at that level until the present. The faecal coliform counts fluctuate dramatically. It is possible that in a rural catchment with significant numbers of stock that the annual mean for coliforms may be directly inflated by short term changes in stocking rates. Such fluctuations may not present a clear indication of any trend in the persistent presence of bacteria in the waterway. Other parameters show no significant trends in the period.

Table 33. Values of Indicators Sampled on Sites 901 and 20 along the Gudgenby River

Indicator	Units	Regulation limits	Long-term average	Average 2008–09	Aug 08	Sep 08	Dec 08	April 09
Acidity	pH	6–9	7.71	7.50	7.50	7.20	7.80	7.67
Chlorophyll 'a'	ug/L	10	1.89	2.10	1.20	3.90	1.20	
Conductivity	uS/cm	N/A	99.84	69.00	64.00	64.00	79.00	85.90
Dissolved Oxygen	mg/L	>4	9.93	10.90	12.00	10.90	9.80	12.26
Faecal Coliforms - Confirmed	cfu/ 100mL	150	333.78	234.00	12.00	520.00	170.00	
Suspended Solids	mg/L	25	9.51	12.33	14.00	18.00	5.00	
Total Nitrogen	mg/L N	N/A	0.44	0.65	0.42	0.78	0.76	
Total Phosphorus	mg/L P	0.1	0.05	0.07	0.05	0.10	0.07	
Turbidity	NTU	30	10.86	16.77	18.00	24.00	8.30	-
		2007–2008				Nov 08		
AUSRIVAS Score (20)	A,B,C,D	C;B				A		B

Minor Waterways

These four waterways are monitored for bioassessment only. There are insufficient data about any of the parameters to draw any conclusions about trends in the water quality. All four sites are among those monitored by Waterwatch volunteers, and further information about their water quality may be obtained from ACT Waterwatch at www.act.waterwatch.org.au .

Tidbinbilla River (Site 15)

Site 15 (Figure 7) on the Tidbinbilla River is only sampled using the AUSRIVAS macroinvertebrate rapid bioassessment protocol in spring and autumn. It is one of the three reference sites. Water quality results presented for this site are those sampled in conjunction with the macroinvertebrate sampling. Indications are that the waterway is in excellent condition with a slightly elevated turbidity from spring rain.

Table 34. Values Indicators Sampled on Site 15 on the Tidbinbilla River

Indicator	Units	Regulation limits	November 08	April 09
Conductivity	(µS/cm)	N/A	70.00	123.20
Acidity	pH	6.5–9	8.11	6.99
Alkalinity	(mg/L CaCO3)	N/A	40.00	60.00
Dissolved Oxygen	(mg/L)	>4	9.13	7.62
Turbidity	(NTU)	<10	12.90	-
		2007–2008		
AUSRIVAS score	A, B, C D	A;A	A	A

Jerrabomberra Creek (Site 246)

Site 246 (Figure 7) on Jerrabomberra Creek is only sampled using the AUSRIVAS macroinvertebrate rapid bioassessment protocol in spring and autumn. Water quality results presented for this site are those sampled in conjunction with the macroinvertebrate sampling. Jerrabomberra Creek drains through industrial, rural and urban settings and water quality is in a satisfactory condition by April 2009 once the first stage of the local road works had been completed. Biological condition remains poor, similar to 2007–2008 both for macroinvertebrates and habitat and may continue so until upstream riparian vegetation improves. The severely impaired rating for November 2008 coincided with grading and other road work upstream, near Hume. Much of the first stage of that roadwork had been completed by April 2009.

Table 35. Values of Indicators Sampled on Site 246 on Jerrabomberra Creek near Hindmarsh Drive

Indicator	Units	Regulation limits	November 08	April 09
Conductivity	(µS/cm)	N/A	208.90	296.30
Acidity	pH	6.5–9	8.30	7.01
Alkalinity	(mg/L CaCO3)	N/A	90.00	108.00
Dissolved Oxygen	(mg/L)	>4	8.65	12.61
Turbidity	(NTU)	<10	25.40	-
		2007–2008		
AUSRIVAS band	A, B, C D	B;C	C	B

Yarralumla Creek (Site 189)

Site 189 (Figure 7) on Yarralumla Creek is only sampled using the AUSRIVAS macroinvertebrate rapid bioassessment protocol in spring and autumn. Water quality results presented for this site are those sampled in conjunction with the macroinvertebrate sampling. This creek is mostly a concrete lined drain meandering through the urban areas of Phillip and Woden but becomes more creek-like as it crosses the horse paddocks before joining the Molonglo River below Scrivener Dam. Water quality in April reflects local infrastructure work and low rainfall with hot weather in February and March. The dissolved oxygen result coincides with a report of very dense filamentous algal growth, which may lead to localised oxygen depletion. With much of Yarralumla Creek confined to concrete drain lines, and the lower creek in horse paddocks, the consistent severely impaired AUSRIVAS rating is unlikely to improve.

Table 36. Values of Indicators Sampled on Site 189 on Yarralumla Creek Downstream Curtain

Indicator	Units	Regulation limits	November 08	April 09
Conductivity	(µS/cm)	N/A	121.40	689.00
Acidity	pH	6.5–9	8.14	8.24
Alkalinity	(mg/L CaCO3)	N/A	45.00	135.00
Dissolved Oxygen	(mg/L)	>4	7.90	4.95
Turbidity	(NTU)	<10	10.80	47.40
		2007–2008		
AUSRIVAS	A, B, C D	B;C	C	C

Yarralumla Creek, at the sewer main crossing in the horse paddocks near Cotter Rd bridge.

Tuggeranong Creek (Site 58)

Site 58 (Figure 7) on Tuggeranong Creek is only sampled using the AUSRIVAS macroinvertebrate rapid bioassessment protocol in spring and autumn. Water quality results presented for this site are those sampled in conjunction with the macroinvertebrate sampling. This site is in the creek downstream of Lake Tuggeranong. Although Lake Tuggeranong helps prevent sediments and pollutants from reaching this section of the creek habitat, the surrounding land use of grazing and the disturbance by bushfires means this site is susceptible to degradation. The turbidity may be associated with sediment loads associated with post-storm flows.

The AUSRIVAS rating for this small waterway is quite variable. The creek vegetation has recovered from the bushfire, but the flow regime through Lake Tuggeranong is partly dependent on storms, and the test site may become a pool for significant periods. While the rating in autumn 2008 was at reference, it had slipped to severely impaired in spring 2008, and returned to significantly impaired in autumn 2009, most probably in response to water level and flow rate fluctuations.

Tuggeranong Creek, looking back towards the Lake Tuggeranong wall, May 2007.

Table 37. Values of Indicators Sampled on Site 58 on Tuggeranong Creek downstream of Lake Tuggeranong

Indicator	Units	Regulation limits	November 08	April 09
Conductivity	(µS/cm)	N/A	98.80	102.40
Acidity	pH	6.5–9	7.97	7.80
Alkalinity	(mg/L CaCO3)	N/A	79.00	80.00
Dissolved Oxygen	(mg/L)	>4	7.32	7.89
Turbidity	(NTU)	<10	22.00	12.40
		2007–2008		
AUSRIVAS score	A, B, C D	C;A	C	B

SECTION 3: RESEARCH AND COMMUNITY ACTIVITIES

Groundwater Resources in the ACT

Geologically the ACT sits on low yield fractured rock aquifers and consequently groundwater in the ACT is a rather small resource compared to surface water. However, in localised situations there will be opportunities to utilise an aquifer in an efficient manner to help offset demand on our water supply dams.

EPA has increased the coverage of monitoring since 2002 as a response to the tremendous increase in demand and use of groundwater. In order to ensure agency resources were being used efficiently a National Water Commission funded analysis project provided strategic direction and identified the priorities for groundwater works and management in the ACT. A risk-based approach to groundwater monitoring has been developed whereby the amount of monitoring an area has is proportional to the risk posed to the groundwater whether through abstraction, contamination or landuse change.

Environment Protection and Water Resources currently maintains 14 dedicated monitoring bores, with information from another 6 sites coming from interested groundwater abstracters. The purpose of these monitoring bores is to gather information about the transmissivity (capacity for water to move through the aquifer), hydraulic conductivity, storage capacity potential, and recharge rates of the various aquifer types within water management areas. Monitoring of the aquifer recharge response to rainfall is seen as a critical activity to be able to quantify potential effects of changed rainfall patterns expected from climate change.

Monitoring the aquifer (left). Environmental Protection officer investigating an abandoned bore in the Capital Precinct (above)

Urban Waterways Project

The Canberra Integrated Urban Waterways project is funded by the Commonwealth Government and ACT Government ($6.8 m) under the Water Smart Australia Program administered by the Department of Environment, Water, Heritage and the Arts. The Urban Waterways Project is being delivered by the Department of the Environment, Climate Change, Energy and Water in partnership with the ACT Planning and Land Authority.

The project is focusing on integrating urban waterway management by investigating opportunities for investment in stormwater harvesting from existing and new lakes/ponds and aquifer storage and recovery where feasible. The objective of the project is to replace 1.5 gigalitres of potable water by 2010 with alternative water sources for irrigation. The project is aiming to meet a longer term target of 3 gigalitres / year of potable water displacement by 2015.

A comprehensive feasibility study by the CSIRO has reviewed over 60 possible sites for stormwater harvesting ponds and high priority end uses including sportsgrounds and other sporting and recreational facilities, parks, golf courses and schools.

The Flemington Road Ponds development was constructed in 2008/09. A concept design for reticulation to end users has been completed and detailed design will be undertaken in 2009/10 for construction of the infrastructure in 2010/11. This pilot project will test the complex issues associated with designing and operating a non-potable water reticulation system that may include direct injection of stormwater to aquifers for storage and recovery. Issues associated with the administration of non-potable water provision will also be tested.

Salinity

The ACT is participating in Commonwealth programs to quantify the movement of salt through the Murray Darling Basin. The Murray Darling Basin Commission (now the Murray Darling Basin Authority) provides support for modelling through the 'Basin Salinity Management Strategy' whilst the Department of Agriculture Fisheries and Forestry has augmented ACT salinity monitoring through the 'Community Stream Sampling Program'.

Continual measurement of stream salinity is now performed at key locations throughout the ACT to enable determination of potential problems zones and to provide a robust dataset to validate salinity modelling.

An ACT salinity model has been developed to quantify a salinity baseline and establish a salt export target. This model combined with the new intensive datasets will allow the ACT to determine compliance with a salt target, identify which areas need attention and assess how effective Water Sensitive Urban Design is on controlling salinity changes brought on by land development.

Restoration of the Lower Cotter Catchment

The Lower Cotter Catchment Strategic Management Plan was formally adopted by the ACT Government in July 2008, after public consultation. The plan emphasises water as the primary value of the Lower Cotter Catchment and articulates a goal of achieving clean water and healthy landscapes. Implementation of key objectives and actions is well underway through a partnership between the ACT Government and ACTEW Corporation.

A range of actions, supporting the work done in the previous twelve months, were undertaken in 2008/09 including planting a further 150,000 native tube stock, removing pine wildlings from the remaining ex-plantation areas, closure of another 20 km of redundant roads; construction of erosion control structures to address sediment sources, and implementing further recreation management initiatives.

The pace and quality of progress underlines the excellent relationships and partnerships between the ACT Government land, fire and environment protection agencies, ACTEW Corporation and a wide range of community groups and individuals.

Murrumbidgee River Riparian Vegetation Survey and Mapping

Over the past two years the riparian vegetation communities have been mapped along the Murrumbidgee River and its major tributaries within the ACT Research and Planning unit of the Department of Territory and Municipal Services. The Murrumbidgee River was the subject of an intensive on-ground verification survey, while the tributaries were remotely assessed. The projects have resulted in an increased knowledge of the distribution and condition of riparian vegetation communities across the major waterways in the ACT. Details can be found in the *Survey of vegetation and habitat in key riparian zones: Murrumbidgee River* with a further description of the major tributaries to follow.

Threatened Fish in the ACT

Monitoring of threatened fish species is conducted by the Research and Planning unit of TAMS. In 2008–09 targeted programs were undertaken for Macquarie Perch (*Macquaria australasica*) (endangered), Trout Cod (*Maccullochella macquariensis*) (endangered) and Two-spined Blackfish (*Gadopsis bispinosus*) (vulnerable). A general survey of the Murrumbidgee River in the ACT was also undertaken. This survey provides monitoring data for Macquarie perch, trout cod, Silver Perch (*Bidyanus bidyanus*) (endangered), and Murray River Crayfish (*Euastacus armatus*) (vulnerable). Currently joint research projects involving ACTEW, the University of Canberra, the Australian National University and ACT Government have been established to gain knowledge on Macquarie Perch and other threatened species populations in the Cotter Reservoir and river.

Macquarie Perch were monitored in the Cotter, Murrumbidgee and Queanbeyan Rivers. The numbers in Cotter Reservoir were the highest recorded since 1997 including large numbers of juveniles less than one year old. The Cotter population has successfully recruited for a number of consecutive years despite periods of drought and high sediment loads entering the Cotter River following the 2003 bushfires. There appears to be spawning well upstream of fish ladders that were installed to mitigate barriers to fish passage. The Cotter River population was found to be in reasonable genetic health. The Queanbeyan River Macquarie perch population has not shown any signs of recovery since a decline in the late 1990s.

Trout Cod have been stocked in the ACT for the local conservation of the species since the 1980s. In 2008–09, monitoring was undertaken on the Murrumbidgee River at Kambah Pool and the Cotter River at Bendora Reservoir. The capture of a large mature trout cod in Bendora Reservoir this year suggests that large trout cod are surviving in the area. Previously, stocking and surveys of trout cod on the Murrumbidgee River have been conducted at Angle Crossing. This year the sampling site was a shifted downstream to Kambah Pool in conjunction with a shift in stocking site in 2006.

Although the number of **Two Spined Blackfish** caught in Bendora Reservoir has declined over the past five years, a higher number of blackfish were recorded in the Cotter River in 2009 than found in the last sampling effort in 2007 despite sediment loads and drought effects which resulted after the 2003 bushfires.

Parks, Conservation and Lands staff backpack electro-fishing on the Cotter River in 2009. Photo by Mark Jekabsons

No **Silver Perch** were recorded during the monitoring of the Murrumbidgee River this year. Silver perch are listed as endangered in the ACT and have not been recorded in official surveys of research projects within the last five years.

Surveys of **Murray River Crayfish** indicate that the species has a patchy distribution within the ACT. A single crayfish was recorded during the monitoring of the Murrumbidgee River this year. Native fish such as Murray Cod (*Macquaria peelii peelii)* listed as vulnerable nationally, and Golden Perch (*Macquaria ambigua*) are also surveyed within the ACT in 2009 as part of Murrumbidgee River monitoring.

The *Fish Stocking Plan for the Australian Capital Territory 2009–2014* was released in July this year. The stocking plan includes guidelines for stocking fish in ACT's urban lakes and ponds as well as Googong Reservoir in order to conserve natural populations in the more vulnerable river systems. The stocking plan includes information on the recovery and research of threatened species in the ACT.

Upper Murrumbidgee River Demonstration Reach

A Demonstration Reach is a large and prominent stretch of river and its catchment where collaboration can be set up between government agencies and academic and community groups to protect, enhance and showcase aquatic life and habitat. Demonstration Reaches are part of the Commonwealth Government's *Caring for Our Country* initiatives. There are several of these Demonstration Reaches in the Murray-Darling basin, usually having an emphasis on native fish and fish habitat.

The Upper Murrumbidgee River Demonstration Reach is about 70 km long, from the Scottsdale area in south-eastern NSW downstream to Kambah Pool in the ACT. It includes the popular Pine Island, Tharwa bridge and Tharwa village recreation areas, and the prominent river crossings at Angle Crossing and Point Hut Crossing.

This reach is of high conservation value for nationally listed threatened fish species including Trout Cod, Murray Cod and Macquarie Perch. It contains examples of floristically diverse riparian communities including ribbon gum tableland riparian woodland, tableland riparian shrubland in Gigerline and Red Rocks gorges and the upper limits of ecologically important river sheoak tableland riparian woodland on the Murrumbidgee.

With the encroachment of urban development, ongoing agricultural land use, and the long-term decline in river flows there are numerous threats to the ecosystem, especially from the spread of weeds and introduced fish.

The Demonstration Reach framework presents the opportunity of a cohesive and interdisciplinary approach to achieve large scale and significant environmental outcomes. The upper Murrumbidgee River, in both NSW and the ACT, is a suitable reach where cooperation at all levels of government can be facilitated. At the same time there are real opportunities for corporate sponsorship and renewed support for the various community groups that already value the reach. Thirteen natural resources management groups from the region are already working together on the project.

Upper Murrumbidgee Catchment Coordinating Committee

The Upper Murrumbidgee Catchment Coordinating Committee (UMCCC) is a community based organisation made up of agencies and groups that are responsible for, or contribute to, natural resource management in the upper Murrumbidgee catchment.

The UMCCC operates as a regional cross border network to promote communication, build awareness and disseminate knowledge between its members. These include agencies and groups in NSW and the Australian Capital Territory. The UMCCC actively participates in community forums and has received presentations and made submissions on numerous natural resource management policy initiatives. The UMCCC is assisted by funding and in-kind support from the Australian and ACT Governments and Queanbeyan City Council.

In June 2009 the UMCCC launched 'Groundwater in the Upper Murrumbidgee', a fact sheet for rural landholders designed to increase knowledge and understanding of sustainable groundwater use.

'Refining and implementing the willow management strategy for the Upper Murrumbidgee Catchment' is now in its fourth year of operation and is due for completion in December 2009. The UMCCC received funding through the Defeating the Weed Menace R&D grants to undertake the project 'Exploring the agents of change to peri-urban weed management'. This research has been undertaken in Partnership with Griffith University and a comprehensive report is due for release in late 2009.

Over the past five years the UMCCC has continued to enjoy strong support from community and Landcare groups, as well as government agencies in both NSW and the ACT as it provides an effective cross border network.

Waterwatch

The past five years have been a time of unprecedented growth in the Upper Murrumbidgee Waterwatch program both in terms of volunteer numbers, sites, and community engagement activities, professional inclusion and use of Waterwatch data and national and regional recognition. Waterwatch has grown to a network of over two-hundred highly trained volunteers working across 89 sites in the region. Community engagement programs extend from a recently expanded curriculum-linked education package to programming for colleges and TAFE. Adult programming over the last five years includes training in macroinvertebrate surveying, assessment of riparian condition and the inclusion of a duel-pronged Platypus monitoring program. Waterwatch data has been taken up and used at a professional level by several ACT government departments, the Bureau of Rural Sciences on a national level as well as by university students in their research. The Upper Murrumbidgee Waterwatch Facilitator (Tanya Rucosky Noakes) has proudly received an ACT Community Environment Support Landcare Award in 2009 for her efforts supporting the volunteer network.

Waterwatch is a nation-wide water quality monitoring program where the sampling and testing is done by community volunteers. ACT Waterwatch is part of that national community that encourages all Australians to become involved and active in the protection and management of their waterways and catchments.

It is a 'monitoring to action' program that aims to equip local communities with the skills and knowledge to become actively involved in the protection and management of their local waterways and catchments. The program in the ACT is funded by both the Commonwealth and the Territory Government, with three part-time coordinators attached to the Ginninderra, Molonglo and Southern ACT Catchment Groups, and supported by the ACT Waterwatch Facilitator in DECCEW. Waterwatch volunteers come from local community groups such as Landcare, Parkcare and Catchment Groups, as well as residents, schools and landowners. They regularly monitor the water quality of local creeks, wetlands, lakes, rivers and stormwater drains. The volunteers, all carefully trained and kept up to date, with support from the ACT Waterwatch Facilitator and Ecowise Environmental, collect information at sites throughout urban and non-urban ACT to complement and extend the coverage provided to DECCEW Water Resources.

Healthy catchments produce healthy ecosystems with fish, frogs, birds, plants, macro-invertebrates and people. Waterwatch groups have initiated many positive, community based conservation activities such as creek restoration, willow removal, removing litter from waterways, eradicating weeds, drain stencilling, development of habitats, reducing the use of pesticides, fertilizers and other pollutants. The three regional Waterwatch coordinators provide environmental education opportunities to all members of the community at no cost. From pre-school 'touch and grow' sessions through to primary, secondary, college, TAFE, community and university levels, Waterwatch provides authentic hands-on learning experiences that complement its monitoring objectives.

Frogwatch

Frogwatch is a community frog monitoring program that aims to involve large numbers of volunteers of all ages to undertake frog monitoring and protect frog habitats. In National Water Week, the third week of October each year, over 200 Frogwatch participants monitor frog populations at approximately 140 sites around the ACT and Region. Frogwatch participants attend a training seminar where they learn all about the fascinating world of frogs, how to monitor them, and ways to help protect them and their habitats. The Frogwatch Census involves an assessment of the types and abundance of frogs living in our environment. Frog species are widely recognised as indicators of environmental health and their presence can indicate the long-term health of a catchment. Results of the Community Frogwatch Census are available on the Ginninderra Catchment Group website at: www.ginninderralandcare.org.au.

The Frogwatch Census Report 2008 offers detailed information about nine of the local frog species, their populations and distribution as mapped during this reporting period.

Over the period 2004–2008 the program has grown to include a significant education program as well as maintaining volunteer numbers for the annual census. During this period, fluctuations in rainfall meant the Frogwatch census captured important data on the impact rainfall has on the breeding population. A new recording of the Green and Golden Bell Frog (Litoria aurea), a species that is considered nationally threatened, was made in 2006.

Getting Involved in Waterwatch

If you are interested in improving the health of your local waterway and meeting or forming a group of likeminded individuals please contact the Waterwatch Facilitator on 6207 2246.

Online information about Waterwatch is available on the website at: www.waterwatch.act.org.au and features Waterwatch resources, contact details and a library of relevant publications and fact sheets.

The ACT Waterwatch Faciilitator with children at a Holiday Program day.

The Waterwatch Information Network (WIN) is a regular information e-mail, which promotes Waterwatch, and water quality issues in the Upper Murrumbidgee Catchment. Membership is free and open to all people with an interest in catchment health. Contact Waterwatch ACT on 6207 2246 for more information on Waterwatch Information Network.

Symbols used in tables

N/A	not applicable
-	zero