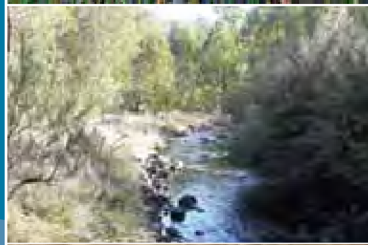
# ACT WATER REPORT
## 2009–2010


DEPARTMENT OF
THE ENVIRONMENT,
CLIMATE CHANGE,
ENERGY AND WATER

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Front cover photos:
Top: Gudgenby River headwaters, vegetation (TAMS)
Middle: Cotter River, below Corin Dam (TAMS)
Bottom: Pump at Gold Creek Country Club (EPA)

# MINISTERIAL FOREWORD ACT WATER REPORT 2009–2010

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

The *ACT Water Report 2009–2010* provides important information about our waterways and the impact of urban, rural, forestry and conservation land practices in the ACT.

The Report comments on how we use our waterways, from recreation to irrigation, and details water access entitlements and licences to take water for the period 2009–2010.

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 all Canberrans. That responsibility is demonstrated in the quality of water leaving the Territory being at least as good as that entering it.

The Report provides data demonstrating that water quality in the region is meeting acceptable standards, and the on-going efficient use of our water 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.

Research continues on Catchment Management processes. Threatened Fish stocks and diversity have continued their post fire recovery in the Murrumbidgee, Cotter and Queanbeyan Rivers. Water related community programs such as Waterwatch continue to attract a high level of interest and community support. Community monitoring programs focus on water quality, and assess aquatic fauna such as platypus, frogs, macroinvertebrates, and riparian condition. These community groups should be commended for their ongoing dedication to our precious 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 and the *Environment Protection Act 1997*, *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. 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. 33). 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 2009–June 2010) showed that rainfall in the urban area was 88mm more than the previous year and, at 612 mm, similar to the long term average rainfall. In 2009–2010 stream flow in waterways arising within the ACT increased with good runoff from storms in September and December and remained high after the heavy falls in February as soil moisture in the catchment returned to satisfactory levels.

Environmental conditions in urban waterways have improved as a result of several storm related flushing events and subsequent good follow-up rain. In non-urban waterways reestablishment of favourable flow regimes has led to enhanced water quality. While Turbidity and Suspended Solids levels have been high at sampling times, which are flow-based, pH, Conductivity and Dissolved Oxygen levels have been in the favourable range since February.

During the sampling period the urban lakes showed overall water quality close to or within recommended limits. However, for the indicator Chlorophyll 'a', all the urban lakes had high readings 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. The recently built Flemington Road Pond has yet to develop the stability that older lakes show.

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 (WAEs) 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 and Platypus Count), continue to attract a high level of interest and support from the community.

# INTRODUCTION

## Purpose

The ACT Water Report 2009-2010 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 2009 to 30 June 2010.

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. This report will cover the past year's water conditions, with reference to historic conditions where appropriate.

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 visit its website http://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 go to http://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 on-going 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. Drought impacts include the concentration of waterway chemicals to above normal levels and sand or silt slugs associated with fragile bare soils and storms. Riparian condition for urban waterways is usually severely modified to park-like landscapes. This can reduce biodiversity markedly and unfavourably promote conditions suitable for aquatic weeds and nuisance algae. Well spaced rainfall in spring and autumn is likely to refresh the watertable over several years, so promoting recovery in both groundwater and stream flow.

## 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: Land use and main rivers of the ACT). 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.

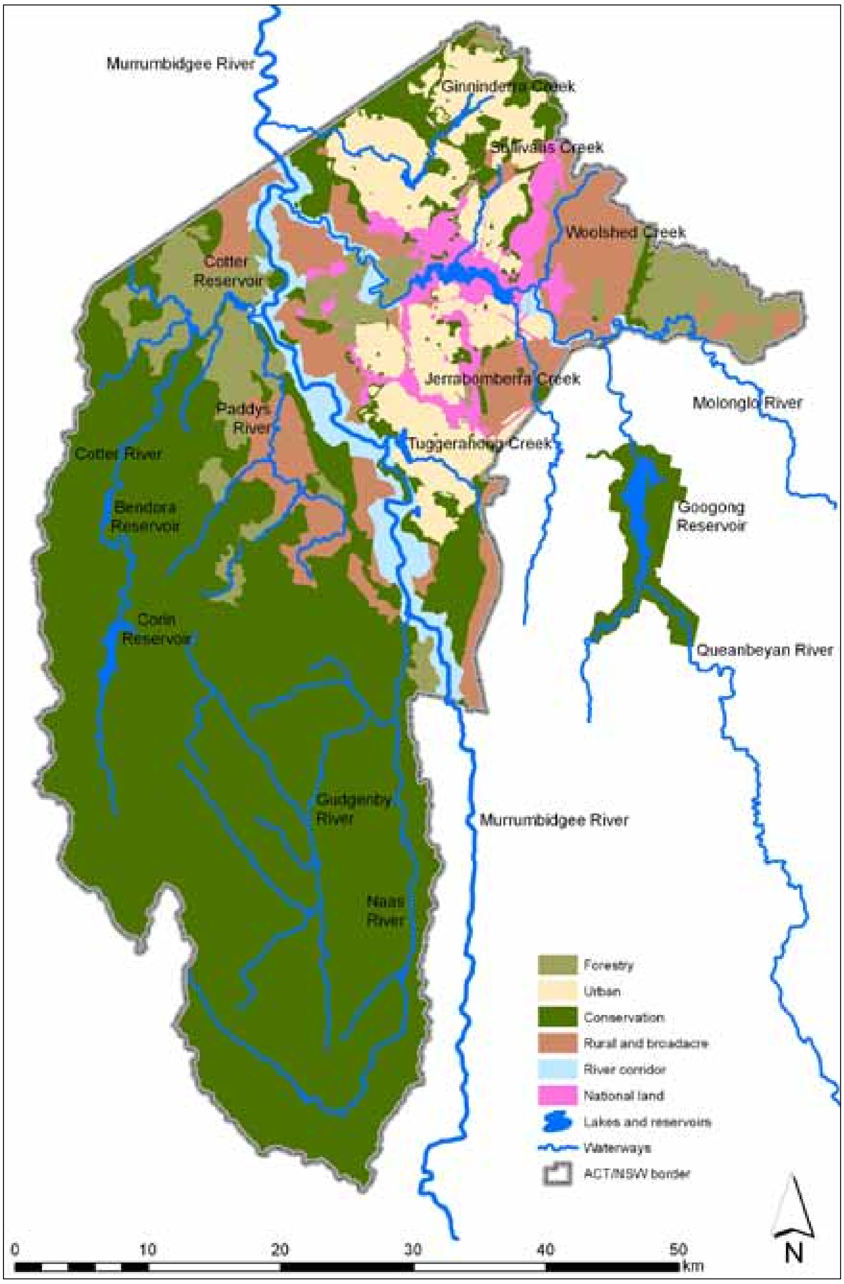



**Figure 1: Land use and main rivers of the ACT**

## Bushfires

Post fire recovery in the catchments of the upper Murrumbidgee following the January 2003 fires has been steady but slow. Low soil moisture remained a major constraint on vegetation recovery throughout the region until the above average rainfall in the first half of 2010. Soil moisture levels are now higher than for ten years and vegetation recovery may be enhanced in coming years. Monitoring and research into various ecosystem components, such as riparian vegetation and sediment transport, highlighted in the Environment ACT Bushfire Recovery Plan is continuing (www.environment.act.gov.au/Files/bushfirerecoveryplan.pdf).

## 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 flood-ways 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 will help ensure that urban development is consistent with sound water resource management (www.actpla.act.gov.au/tools_resources/legislation_plans_registers/plans/territory_plan).

## 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.

**Table 1. Water Quality Standards (*Ref: 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 Act and its regulation 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 (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 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 http://www.environment.act.gov.au/home 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 WAEs., The Environment Protection Authority (EPA) issues Licences to Take Water (Tables 3a & b), Bore Works Licences and Waterway Works Licences (needed for construction of dams), subject to conditions and volume considerations and approves application to trade WAEs both within the ACT and with other jurisdictions. Together these controls allow the EPA to manage the use of water resources in an environmentally sensitive manner.

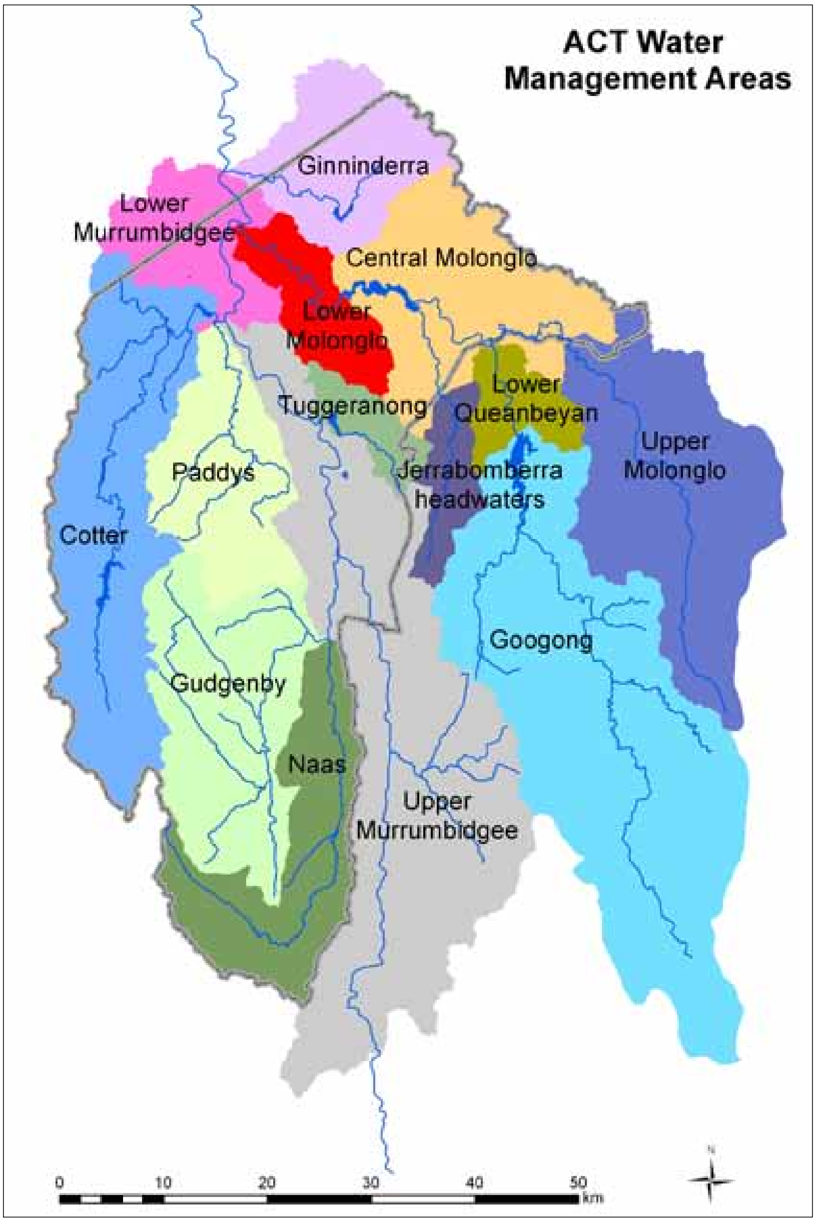



**Figure 2: Boundaries of Water Management Areas under the *Water Resources Act 2007***

The Act requires that water is set aside for the environment before consideration of extractive use. Table 2 sets our the total average volume of water available in each water management area in the ACT, the volume set aside for the environment, the volume available for extraction, the amount allowed for extraction (entitlements issued) and the volumes extracted in 2009-10. The totals for the whole ACT and the portion of the total resource of each component are set out at the bottom of the Table.

**Table 2a: Water Resources, Entitlements and Use, 2009-2010**

| Water management area | Total Water Resource (ML) | Environmental allocation (ML) | Total water available for extraction (ML) | Total water entitlements issued (ML ) | Water extracted during 2009/10 (ML) | Number of entitlements |
|---|---|---|---|---|---|---|
| Central Molonglo | 24489 | 18609 | 7832 | 1791 | 1119 | 134 |
| Cotter | 145702 | 34294 | 111408 | 58000 | 33483 | 3 |
| Ginninderra | 19895 | 11746 | 5352 | 821 | 387 | 33 |
| Googong | 103164 | 4250 | 98914 | 12990 | 11738 | 7 |
| Gudgenby | 50522 | 46569 | 3558 | 23 | 3 | 3 |
| Jerrabomberra headwaters | 0 | 0 | 0 | 0 | 0 | 0 |
| Lower Molonglo | 15932 | 10594 | 3304 | 599.5 | 116 | 17 |
| Lower Murrumbidgee | 17223 | 15728 | 29925 | 133 | 36 | 5 |
| Lower Queanbeyan | 22 | 15 | 7 | 0 | 0 | 0 |
| Naas | 38554 | 35619 | 2641 | 2 | 1 | 1 |
| Paddys | 39799 | 36571 | 2905 | 83 | 15 | 5 |
| Tuggeranong | 7909 | 4860 | 1461 | 399.5 | 60 | 8 |
| Upper Molonglo | 1274 | 1160 | 102 | 2 | 1 | 1 |
| Upper Murrumbidgee | 27482 | 24408 | 2517 | 1421.5 | 231 | 32 |
| **Total** | **491967** | **244422** | **272927** | **76265.5** | **47190 (1969 excluding ACTEW licence)** | **249** |
| % of the Total resource | 100% | 50% | 55%[1] | 16% | 9.6% | |

Notes: 1. This figure includes returns from sewage treatment plants not included in the Total Water Resource.

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 telephone 13 22 81.

## Water Entitlements

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 14 Water Management Areas(WMA) in which WAEs may be held. All 249 WAEs (or surviving allocations) are listed below in Table 2.

## Water Trading

Water trading is a key aspect of national water reforms. The Act makes provision for the trading, sale and purchase of a WAE either permanently, known as entitlement or permanent trading, or for a period of time, known as temporary or allocation trading. The Act makes provision for trading both within the ACT and with other jurisdictions. Only trade within the ACT is currently available. Trade with other jurisdictions is dependent on the development of interstate water trading protocols. There was little demand for water trading during 2009-10 with only one entitlement trade and no allocation trading. Details of 2009-10 water trading are set out in Table 2b.

**Table 2b: Water trades 2009-2010**

| Type of trade | Number of trades | Volume of trades (ML) |
|---|---|---|
| Intrastate entitlement trade | 1 | 10 |
| Interstate entitlement trade | 0 | 0 |
| Intrastate allocation trade | 0 | 0 |
| Interstate allocation trade | 0 | 0 |

## Water Trade Processing Times

The Council of Australian Governments and the Natural Resource Management Ministerial Council have developed service and reporting standards for trade processing times by jurisdictions within the Murray Darling Basin (MDB) for both entitlement and allocation trades. The ACT Government is committed to meeting those standards. The standards can be viewed at http://www.nationalwatermarket.gov.au/about/trade-processing.html

## Licences to Take Water

Among the 183 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 | 49 |
| Bore Works Licence | 9 |
| Driller's Licence | 7 |
| New Licence to Take Water | 7 |
| Current Licences | 183* |

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

**Table 3b: The number of Entitlements 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 | | 3 | | 58,000 |
| Googong | | 3 | 4 | 12,990 |
| **Total (urban water supply)** | | **6** | **4** | **70,990** |
| Central Molonglo | 93 | 22 | 19 | 1791 |
| Ginninderra | 11 | 17 | 5 | 821 |
| Upper Murrumbidgee | 17 | 9 | 6 | 1421.5 |
| Lower Molonglo | 10 | 4 | 3 | 599.5 |
| Tuggeranong | 3 | 4 | 1 | 399.5 |
| Lower Murrumbidgee | | 3 | 2 | 133 |
| Paddys | 3 | | 2 | 83 |
| Gudgenby | 1 | | 2 | 23 |
| Upper Molonglo | 1 | | | 2 |
| Naas | 1 | | | 2 |
| Jerrabomberra Headwaters | | | | 0 |
| Lower Queanbeyan | | | | 0 |
| **Total (other)** | **140** | **59** | **40** | **5275.5** |

While the table above is definitive in its depiction of total entitlement volume of water in the ACT, it is recognised that there may still be bores without entitlement in use and existing entitlement holders may exceed their entitlement volume. The EPA conducts a compliance program to monitor volumes extracted and detect unauthorised 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 2009–2010 stream flow in waterways arising within the ACT increased with good runoff from storms in September and December and remained high after the heavy falls in February as soil moisture in the catchment returned to satisfactory levels. 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 800-1000 mm. In the flatter tablelands on which

Canberra is built, the annual rainfall reaches 600-700 mm. In the present 12-month reporting period Canberra's annual rainfall was 612 mm, 88 mm above the 524 mm in 2008–2009 and 99% of 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 2009-2010 reporting period are presented.

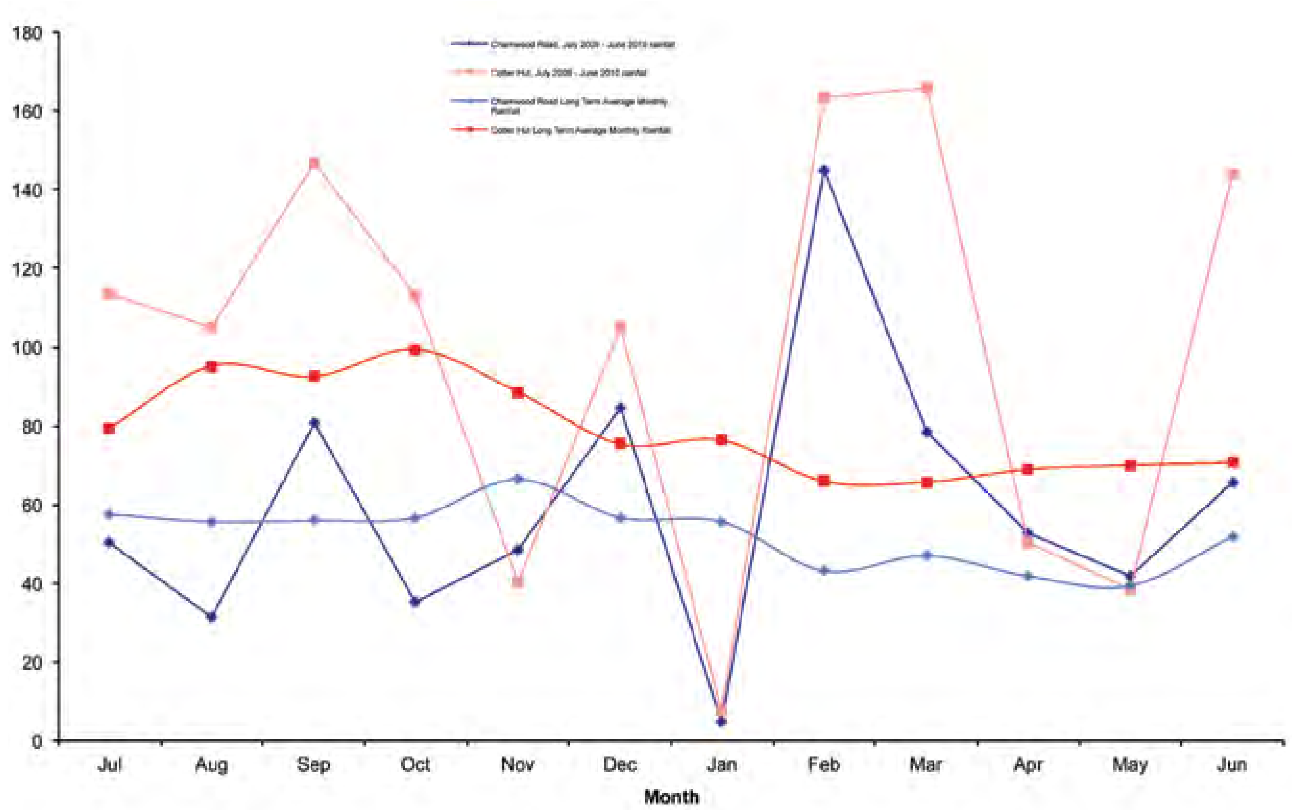



**Figure 3: Comparison of 2009-2010 monthly rainfalls in Belconnen near Charnwood Road and Cotter Hut in the Corin Reservoir Catchment with the long term average monthly rainfall**

Rainfall at both the Cotter Hut and Charnwood Road stations was above average in 2009–2010. Annual rainfall at the Charnwood Road site in Belconnen was 719 mm, 107% of long term annual rainfall. This was more than 200mm greater than 2008–2009 with good falls in September and December, and from February to June. The 1193mm of rain recorded at Cotter Hut was 126% above average rainfall with above average rain at similar times to Charnwood Road. The water supply reservoirs have received good flows throughout the year, and by June 2010 were approaching 55% of capacity.

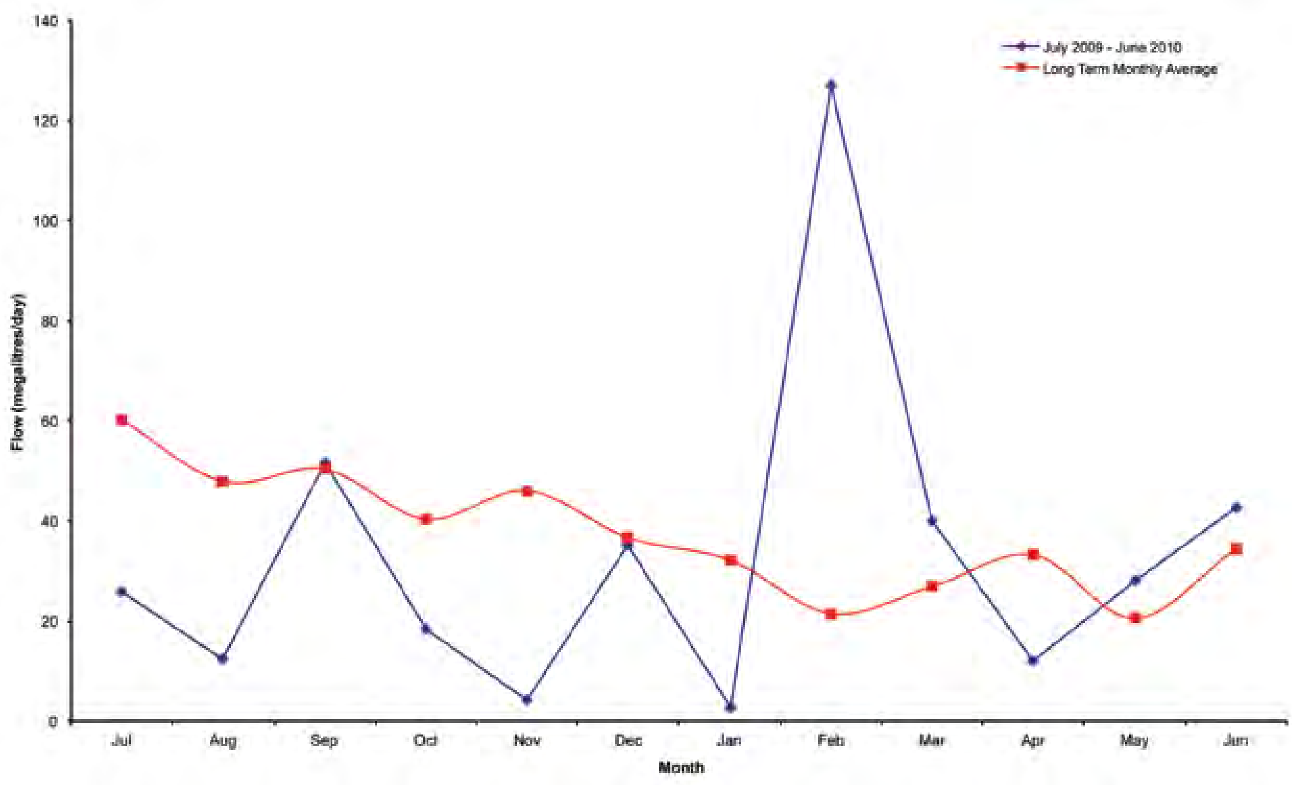



**Figure 4: Average monthly flow July 2009 to June 2010 in Ginninderra Creek (410750) upstream of Charnwood Road compared with the long-term average monthly flow for that site**

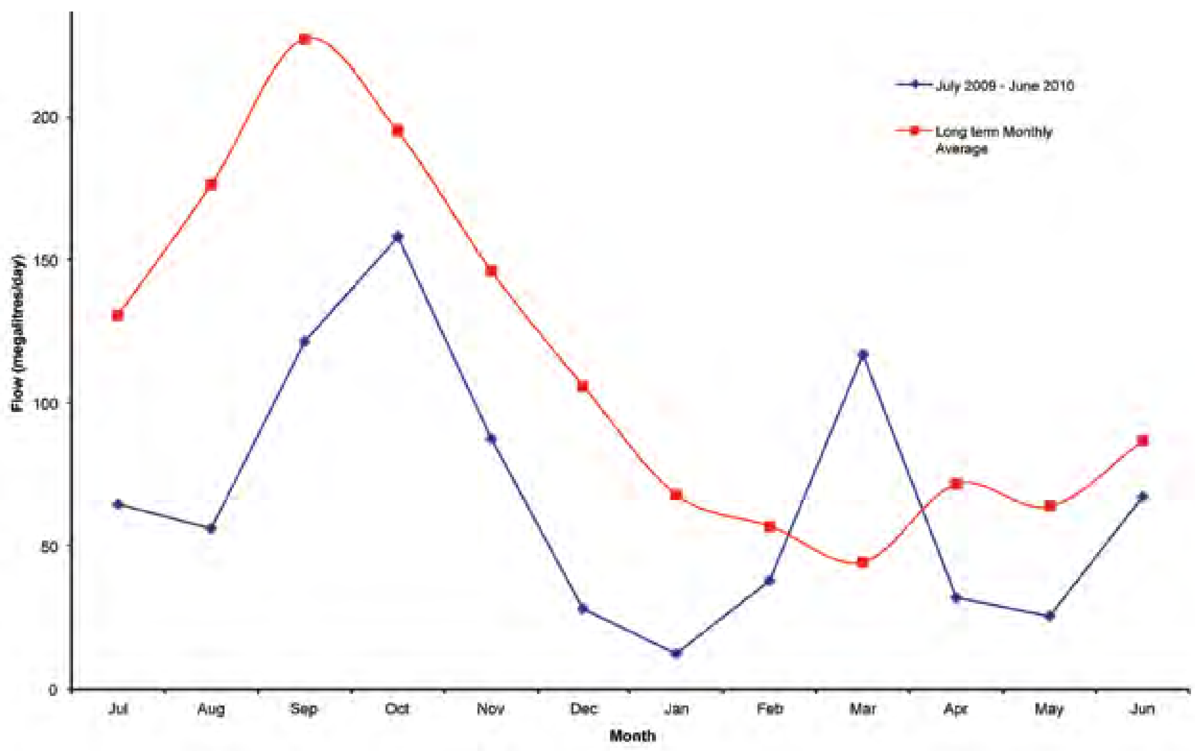



**Figure 5: A comparison of the average monthly flow (July 2009–June 2010) to the long-term average monthly flow for a site upstream of Corin Reservoir**

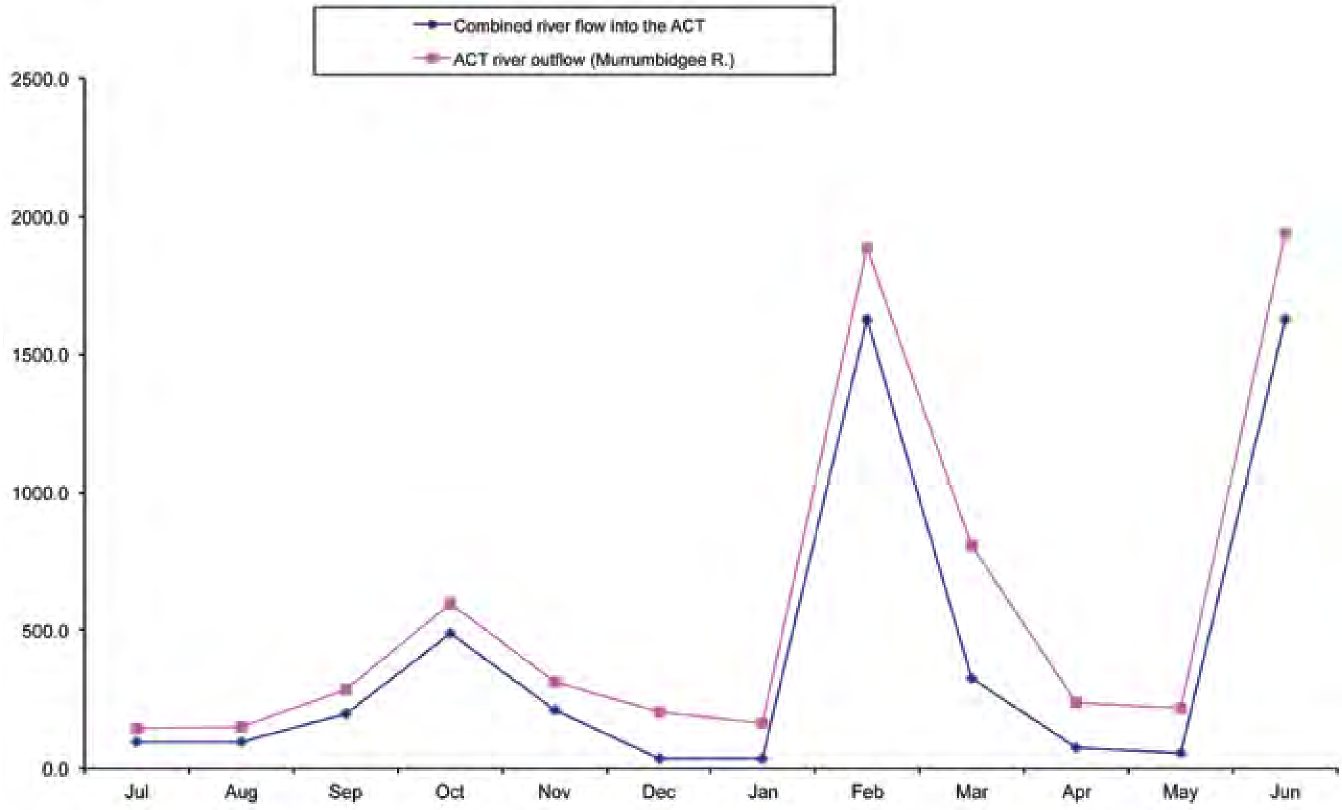



**Figure 6: A comparison of the average monthly inflows into the ACT (combined monthly data for the Murrumbidgee, Molonglo and Queanbeyan Rivers) with the average monthly outflows from the ACT (Murrumbidgee River, just after the downstream exit of theACT border, at Hall Crossing) for the July 2009 to June 2010 period**

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 across the year (Figure 3). The February rains are clearly reflected in the peak well above the average summer flows. The pattern for the Cotter River shows spring runoff peaks with troughs while the catchment soil regained its moisture, and then high flow rates as the now well wetted catchment shed most of the water collected (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 Murrumbidgee River at the Lobbs Hole gauge experienced average daily flows of greater than 80ML/day in all months except December, January, April and May, with daily flows greater than 1000ML/day in February and June. The Molonglo River contribution reflected rainfall, with negligible flow in December and January followed by more than 100ML/day in February 2010.  With such a range of flows in the river systems five flow-based samples covering the percentile bands (Table 4) were taken in 2009-2010. Flows in the Murrumbidgee were supplemented by the returns from sewage treatment.

# SECTION 2: WATER QUALITY CONDITION

## Water Quality Monitoring Program

The Environment Protection Authority (EPA) manages a monitoring program for the ACT'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. This information is used to determine whether waters flowing through 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 the 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 is collected by other government agencies, research institutions and authorised dischargers such as ACTEW (Lower Molonglo Water Quality Control Centre, Water Supply Reservoirs) and the Queanbeyan City Council (Queanbeyan Sewage Treatment Plant). Although the EPA may use this data for assessing compliance with licence conditions and the *Environment Protection Regulations 2005*, the data collected by those organisations is 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 and 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%, 30–49%, 50–69% and 70–89%). The 5th percentile flow is the flow exceeded only 5% 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 | - |

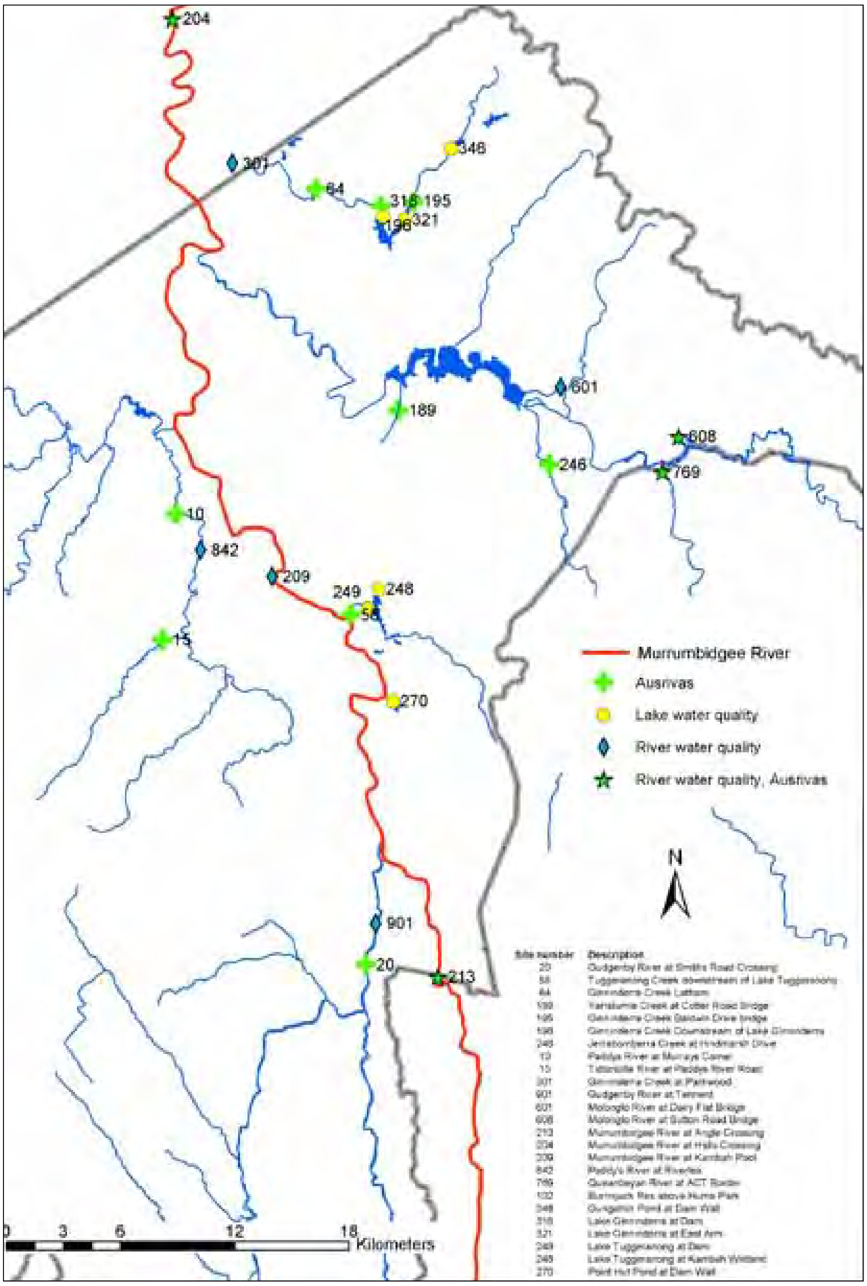



**Figure 7: Locations of Water Quality and Biological (AUSRIVAS) Sampling Sites in the ACT Water Quality Monitoring Program**

Flow based sampling operates well in years of average rainfall with rain and run-off at well spaced intervals across the whole year. Five river Water Quality samples were taken in October, November and December 2009, and February and June 2010, with at least one sample in each percentile band between base flow and high flow. 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 if there is a return to conditions prevailing between 2006 and 2009.

**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 | 6 | 5 | 5 | 5 | 4 | 4 | 3 | 5 |

### *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. 34). 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 ten test sites and three reference sites were sampled on 18 and 19 November 2009 and 19 and 20 May 2010.

### *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 (Table1). 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.

Prolonged drought affects the whole of our catchment. As the drought deepens, trees and shrubs have access to less and less soil moisture. They do not carry as much foliage as they can in more favourable times. The grasses and herbs thin out beneath and between the tree canopy. Mosses and lichens that once held the soil in place turn to dust. More sunlight reaches the soil and evaporates what little moisture is left in the crumbling leaf litter on top. The soil becomes water repellent and easily disturbed.

In those waterways that do continue to have water, there is insufficient flow to keep suspended solids moving. The deeper pools accumulate fine sediment with rotting material in them. The bacteria that thrive in these sediments increase in numbers but are not thinned by being flushed down stream. River pools develop patches of dead water. This process also happens in urban lakes and, significantly, in the basins of Gross Pollution Traps.

The very welcome rains in September, December and from February to the present have revitalised the waterways in the catchment.

When the reliable rains return, the loose and water repellent surface of the soil is washed off in the first flush. This leads to spikes in Turbidity, Suspended Solids levels, Phosphorus and usually Nitrogen levels in water quality monitoring. Once the ground begins to absorb the water, the soil moisture right through to the ground water aquifers gradually returns to favourable levels. Mosses and lichens quickly re-establish the protective soil crust. The grasses and herbs germinate again and spread a new layer of ground cover and spongy root systems. Together these plants help the soil continue to absorb water and protect it from erosion by the rain run-off. The trees and shrubs put out new leaves and reinvigorate their root systems and the soil once again is sufficiently shaded and porous.

As all this happens, the groundwater aquifers flow and direct run-off into creeks and rivers increases. The reservoirs gradually fill. The run-off is chemically close to rainwater and so pH, electrical conductivity and nutrient loadings across the catchment all approach most favourable reference levels. Increased persistent flows stir up the dead water from river pools and lake bottoms and flush the Gross Pollutant Traps. This flushing is seen in water quality data as elevations in Nitrogen and Faecal Coliform levels. Although dramatic, these are short duration events, usually a matter of days. All these phenomena were seen in our catchment this year.

As flows persist in waterways, aquifers reach capacity, and the water table is connected from the soil surface to below the roots of the trees, our water quality should remain well within regulatory expectations. The whole catchment benefits from such environmentally sustaining flows. In recent months, streams that deteriorated post-bushfire have improved from moderate to good condition and will continue to improve with more consistent flow regimes.

Urban sites are commonly impacted by human actions such as altered flow regimes, nutrient enrichment, weed infestation and increased pollutants. Until the rains of the last year, urban water quality remained poor because with drought conditions, stream flows were generally low and any pollutants entering waterways were not diluted. Storm flushing of urban waterways has led to improvements in overall water quality. Some silt movement has occurred, but good follow-up rains have, in general, allowed large deposits to be dispersed. Parameters of Water Quality, including pH, Electrical Conductivity and Dissolved Oxygen values, have returned to levels indicating good catchment health following the February rains. The coincidence of fresh nutrient suspensions and warm weather following the February rain has resulted in phytoplankton populations, often dominated by cyanobacteria (blue-green algae), reaching high levels and remaining high for several months, in urban lakes. Such algal blooms are the natural way of mopping up nutrients and distributing them down stream. The follow-up rains have done this gradually with the June rains clearing the system.

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 2009–2010

### Table 6. Summary of Water Quality in the ACT, 2009–2010

| 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 | High levels after February rain. |
| 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 | High levels after February rain. |
| 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. | Slightly elevated all year, with the rain |
| Turbidity | <10 NTU, flowing <30 NTU, standing | Soil and country rock clay fraction; humic 'tea'. | Modification of biological light regime; poor aesthetics | Murrumbidgee sites elevated all year, with rain |
| 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 | Flushing of minor waterways in February rains elevated levels across the ACT. |
| Conductivity | N/A. | Salts in country rock and ground water; sewage treatment plants. | Salinity or corrosion problems, where water is used | Lower than recent levels with return of flow to waterways |
| pH | 6–9 | Catchment geology | Changes to biodynamics; may release toxic metals | Returned flows have promoted pH readings close to neutral. |
| 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 | Depressed levels because of poor flow reversed after February rain. |
| Chlorophyll 'a' | < 10 µg/L | Phytoplankton | Poor aesthetics; scums; unpleasant smells (geosmin); blooms outside of normal population fluctuation | Lakes and Kambah Pool closed in late summer and autumn. |

## 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.

Most of the elevated Phosphorus readings for 2009–2010 were aligned to the significant rains in February. Burrinjuck Dam and the three Murrumbidgee River sites show phosphorus levels 2–5 times the regulation limit at this period. The two Molonglo River sites also have above regulation readings for February. The other waterways have phosphorous levels generally within regulation limits even in times of high flow.

**Table 7: Total Phosphorus (mg/L) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers 2009-2010**

| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 0.05 | 0.46 | 0.12 | 0.149 | 0.10 |
| 248 | Lake Tuggeranong at Kambah Wetland | 0.07 | 0.15 | 0.09 | 0.021 | 0.10 |
| 249 | Lake Tuggeranong at Dam | 0.04 | 0.11 | 0.07 | 0.021 | 0.10 |
| 261 | Flemington Road Pond | 0.03 | 0.27 | 0.06 | 0.082 | 0.10 |
| 262 | Yerrabi Pond, dam wall | 0.01 | 0.05 | 0.02 | 0.017 | 0.10 |
| 270 | Point Hut Pond at Dam Wall | 0.05 | 0.12 | 0.08 | 0.021 | 0.10 |
| 318 | Lake Ginninderra at Dam | 0.02 | 0.05 | 0.03 | 0.010 | 0.10 |
| 321 | Lake Ginninderra at East Arm | 0.03 | 0.07 | 0.05 | 0.016 | 0.10 |
| 346 | Gungahlin Pond at Dam Wall | 0.01 | 0.06 | 0.03 | 0.015 | 0.10 |
| 204 | Murrumbidgee River at Halls Crossing | 0.05 | 0.16 | 0.10 | 0.04 | 0.10 |
| 209 | Murrumbidgee River at Kambah Pool | 0.03 | 0.52 | 0.16 | 0.20 | 0.10 |
| 213 | Murrumbidgee River at Angle Crossing | 0.04 | 0.49 | 0.15 | 0.19 | 0.10 |
| 301 | Ginninderra Creek at Parkwood | 0.03 | 0.07 | 0.05 | 0.01 | 0.10 |
| 601 | Molonglo River at Dairy Flat Bridge | 0.03 | 0.13 | 0.06 | 0.04 | 0.10 |
| 608 | Molonglo River at Yass Road Bridge | 0.03 | 0.11 | 0.06 | 0.04 | 0.10 |
| 769 | Queanbeyan River at ACT Border | 0.03 | 0.07 | 0.05 | 0.02 | 0.10 |
| 842 | Paddys River at Riverlea | 0.03 | 0.07 | 0.04 | 0.02 | 0.10 |
| 901 | Gudgenby River at Tennent | 0.06 | 0.08 | 0.06 | 0.01 | 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 not 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 the over-population of 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 throughout the year, 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. 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.

All sites showed elevated nitrogen readings in February. Like the phosphorus pulse, the nitrogen is probably mainly released from soil organic matter disturbance by the rain. The reading remained elevated in March, but had returned to background levels by May. This strongly supports the elevated levels as a post-drought system flushing phenomenon.

**Table 8: Total Nitrogen (mg/L) summary results for ACT Water Quality Monitoring Sites - Lakes and Rivers 2009-2010**

| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 1.5 | 5.2 | 2.41 | 1.44 | N/A |
| 248 | Lake Tuggeranong at Kambah Wetland | 0.76 | 2.8 | 1.20 | 0.72 | N/A |
| 249 | Lake Tuggeranong at Dam | 0.71 | 1.5 | 0.96 | 0.26 | N/A |
| 261 | Flemington Road Pond | 0.75 | 2.7 | 1.40 | 0.69 | N/A |
| 262 | Yerrabi Pond, dam wall | 0.44 | 0.9 | 0.64 | 0.25 | N/A |
| 270 | Point Hut Pond at Dam Wall | 0.76 | 1.4 | 1.21 | 0.26 | N/A |
| 318 | Lake Ginninderra at Dam | 0.46 | 0.83 | 0.62 | 0.12 | N/A |
| 321 | Lake Ginninderra at East Arm | 0.53 | 1.2 | 0.71 | 0.24 | N/A |
| 346 | Gungahlin Pond at Dam Wall | 0.35 | 1.5 | 0.69 | 0.40 | N/A |
| 204 | Murrumbidgee River at Halls Crossing | 1.70 | 8.80 | 3.70 | 3.01 | N/A[15] |
| 209 | Murrumbidgee River at Kambah Pool | 0.47 | 3.40 | 1.30 | 1.22 | N/A |
| 213 | Murrumbidgee River at Angle Crossing | 0.40 | 3.20 | 1.17 | 1.18 | N/A |
| 301 | Ginninderra Creek at Parkwood | 0.51 | 1.10 | 0.73 | 0.22 | N/A |
| 601 | Molonglo River at Dairy Flat Bridge | 1.10 | 4.60 | 2.66 | 1.34 | N/A[15] |
| 608 | Molonglo River at Yass Road Bridge | 0.45 | 1.70 | 0.86 | 0.56 | N/A |
| 769 | Queanbeyan River at ACT Border | 0.45 | 2.20 | 0.98 | 0.75 | N/A |
| 842 | Paddys River at Riverlea | 0.36 | 2.40 | 0.83 | 1.00 | N/A |
| 901 | Gudgenby River at Tennent | 0.53 | 0.75 | 0.64 | 0.09 | 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.

Firstly, higher concentrations of suspended solids reduce the light penetration of water, slowing plant growth and changing the kinds of algae present. Secondly, larger amounts of suspended solids ultimately result in increased sedimentation in streams and lakes. The sand and silt may choke habitats for bottom dwelling organisms while increasing the potential for elevated phosphorus levels arriving as part of silt slugs or fine sediment coatings.

Flow based sampling highlights storm effects, while the long term average may indicate closer general conformity to regulation limits. In 2009–2010, the elevated readings in February demonstrate the flow-based effect. Levels in the rivers, and those lakes with soft bottoms, were above the standard for much of the year most likely as a result of more active water movement than in recent years. A recently constructed wetland such as the Flemington Road Pond is likely to have elevated levels which may gradually stabilise with time.

**Table 9: Suspended Solids (mg/L) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers 2009-2010**

| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 14 | 730 | 126.00 | 266.54 | 25 |
| 248 | Lake Tuggeranong at Kambah Wetland | 16 | 33 | 25.57 | 7.35 | 25 |
| 249 | Lake Tuggeranong at Dam | 11 | 32 | 17.86 | 7.38 | 25 |
| 261 | Flemington Road Pond | 6 | 100 | 33.00 | 32.75 | 25 |
| 262 | Yerrabi Pond, dam wall | 1 | 41 | 12.00 | 14.72 | 25 |
| 270 | Point Hut Pond at Dam Wall | 10 | 110 | 37.71 | 33.20 | 25 |
| 318 | Lake Ginninderra at Dam | 6 | 20 | 9.71 | 5.15 | 25 |
| 321 | Lake Ginninderra at East Arm | 5 | 46 | 21.14 | 16.62 | 25 |
| 346 | Gungahlin Pond at Dam Wall | 4 | 24 | 10.86 | 8.75 | 25 |
| 204 | Murrumbidgee River at Halls Crossing | 21 | 42 | 31.50 | 9.33 | 25 |
| 209 | Murrumbidgee River at Kambah Pool | 10 | 1000 | 274.50 | 483.97 | 25 |
| 213 | Murrumbidgee River at Angle Crossing | 17 | 970 | 265.25 | 469.97 | 25 |
| 301 | Ginninderra Creek at Parkwood | 8 | 28 | 14.75 | 9.07 | 25 |
| 601 | Molonglo River at Dairy Flat Bridge | 6 | 74 | 27.50 | 31.46 | 25 |
| 608 | Molonglo River at Yass Road Bridge | 3 | 38 | 16.50 | 15.29 | 25 |
| 769 | Queanbeyan River at ACT Border | 4 | 12 | 9.00 | 3.46 | 25 |
| 842 | Paddys River at Riverlea | 4 | 13 | 7.33 | 4.93 | 25 |
| 901 | Gudgenby River at Tennent | 4 | 10 | 6.75 | 2.50 | 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 determines the depth to which light penetrates the water, an important ecological phenomenon 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. The small clay particles remain suspended 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 sand and silt into the waterway. As the urban lakes are fed by drainage lines they show storm peaks and long periods of turbidity within the regulation limits. Most of the lacustrine sites show elevated levels in October and February. As urban catchments begin to recover from prolonged sensitive dry soils, run-off to the lakes had turbidity levels within the 30 NTU limit. The smaller waterways are usually within standards, but the Murrumbidgee River once again showed extreme levels related to disturbance in the tributaries of the upper catchment.

**Table 10: Turbidity (NTU) summary results for ACT Water Quality Monitoring Sites - Lakes and Rivers 2009-2010**

| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 8.8 | 690 | 113.26 | 254.45 | 30 |
| 248 | Lake Tuggeranong at Kambah Wetland | 10 | 36 | 22.29 | 12.45 | 30 |
| 249 | Lake Tuggeranong at Dam | 6.6 | 38 | 18.06 | 11.24 | 30 |
| 261 | Flemington Road Pond | 10 | 170 | 45.60 | 55.03 | |
| 262 | Yerrabi Pond, dam wall. | 1.2 | 59 | 11.24 | 22.54 | |
| 270 | Point Hut Pond at Dam Wall | 27 | 190 | 75.29 | 54.78 | 30 |
| 318 | Lake Ginninderra at Dam | 4.8 | 19 | 9.83 | 5.55 | 30 |
| 321 | Lake Ginninderra at East Arm | 4.7 | 56 | 21.50 | 19.78 | 30 |
| 346 | Gungahlin Pond at Dam Wall | 3.3 | 45 | 14.79 | 16.97 | 30 |
| 204 | Murrumbidgee River at Halls Crossing | 10.00 | 100.00 | 36.40 | 36.26 | 10 |
| 209 | Murrumbidgee River at Kambah Pool | 8.50 | 770.00 | 194.10 | 323.29 | 10 |
| 213 | Murrumbidgee River at Angle Crossing | 13.00 | 630.00 | 152.00 | 267.58 | 10 |
| 301 | Ginninderra Creek at Parkwood | 5.00 | 15.00 | 10.32 | 4.71 | 10 |
| 601 | Molonglo River at Dairy Flat Bridge | 4.80 | 75.00 | 26.74 | 28.76 | 10 |
| 608 | Molonglo River at Yass Road Bridge | 2.20 | 61.00 | 26.80 | 25.79 | 10 |
| 769 | Queanbeyan River at ACT Border | 2.10 | 16.00 | 9.10 | 4.99 | 10 |
| 842 | Paddys River at Riverlea | 4.20 | 17.00 | 8.84 | 5.61 | 10 |
| 901 | Gudgenby River at Tennent | 3.50 | 18.00 | 9.34 | 5.90 | 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 may serve as a food source for aquatic organisms without causing them harm.

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 other secondary contact is 1000 cfu/100ml. These standards are applied at individual sites depending on whether they are classed for swimming or secondary contact recreation in the Territory Plan. A shallow urban wetland such as Flemington Road Pond in Sullivans Creek is designed for storm water retention and so water quality standards for bacteria have not been monitored to date.

The unusually high levels of faecal coliforms in the rivers from late summer to winter may reflect the cumulative effects of well spaced rain events. There is no indication of human sewage contributions, and the likely sources are turnover of in situ organic matter and urban or rural animal waste. The elevated levels in Lake Ginninderra at the dam, and raised levels in parts of the other urban lakes in February, with rapid returns to more normal levels in March, may have links to storm clearance of the various Gross Pollution Traps along feeder creeks and drains. GPTs often develop a rich bacterial flora, and coliforms may make up a substantial fraction, especially where the traps collect a goodly proportion of native and domestic animal manure.

**Table 11: Faecal Coliforms (cfu/100mL) summary results for ACT Water Quality Monitoring Sites - Lakes and Rivers 2009-2010**

| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 10 | 2000 | 313 | 744.31 | N/A |
| 248 | Lake Tuggeranong at Kambah Wetland | 6 | 700 | 153 | 245.48 | 1000 |
| 249 | Lake Tuggeranong at Dam | 4 | 200 | 41 | 70.72 | 150 |
| 261 | Flemington Road Pond | | | | | N/A |
| 262 | Yerrabi Pond, dam wall. | 2 | 280 | 55 | 100.50 | 1000 |
| 270 | Point Hut Pond at Dam Wall | 5 | 310 | 78 | 107.2 | 1000 |
| 318 | Lake Ginninderra at Dam | 4 | 2000 | 300 | 749.80 | 150 |
| 321 | Lake Ginninderra at East Arm | <2 | 140 | 29 | 54.55 | 1000 |
| 346 | Gungahlin Pond at Dam Wall | <2 | 40 | 12 | 13.59 | 1000 |
| 204 | Murrumbidgee River at Halls Crossing | 15 | 1200 | 403 | 545.55 | 150 |
| 209 | Murrumbidgee River at Kambah Pool | <2 | 2700 | 852 | 215.67 | 150 |
| 213 | Murrumbidgee River at Angle Crossing | 6 | 2500 | 705 | 1082.49 | 150 |
| 301 | Ginninderra Creek at Parkwood | 40 | 700 | 290 | 291.33 | 1000 |
| 601 | Molonglo River at Dairy Flat Bridge | 24 | 700 | 329 | 343.04 | 1000 |
| 608 | Molonglo River at Yass Road Bridge | 25 | 3000 | 753 | 1278.02 | 1000 |
| 769 | Queanbeyan River at ACT Border | 40 | 180 | 106 | 69.14 | 1000 |
| 842 | Paddys River at Riverlea | 130 | 1800 | 653 | 785.26 | 150 |
| 901 | Gudgenby River at Tennent | 58 | 410 | 206 | 158.68 | 1000 |

### *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.

The long-term downward trend in conductivity in the majority of lake sites continues. The upper Molonglo catchment, as demonstrated by the Waterwatchers' reports, produces water with a high mineral content. The country rock includes both shale and limestone, and there are areas of high mineralisation around Captains Flat. The elevated Electrical Conductivity in all the rivers were all reported before January but after that time the reported conductivities were markedly lower. Moderate to high flows in tributaries and the Murrumbidgee River lead to dilution, but conductivity rarely stays below 150 µS/cm once flow decreases because of minerals in ground water seepage.

Although there are no regulated standards for Electrical Conductivity of water for the ACT, readings that reflect the local geology are preferred. The regularly elevated levels at Halls Crossing (204) that include bicarbonate ions from the water treatment plants, although not noted in autumn or winter this year, are the subject of on-going study.

**Table 12: Conductivity (uS/cm) summary results for ACT Water Quality Monitoring Sites - Lakes and Rivers 2009-2010**

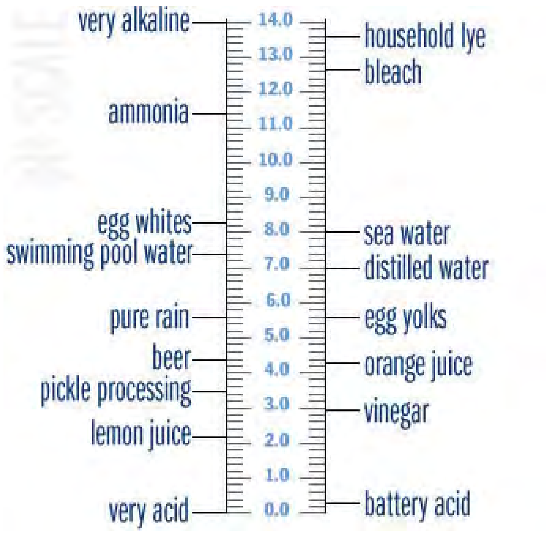
| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 100 | 380 | 230.00 | 101.98 | N/A |
| 248 | Lake Tuggeranong at Kambah Wetland | 81 | 110 | 91.29 | 9.36 | N/A |
| 249 | Lake Tuggeranong at Dam | 75 | 93 | 85.57 | 6.83 | N/A |
| 261 | Flemington Road Pond | 120 | 170 | 148.57 | 16.76 | |
| 262 | Yerrabi Pond, dam wall | 200 | 270 | 207.14 | 27.87 | |
| 270 | Point Hut Pond at Dam Wall | 98 | 130 | 111.14 | 11.07 | N/A |
| 318 | Lake Ginninderra at Dam | 150 | 200 | 174.29 | 20.70 | N/A |
| 321 | Lake Ginninderra at East Arm | 140 | 190 | 171.43 | 21.16 | N/A |
| 346 | Gungahlin Pond at Dam Wall | 190 | 240 | 208.57 | 22.68 | N/A |
| 204 | Murrumbidgee River at Halls Crossing | 71 | 500 | 252.20 | 162.66 | N/A |
| 209 | Murrumbidgee River at Kambah Pool | 41 | 100 | 73.40 | 26.74 | N/A |
| 213 | Murrumbidgee River at Angle Crossing | 43 | 95 | 69.60 | 24.69 | N/A |
| 301 | Ginninderra Creek at Parkwood | 170 | 310 | 228.00 | 65.95 | N/A |
| 601 | Molonglo River at Dairy Flat Bridge | 110 | 510 | 374.00 | 166.52 | N/A |
| 608 | Molonglo River at Yass Road Bridge | 100 | 540 | 286.00 | 199.95 | N/A |
| 769 | Queanbeyan River at ACT Border | 200 | 450 | 286.00 | 104.55 | N/A |
| 842 | Paddys River at Riverlea | 70 | 110 | 89.50 | 17.06 | N/A |
| 901 | Gudgenby River at Tennent | 57 | 110 | 81.60 | 20.52 | 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.

Where there is biological equilibrium in standing water, the pH trend is towards the alkaline end of the scale. The lakes all showed readings close to neutral during the February rains, and more alkaline readings at other times. The above limit readings are indication of dynamic equilibrium in response to nutrients.




The riverine waterways all showed a marked trend towards neutral from more alkaline ranges in previous years. This trend continued into the slightly acid range as the waterways maintained rain based flow from February to June.

**Table 13: pH summary results for ACT Water Quality Monitoring Sites - Lakes and Rivers 2009-2010**

| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 7.1 | 9.0 | 8.26 | 0.71 | 6-9 |
| 248 | Lake Tuggeranong at Kambah Wetland | 7.0 | 9.4 | 7.64 | 0.79 | 6-9 |
| 249 | Lake Tuggeranong at Dam | 7.1 | 7.7 | 7.43 | 0.25 | 6-9 |
| 261 | Flemington Road Pond | 6.7 | 8.2 | 7.95 | 0.48 | 6-9 |
| 262 | Yerrabi Pond, dam wall | 7.8 | 9.0 | 8.33 | 0.50 | 6-9 |
| 270 | Point Hut Pond at Dam Wall | 7.4 | 7.8 | 7.64 | 0.18 | 6-9 |
| 318 | Lake Ginninderra at Dam | 7.4 | 8.2 | 7.86 | 0.29 | 6-9 |
| 321 | Lake Ginninderra at East Arm | 7.3 | 8.2 | 7.84 | 0.30 | 6-9 |
| 346 | Gungahlin Pond at Dam Wall | 7.8 | 9.2 | 8.59 | 0.55 | 6-9 |
| 204 | Murrumbidgee River at Halls Crossing | 6.6 | 8.6 | 7.88 | 0.82 | 6-9 |
| 209 | Murrumbidgee River at Kambah Pool | 6.3 | 7.7 | 7.00 | 0.56 | 6-9 |
| 213 | Murrumbidgee River at Angle Crossing | 6.2 | 7.9 | 6.94 | 0.77 | 6-9 |
| 301 | Ginninderra Creek at Parkwood | 6.5 | 7.3 | 7.00 | 0.30 | 6-9 |
| 601 | Molonglo River at Dairy Flat Bridge | 6.5 | 8.3 | 7.30 | 0.70 | 6-9 |
| 608 | Molonglo River at Yass Road Bridge | 6.6 | 7.1 | 6.84 | 0.19 | 6-9 |
| 769 | Queanbeyan River at ACT Border | 6.4 | 7.0 | 6.72 | 0.24 | 6-9 |
| 842 | Paddys River at Riverlea | 6.9 | 7.7 | 7.20 | 0.38 | 6-9 |
| 901 | Gudgenby River at Tennent | 6.6 | 7.5 | 7.12 | 0.34 | 6-9 |

### *Dissolved Oxygen*

Dissolved oxygen (DO) 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 DO can affect the species present. Low levels of DO can stress fish, which can lead to fungal infections and disease or result directly in fish kills. Levels of DO 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 (BOD) is an indication of the rate of oxygen use in the system, restricting oxygen availability for fish and other aquatic animals.

Oxygen levels generally improved in the lakes in the cooler weather. Levels fell in all lakes except Burrinjuck Reservoir on occasions across the warmer months, especially February. Following the rain, March levels were among the most elevated for the year. The Molonglo River, and the Queanbeyan River below the town weir, almost came to a standstill in the spring and early summer of 2009, and this is clearly reflected in the minimal DO results. It is worth noting that there was no DO reading for the Paddys River in December, as there was no water.

**Table 14: DO (mg/L) summary results for ACT Water Quality Monitoring Sites - Lakes and Rivers 2009-2010**

| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 8.8 | 13.8 | 11.24 | 1.92 | > 4 |
| 248 | Lake Tuggeranong at Kambah Wetland | 5.9 | 12.9 | 8.27 | 2.30 | > 4 |
| 249 | Lake Tuggeranong at Dam | 6.8 | 13.6 | 9.00 | 2.25 | > 4 |
| 261 | Flemington Rd Pond | * | * | | | >4 |
| 262 | Yerrabi Pond, dam wall | 5.4 | 9.7 | 7.92 | 1.47 | >4 |
| 270 | Point Hut Pond at Dam Wall | 7.4 | 8.6 | 7.97 | 0.49 | > 4 |
| 318 | Lake Ginninderra at Dam | 5.6 | 9.7 | 7.44 | 1.43 | > 4 |
| 321 | Lake Ginninderra at East Arm | 6.3 | 9.9 | 8.20 | 1.13 | > 4 |
| 346 | Gungahlin Pond at Dam Wall | 6.6 | 10.9 | 9.16 | 1.40 | > 4 |
| 204 | Murrumbidgee River at Halls Crossing | 8.0 | 10.7 | 9.77 | 1.450 | > 4 |
| 209 | Murrumbidgee River at Kambah Pool | 8.1 | 11.3 | 9.69 | 1.521 | > 4 |
| 213 | Murrumbidgee River at Angle Crossing | 8.5 | 12.2 | 10.06 | 2.158 | > 4 |
| 301 | Ginninderra Creek at Parkwood | 4.7 | 10.1 | 7.34 | 2.512 | > 4 |
| 601 | Molonglo River at Dairy Flat Bridge | 5.1 | 8.3 | 6.90 | 1.281 | > 4 |
| 608 | Molonglo River at Yass Road Bridge | 2.7 | 9.6 | 6.56 | 2.915 | > 4 |
| 769 | Queanbeyan River at ACT Border | 3.1 | 6.5 | 4.96 | 1.522 | > 4 |
| 842 | Paddys River at Riverlea | 7.9 | 12.8 | 10.55 | 2.189 | > 4 |
| 901 | Gudgenby River at Tennent | 7.4 | 11.5 | 9.68 | 1.760 | > 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). All phytoplanktonic organisms, including Cyanobacteria (blue-green algae), use Chlorophyll 'a', so the reading indicates whole population dynamics not any single organism population. This measure can therefore serve as a useful indicator of the extent to which an ecosystem has been affected by nutrient inputs. There are also normal seasonal fluctuations in planktonic algal biomass that may appear in the figures, independent of flow rates or exceptional nutrient loads.

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 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.

The bloom in Flemington Road Pond (39.0 µg/L for 60,500 cells/mL Chlorophyta) was associated with the February rain. This storm retention pondage has only been constructed in the last two years. A bloom of green algae with the first really prolonged rain is to be expected in such a construction. The riverine sites displayed late spring or early summer blooms. The lakes generally had spring blooms of diatoms or green algae, then mixed or blue-green algal blooms in summer and autumn.

**Table 15: Chlorophyll-a (µg/L) summary results for ACT Water Quality Monitoring Sites – Lakes and Rivers 2009-2010**

| Site number | Site name | Minimum | Maximum | Mean 2009–10 | Standard deviation | Regulation limits |
|---|---|---|---|---|---|---|
| 102 | Burrinjuck Res above Hume Park | 33 | 79 | 47.00 | 16.94 | 10 |
| 248 | Lake Tuggeranong at Kambah Wetland | 13 | 51 | 35.86 | 15.50 | 10 |
| 249 | Lake Tuggeranong at Dam | 8.7 | 52 | 23.39 | 15.27 | 10 |
| 261 | Flemington Rd Pond | 4.7 | 39.00 | 13.72 | 12.06 | N/A |
| 262 | Yerrabi Pond, dam wall | 2.3 | 8.9 | 5.13 | 2.52 | 10 |
| 270 | Point Hut Pond at Dam Wall | 0.17 | 23 | 5.51 | 8.21 | 10 |
| 318 | Lake Ginninderra at Dam | 6.00 | 60.00 | 18.24 | 19.18 | 10 |
| 321 | Lake Ginninderra at East Arm | 6.80 | 19.00 | 12.37 | 5.09 | 10 |
| 346 | Gungahlin Pond at Dam Wall | 1.8 | 12 | 5.94 | 4.16 | 10 |
| 204 | Murrumbidgee River at Halls Crossing | 5.30 | 67.00 | 31.86 | 29.79 | N/A |
| 209 | Murrumbidgee River at Kambah Pool | 5.60 | 47.00 | 19.38 | 16.93 | N/A |
| 213 | Murrumbidgee River at Angle Crossing | 4.80 | 52.00 | 18.60 | 19.72 | N/A |
| 301 | Ginninderra Creek at Parkwood | 2.90 | 20.00 | 9.72 | 4.47 | N/A |
| 601 | Molonglo River at Dairy Flat Bridge | 4.20 | 17.00 | 10.20 | 4.78 | N/A |
| 608 | Molonglo River at Yass Road Bridge | 4.40 | 20.00 | 9.74 | 6.22 | N/A |
| 769 | Queanbeyan River at ACT Border | 3.60 | 5.40 | 4.70 | 0.71 | N/A |
| 842 | Paddys River at Riverlea | 1.30 | 8.00 | 3.10 | 2.76 | N/A |
| 901 | Gudgenby River at Tennent | 1.10 | 29.00 | 7.64 | 12.02 | 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, 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 amorphous masses suspended in the water column, in front of the aquatic plant debris and pontoon of green algae.

**Figure 8: Blue-green algal flakes, bloom on Jarramlee Pond, February 2010**

Weekly monitoring of visible planktonic algal conditions (especially for blue-green *Anabaena* and *Microcystis*) is performed by EPA and Health Protection Service 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).

A spring bloom of *Aphanocapsa* in Lake Tuggeranong was followed by a mixed cyanobacterial bloom, dominated at times by an *Anabaena* species, which peaked in February but persisted until May 2010. Point Hut Pond also had minor blooms of *Anabaena* species in February and March and *Microcystis* species in May. The Molonglo River in the water-ski reach had a minor mixed bloom dominated by *Cylindospermopsis* species in January. Lake Ginninderra had a large population of *Aphanocapsa* species in April, and it was still present in June. Gungahlin Pond and Yerrabi Pond had no incidents involving cyanobacteria. Many of the stormwater retention ponds did show blooms; for example, David Street Wetland had a striking red skin of *Euglena sanguinea* across most of the summer. There were high alert closures of the Molonglo Water Ski area and Point Hut Pond, and extreme alert closures at Kambah Pool on the Murrumbidgee and Lake Tuggeranong, in January and February 2010. The Kambah Pool closure was prompted by inflated levels of not only blue-green algae but faecal coliform bacteria related to riverbed disturbance and water turnover in the reach.

**Table 16: Algal 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. |
| | >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 | ≥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 for primary contact* users. |
| Extreme | ≥125,000 (40,000 cells/mL *Anabaena circinalis*) or scums are consistently present | ≥10 mm³/L | EPA continues twice weekly visual inspection, and water samples are taken as required. On-site signs are erected to advise secondary contact users that contact with the water increases the risk of harm, and that secondary contact** users' protocols must be followed |

* Primary contact users are those whose sporting activities involve their partial or total immersion in the water. Examples include swimming; snorkelling or scuba diving; water skiing; wind surfing or parasailing over water.

** Secondary contact users are those whose sporting activities are conducted on or near the water but involve water contact such as splashing or occasional immersion of extremities. Examples include rowing; dragon boat racing; yachting or kayaking. When signs have been erected, experienced members of clubs proceed at their own risk and must follow the protocols.

The algal cell counts and biovolumes above are based on those for *Microcystis aeruginosa* unless otherwise specified.

Full details of the Blue-Green Algae in Recreational Water Management Strategy can be found at the ACT Health website at http://www.health.act.gov.au

### *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.

*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.<br>Potential biodiversity 'hot-spot' or mild organic enrichment.<br>Continuous irrigation flow in a normally intermittent stream.<br>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% of the reference sites. |
| B | SIGNIFICANTLY IMPAIRED | Fewer families than expected.<br>Potential impact either on water and/or habitat resulting in a loss of families. |
| C | SEVERELY IMPAIRED | Many fewer families than expected.<br>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.<br>Severe impairment. |

**Table 18: Summary of AUSRIVAS Band Scores for sites in the ACT from spring 2005 to autumn 2010. Note there is no regulation limit for this parameter (although the ideal would be an A for each site).**

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

Reference sites (10, 15, 213) degraded immediately after the 2003 bushfires and have fluctuated in macroinvertebrate diversity and complexity ever since. In recent years drought and lack of flow have been the major environmental constraints on the vitality of macroinvertebrates. Reference site 15 has remained at reference standard for another year. Reference site 10 dropped to C in spring 2009 as the Paddys River had shrunk to a series of pools from autumn 2009 until the spring rains that arrived at sampling time. This site regained reference standard in autumn 2010. Reference Site 213 continued at B in spring 2009, but the diversity was already there for rapid recovery as conditions improved.

The biological communities in urban sites are under considerable stress from habitat degradation, altered flow regimes, pollutant inputs, or pest species (especially the Plague Minnow) and are not as resilient to natural stresses like drought as non-urban sites. The fluctuations in rating for peri-urban sites 58, 769 and 608 and the C rating over long periods at the urban sites (189, 64, 195 and 196) illustrate this.

Spring 2009 followed a dry winter. There was a single good downpour in September followed by very warm weather in October and in November, particularly in the days just prior to and during the survey. The field observations in the AUSRIVAS report frequently include mention of sand slugs, large quantities of periphyton and the presence of filamentous algae. These conditions favour tolerant grazer species over more sensitive and specialised feeders that prefer a varied stream bottom structure.

Comparing the spring 2008 and 2009 scores, Yarralumla Creek improved from C to B, Ginninderra Creek (64) improved from D to C and the Queanbeyan River (235) improved from D to B, but all had a fauna dominated by non-biting midges and worms that thrive in slow flowing water with plenty of algae and other biofilm. Similar faunas were collected at most other sites. No site was categorised as Extremely Impaired or D, compared to 2008 when two sites scored D.

As in autumn 2009, the rural rivers (sites 20, 58, 204) and 608 all scored a B rating in autumn 2010. Improved flow conditions will have allowed a greater range of feeding sites and so allowed a wider diversity of macroinvertebrates in the Gudgenby (17% mayfly nymphs) and the Molonglo Rivers (7% caddis fly larvae). The fauna of the urban waterways (sites 64, 195, 196, 189, 246 and 769) continue to be constrained by lack of habitat diversity. Jerrabomberra Creek will remain fragile while the new bridges are built on Lanyon Drive near Hume.

## Lakes

### *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 by comparison with other lake sites in the ACT. The watershed is almost entirely urban, and the floor of the Pond is silt-like. Turbidity remains elevated because of storm disturbance of that unconsolidated base. The elevated chlorophyll 'a' reading in January and February was associated with a bloom of a filamentous cyanobacterium and *Microcystis*. The bloom triggered a closure of the Pond to primary contact recreation. Other parameters have fitted within regulation expectations in 2009-2010.

**Table 19: Site 270 Point Hut Pond**

| Indicator | Units | Reg limits | Long-term average | Mean | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | May 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.93 | 7.64 | 7.6 | 7.8 | 7.8 | 7.7 | 7.4 | 7.8 | 7.4 |
| Chlorophyll 'a' | ug/L | 10 | 11.55 | 5.51 | 2.1 | 2.3 | 1.3 | 8.7 | 23.0 | 0.97 | 0.17 |
| Conductivity | uS/cm | N/A | 223.98 | 111.14 | 100 | 120 | 130 | 110 | 98 | 110 | 110 |
| Dissolved Oxygen | mg/L | >4 | 8.01 | 7.97 | 8.5 | 7.5 | 8.0 | 8.2 | 7.4 | 8.6 | 7.6 |
| Faecal Coliforms – Confirmed | cfu/ 100mL | 1000 | 129.25 | 73.08 | 90 | 5 | 10 | 30 | 310 | 20 | 80 |
| Suspended Solids | mg/L | 25 | 31.59 | 37.71 | 110 | 33 | 34 | 10 | 35 | 18 | 24 |
| Total Nitrogen | mg/L N | N/A | 1.16 | 1.21 | 1.4 | 1.1 | 1.4 | 0.76 | 1.4 | 1.4 | 0.98 |
| Total Phosphorus | mg/L P | 0.1 | 0.08 | 0.08 | 0.12 | 0.07 | 0.10 | 0.05 | 0.09 | 0.08 | 0.08 |
| Turbidity | NTU | 30 | 75.93 | 75.29 | 190 | 87 | 74 | 40 | 43 | 27 | 66 |

### *Lake Tuggeranong*

Two sites are monitored in Lake Tuggeranong, one at the Kambah Wetland (Site 248) near the northern inflow of Village and Wanniassa Creeks, and the other at the dam wall (Site 249).

The pulses in faecal coliform counts in both the Kambah basin and the main lake in February are almost certainly an indication of the storm water flushing of the two Gross Pollution Traps at the top of Kambah Wetland with the cumulative effect at the Dam wall from all inlets. A spring flush of various cyanobacteria was followed by a persistent bloom of *Microcystis* and *Anabaena* from late January until May. This resulted in closure of the lake to both primary and secondary contact recreation for some time this year. The elevated Turbidities plot the rainfall events, until there is little loose material to be moved in the catchment.

**Table 20: Site 248 Lake Tuggeranong Kambah Wetland**

| Indicator | Units | Reg limits | Long-term average | Mean | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | May 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.71 | 7.64 | 7.5 | 7.4 | 7.4 | 7.4 | 7.0 | 9.4 | 7.4 |
| Chlorophyll 'a' | ug/L | 10 | 13.12 | 35.86 | 45 | 27 | 13 | 20 | 46 | 49 | 51 |
| Conductivity | uS/cm | N/A | 180.47 | 91.29 | 81 | 91 | 95 | 89 | 110 | 88 | 85 |
| Dissolved Oxygen | mg/L | >4 | 7.37 | 8.27 | 9.0 | 5.9 | 7.2 | 7.9 | 6.6 | 12.9 | 8.4 |
| Faecal Coliforms – Confirmed | cfu/ 100mL | 1000 | 11707.12 | 153.43 | 140 | 14 | 60 | 54 | 700 | 6 | 100 |
| Suspended Solids | mg/L | 25 | 21.17 | 25.57 | 32 | 29 | 33 | 17 | 31 | 21 | 16 |
| Total Nitrogen | mg/L N | N/A | 1.06 | 1.20 | 0.99 | 0.93 | 0.92 | 0.76 | 2.8 | 1.2 | 0.83 |
| Total Phosphorus | mg/L P | 0.1 | 0.09 | 0.09 | 0.08 | 0.10 | 0.10 | 0.08 | 0.15 | 0.07 | 0.07 |
| Turbidity | NTU | 30 | 31.86 | 22.29 | 36 | 28 | 31 | 14 | 23 | 14 | 10 |

**Table 21: Site 249 Lake Tuggeranong Dam Wall**

| Indicator | Units | Reg limits | Long-term average | Mean | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | May 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.68 | 7.43 | 7.6 | 7.2 | 7.6 | 7.2 | 7.1 | 7.7 | 7.6 |
| Chlorophyll 'a' | ug/L | 10 | 10.65 | 23.39 | 15 | 8.7 | 24 | 15 | 52 | 14 | 35 |
| Conductivity | uS/cm | N/A | 173.94 | 85.57 | 77 | 89 | 93 | 87 | 75 | 88 | 90 |
| Dissolved Oxygen | mg/L | >4 | 6.96 | 9.0 | 9.1 | 6.8 | 9.0 | 8.8 | 6.9 | 13.6 | 8.9 |
| Faecal Coliforms - Confirmed | cfu/ 100mL | 1000 | 273.41 | 40.57 | 20 | 24 | 10 | 6 | 200 | 4 | 20 |
| Suspended Solids | mg/L | 25 | 17.37 | 17.86 | 32 | 19 | 22 | 13 | 16 | 12 | 11 |
| Total Nitrogen | mg/L N | N/A | 1.03 | 0.96 | 0.96 | 0.89 | 0.84 | 0.83 | 1.5 | 1 | 0.71 |
| Total Phosphorus | mg/L P | 0.1 | 0.08 | 0.07 | 0.078 | 0.07 | 0.078 | 0.084 | 0.11 | 0.061 | 0.04 |
| Turbidity | NTU | 30 | 33.48 | 18.06 | 38 | 24 | 24 | 12 | 14 | 7.8 | 6.6 |

### *Flemington Road Pond*

Flemington Road Pond (Site 261) is a recently constructed storm water retention pondage system in Sullivans Creek. Above the Barton Highway, the creek-line is incised through cleared grazing land.

The water quality reflects the youth of the water body, with wide fluctuations in pH, suspended solids, total phosphates and turbidity indicating an unconsolidated base. The elevated Chlorophyll 'a' counts are indicative of biological development of the site, with green algae dominating the phytoplankton in November, and a mixture of diatoms, cyanobacteria and green algae in February. This is not atypical of developing ponds large or small. It is to be hoped that Dissolved Oxygen and Faecal Coliform data will be collected in the future.

**Table 22: Site 261 Flemington Road Pond**

| Indicator | Units | Reg limits | Long-term average | Mean | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | May 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | | 7.70 | 7.7 | 7.9 | 8.0 | 8.2 | 6.7 | 7.6 | 7.8 |
| Chlorophyll 'a' | ug/L | 10 | | 13.72 | 4.7 | 39.0 | 13 | 6.9 | 18 | 5.5 | 9.3 |
| Conductivity | uS/cm | N/A | | 148.57 | 120 | 140 | 140 | 160 | 150 | 160 | 170 |
| Dissolved Oxygen | mg/L | >4 | | | * | * | * | * | * | * | * |
| Faecal Coliforms - Confirmed | cfu/ 100mL | 1000 | | | * | * | * | * | * | * | * |
| Suspended Solids | mg/L | 25 | | 33.00 | 34 | 44 | 27 | 9 | 100 | 6 | 11 |
| Total Nitrogen | mg/L N | N/A | | 1.40 | 1.6 | 2.7 | 1.1 | 0.94 | 1.8 | 0.900 | 0.75 |
| Total Phosphorus | mg/L P | 0.1 | | 0.06 | 0.11 | 0.27 | 0.07 | 0.057 | 0.11 | 0.032 | 0.037 |
| Turbidity | NTU | 30 | | 45.60 | 170 | 97 | 73 | 61 | 88 | 10 | 11 |

* Data not available for month

### *Yerrabi Pond*

While Yerrabi Pond (Site 262) has been part of the urban waterways of Canberra for several years, its importance as an indicator of water quality is now being realised as the infrastructure for the suburbs in its catchment approach maturity.

Water quality is close to that expected for a moderate urban lake. The pH readings towards the upper end of acceptability and the locally high conductivity readings are indications of the calcareous nature of the country rock. Storm run-off produced the elevated turbidity and suspended solids readings in February.

**Table 23: Site 262 Yerrabi Pond**

| Indicator | Units | Reg limits | Long-term average | Mean | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | May 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | | 8.40 | * | 9.0 | 8.6 | 8.9 | 7.8 | 8.1 | 8.0 |
| Chlorophyll 'a' | ug/L | 10 | | 5.13 | 7.1 | 5.5 | 3.2 | 2.3 | 3.8 | * | 8.9 |
| Conductivity | uS/cm | N/A | | 207.14 | * | 270 | 270 | 250 | 200 | 220 | 240 |
| Dissolved Oxygen | mg/L | >4 | | 7.92 | * | 9.7 | 8.1 | 7.6 | 5.4 | 9.0 | 7.7 |
| Faecal Coliforms - Confirmed | cfu/ 100mL | 1000 | | 54.57 | 6 | 2 | 24 | 44 | 280 | 22 | 4 |
| Suspended Solids | mg/L | 25 | | 12.00 | * | 5 | 4 | 1 | 41 | 9 | 12 |
| Total Nitrogen | mg/L N | N/A | | 0.51 | * | 0.51 | 0.5 | 0.44 | 0.09 | 0.840 | 0.67 |
| Total Phosphorus | mg/L P | 0.1 | | 0.02 | * | 0.013 | 0.017 | 0.006 | 0.038 | 0.051 | 0.023 |
| Turbidity | NTU | 30 | | 13.43 | | 2 | 2.2 | 2.1 | 59 | 10 | 5.30 |

### *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 higher Chlorophyll 'a' reading in October was associated with a spring flush of green algae, and that in February with an elevated cyanobacterial population. Smaller water bodies in the area experienced cyanobacterial blooms in January and February and may have provided inoculum for the Pond.

**Table 24: Site 346 Gungahlin Pond**

| Indicator | Units | Reg limits | Long-term average | Mean | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | May 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 8.21 | 8.8.59 | 7.9 | 8.6 | 9.0 | 9.2 | 7.8 | 8.6 | 9.0 |
| Chlorophyll 'a' | ug/L | 10 | 5.97 | 5.94 | 12 | 3.5 | 4.7 | 6.7 | 11 | 1.8 | 1.9 |
| Conductivity | uS/cm | N/A | 310.73 | 208.57 | 210 | 240 | 240 | 190 | 190 | 200 | 190 |
| Dissolved Oxygen | mg/L | >4 | 8.13 | 9.16 | 8.5 | 8.6 | 9.6 | 9.8 | 6.6 | 10.1 | 10.9 |
| Faecal Coliforms - Confirmed | cfu/ 100mL | 1000 | 23.96 | 12.43 | 20 | 10 | 6 | 4 | 40 | 6 | 1 |
| Suspended Solids | mg/L | 25 | 17.53 | 10.86 | 23 | 8 | 7 | 5 | 24 | 4 | 5 |
| Total Nitrogen | mg/L N | N/A | 0.96 | 0.69 | 0.92 | 0.51 | 0.48 | 0.46 | 1.5 | 0.640 | 0.35 |
| Total Phosphorus | mg/L P | 0.1 | 0.04 | 0.026 | 0.037 | 0.014 | 0.022 | 0.023 | 0.056 | 0.017 | 0.014 |
| Turbidity | NTU | 30 | 27.90 | 14.79 | 45 | 8 | 5.6 | 4 | 33 | 3.300 | 4.60 |

### *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 spring and summer indicates some water column stirring because of rain. In summer the main organism was an *Aphanocapsa* species, a benign planktonic cyanobacterium. High levels of turbidity and suspended solids, in the East Arm, mark storm run-off in October, November and February, possibly aggravated by local construction activity. Faecal coliform levels in February are related to storm disturbances in the catchment.

**Table 25: Site 318 Lake Ginninderra Dam Wall**

| Indicator | Units | Reg limits | Long-term average | Mean | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | May 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.93 | 7.86 | 8.2 | 8.20 | 7.90 | 7.90 | 7.40 | 7.80 | 7.60 |
| Chlorophyll 'a' | ug/L | 10 | 5.54 | 18.24 | 21 | 14 | 6.1 | 13 | 6.0 | 60 | 7.6 |
| Conductivity | uS/cm | N/A | 278.34 | 174.29 | 180 | 190 | 200 | 190 | 160 | 150 | 150 |
| Dissolved Oxygen | mg/L | >4 | 7.24 | 7.44 | 9.7 | 8.8 | 8.0 | 9.7 | 5.6 | 9.7 | 7.6 |
| Faecal Coliforms - Confirmed | cfu/ 100mL | 1000 | 81.73 | 300.29 | 10 | 64 | 8 | 12 | 2000 | 4 | 4 |
| Suspended Solids | mg/L | 25 | 11.72 | 9.71 | 20 | 9 | 7 | 6 | 13 | 6 | 7 |
| Total Nitrogen | mg/L N | N/A | 0.72 | 0.63 | 0.57 | 0.56 | 0.46 | 0.64 | 0.83 | 0.730 | 0.61 |
| Total Phosphorus | mg/L P | 0.1 | 0.03 | 0.033 | 0.043 | 0.027 | 0.025 | 0.043 | 0.045 | 0.024 | 0.027 |
| Turbidity | NTU | 30 | 14.08 | 9.83 | 19 | 6.9 | 5.8 | 4.8 | 16 | 6.3 | 10 |

**Table 26: Site 321 Lake Ginninderra East Arm**

| Indicator | Units | Reg limits | Long-term average | Mean | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | May 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 8.00 | 7.84 | 8.00 | 8.20 | 8.00 | 8.00 | 7.30 | 7.80 | 7.6 |
| Chlorophyll 'a' | ug/L | 10 | 9.95 | 12.37 | 17 | 17 | 6.8 | 8.0 | 10 | 19 | 8.8 |
| Conductivity | uS/cm | N/A | 289.71 | 171.43 | 180 | 190 | 190 | 190 | 140 | 160 | 150 |
| Dissolved Oxygen | mg/L | >4 | 7.97 | 8.2 | 9.9 | 8.3 | 8.5 | 9.1 | 6.3 | 8.2 | 7.7 |
| Faecal Coliforms - Confirmed | cfu/ 100mL | 1000 | 240.08 | 28.83 | 10 | 140 | 8 | 6 | * | 1 | 8 |
| Suspended Solids | mg/L | 25 | 24.08 | 21.14 | 46 | 23 | 12 | 5 | 42 | 12 | 8 |
| Total Nitrogen | mg/L N | N/A | 0.78 | 0.71 | 0.67 | 0.53 | 0.53 | 0.57 | 1.2 | 0.850 | 0.59 |
| Total Phosphorus | mg/L P | 0.1 | 0.05 | 0.045 | 0.058 | 0.033 | 0.038 | 0.036 | 0.071 | 0.052 | 0.028 |
| Turbidity | NTU | 30 | 26.55 | 21.50 | 43 | 16 | 9.1 | 4.7 | 56 | 12.000 | 9.70 |

* 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. However, the influence of catchment wide drainage following heavy rains in February can be seen in elevated levels for suspended Solids, Faecal Coliforms and Turbidity for that month. 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. Elevated and increasing faecal coliform counts at Kambah Pool may result from the interaction of a mixture of contributors including urban run-off from Lake Tuggeranong and bottom mixing of the deep pool above cascades that constitutes the sampling site.

**Table 27: Values of Indicators sampled on Site 204 on the Murrumbidgee River at Halls Crossing**

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 8.30 | 7.88 | 7.8 | 8.6 | 8.6 | 7.8 | 6.6 |
| Chlorophyll 'a' | ug/L | 10 | 14.59 | 31.86 | 61 | 67 | 8 | 18 | 5.3 |
| Conductivity | uS/cm | N/A | 197.29 | 252.20 | 150 | 250 | 500 | 290 | 71 |
| Dissolved Oxygen | mg/L | >4 | 10.09 | 10.70 | 10.7 | 9.1 | 9.8 | 8.5 | 12.2 |
| Faecal Coliforms - Confirmed | cfu/100mL | 150 | 407.37 | 403.40 | 15 | 20 | 32 | 750 | 15 |
| Suspended Solids | mg/L | 25 | 17.12 | 31.50 | 36 | 27 | 21 | 42 | |
| Total Nitrogen | mg/L N | N/A | 3.65 | 3.70 | 1.9 | 4.1 | 8.8 | 2 | 1.7 |
| Total Phosphorus | mg/L P | 0.1 | 0.11 | 0.10 | 0.091 | 0.083 | 0.051 | 0.091 | 0.16 |
| Turbidity | NTU | 30 | 13.07 | 36.4 | 28 | 18 | 10 | 26 | 100 |
| | | 2009-2010 | | | | Nov | | | May |
| AUSRIVAS score | A,B,C,D | A;B | | | | B | | | B |

## Table 28: Values of Indicators sampled on Site 209 on the Murrumbidgee River at Kambah Pool

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.95 | 7.00 | 7.1 | 7.3 | 7.7 | 6.6 | 6.3 |
| Chlorophyll 'a' | ug/L | 10 | 5.85 | 19.38 | 11 | 47 | 9.3 | 24 | 5.6 |
| Conductivity | uS/cm | N/A | 137.90 | 73.40 | 50 | 80 | 100 | 96 | 41 |
| Dissolved Oxygen | mg/L | >4 | 9.45 | 9.68 | 11.3 | 8.1 | 8.6 | 9.1 | 11.3 |
| Faecal Coliforms - Confirmed | cfu/100mL | 150 | 291.87 | 852.2 | 50 | 10 | 1 | 1500 | 2700 |
| Suspended Solids | mg/L | 25 | 20.81 | 274.5 | 36 | 52 | 10 | 1000 | |
| Total Nitrogen | mg/L N | N/A | 0.56 | 1.30 | 0.47 | 0.76 | 0.56 | 3.4 | 1.3 |
| Total Phosphorus | mg/L P | 0.1 | 0.05 | 0.16 | 0.06 | 0.082 | 0.03 | 0.52 | 0.13 |
| Turbidity | NTU | 30 | 17.99 | 194.7 | 36 | 80 | 8.5 | 770 | 76 |

* Data not available for this month

## Table 29: Values of Indicators sampled on Site 213 on the Murrumbidgee River at Angle Crossing

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.78 | 6.94 | 6.7 | 7.9 | 7.6 | 6.3 | 6.2 |
| Chlorophyll 'a' | ug/L | 10 | 3.91 | 18.60 | 8.4 | 21 | 6.8 | 52 | 4.8 |
| Conductivity | uS/cm | N/A | 127.44 | 69.60 | 43 | 77 | 95 | 89 | 44 |
| Dissolved Oxygen | mg/L | >4 | 9.28 | 8.92 | 11.3 | 8.8 | 7.5 | 6.2 | 10.8 |
| Faecal Coliforms - Confirmed | cfu/100mL | 150 | 254.92 | 705.2 | 20 | 40 | 6 | 2500 | 960 |
| Suspended Solids | mg/L | 25 | 13.86 | 265.25 | 29 | 45 | 17 | 970 | |
| Total Nitrogen | mg/L N | N/A | 0.50 | 1.17 | 0.4 | 0.6 | 0.47 | 3.2 | 1.2 |
| Total Phosphorus | mg/L P | 0.1 | 0.05 | 0.15 | 0.051 | 0.068 | 0.037 | 0.49 | 0.11 |
| Turbidity | NTU | 30 | 9.75 | 152.0 | 27 | 39 | 13 | 630 | 51 |
| | | 2009-2010 | | | | Nov | | | May |
| AUSRIVAS score | A, B, C, D | A;B | | | | B | | | A |

*Murrumbidgee River, Angle Crossing, August 2009*

### *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).

The water quality in Ginninderra Creek shows much improvement in 2009–2010 with all parameters having an average reading for this year below the long term average, and inside recommended standards. As elsewhere, the faecal coliform elevated reading in February is storm related, with warm weather, high flow and runoff as well as bottom mixing in Gross Pollution Traps and the Lake all contributing.

**Table 30: Values of Indicators Sampled at Sites 301, 195, 196 and 64 along Ginninderra Creek**

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.76 | 7.00 | 7.1 | 6.5 | 7 | 7.3 | 7.1 |
| Chlorophyll 'a' | ug/L | 10 | 14.47 | 9.72 | 12 | 9.6 | 15 | 9.1 | 2.9 |
| Conductivity | uS/cm | N/A | 411.35 | 230.00 | 190 | 320 | 280 | 190 | 170 |
| Dissolved Oxygen | mg/L | >4 | 8.21 | 7.34 | 9.9 | 4.7 | 5.5 | 6.5 | 10.1 |
| Faecal Coliforms - Confirmed | cfu/100mL | 150/1000 | 1343.91 | 290.40 | 490 | 40 | 160 | 700 | 62 |
| Suspended Solids | mg/L | 25 | 15.98 | 14.75 | 13 | 10 | 8 | 28 | |
| Total Nitrogen | mg/L N | N/A | 1.15 | 0.73 | 0.51 | 0.64 | 0.66 | 1.1 | 0.72 |
| Total Phosphorus | mg/L P | 0.1 | 0.93 | 0.05 | 0.043 | 0.043 | 0.051 | 0.066 | 0.03 |
| Turbidity | NTU | 30 | 12.06 | 10.32 | 14 | 5.6 | 5 | 12 | 15 |
| | | 2009-2010 | | | | Nov | | | May |
| AUSRIVAS score (195) | A, B, C, D | B;C | | | | C | | | C |
| AUSRIVAS score (196) | A, B, C, D | C;C | | | | C | | | B |
| AUSRIVAS score (64) | A, B, C, D | D;C | | | | C | | | C |

### *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 well below Lake Burley Griffin, 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 Road is elevated by contributions from the Queanbeyan River (Table 30) and the Queanbeyan Sewage Treatment Plant.

The lower readings for Conductivity at both sites in February and June indicate the flushing effect of the good flows in the Molonglo enhanced by good late summer and autumn rain. Other distinct rain related effects are the increased values for both Suspended Solids and Turbidity, and the faecal coliform counts. Yass Road Bridge AUSRIVAS scores for 2009-2010 reflect the low flows just prior to sampling in spring, and improved flow by the end of autumn. There were many expected animals missing in the spring sample that included various macroinvertebrates found in numbers in standing rather than flowing water systems.

**Table 31: Values of Indicators sampled on Site 601 on the Molonglo River at Dairy Flat Bridge**

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.58 | 7.30 | 7.3 | 7.6 | 8.3 | 6.5 | 6.8 |
| Chlorophyll 'a' | ug/L | 10 | 14.97 | 10.20 | 7.8 | 17 | 10 | 12 | 4.2 |
| Conductivity | uS/cm | N/A | 247.50 | 374.00 | 510 | 460 | 480 | 110 | 310 |
| Dissolved Oxygen | mg/L | >4 | 7.66 | 6.90 | 7.5 | 7.5 | 8.3 | 5.1 | 6.1 |
| Faecal Coliforms - Confirmed | cfu/100mL | 150 | 102.98 | 328.50 | 50 | | 24 | 700 | 540 |
| Suspended Solids | mg/L | 25 | 11.98 | 27.50 | 19 | 6 | 11 | 74 | |
| Total Nitrogen | mg/L N | N/A | 1.47 | 2.66 | 4.6 | 2.2 | 1.1 | 2.1 | 3.3 |
| Total Phosphorus | mg/L P | 0.1 | 0.10 | 0.06 | 0.042 | 0.031 | 0.042 | 0.13 | 0.075 |
| Turbidity | NTU | 30 | 12.21 | 26.74 | 17 | 4.8 | 6.9 | 75 | 30 |

**Table 32: Values Indicators sampled on Site 608 (AUSRIVAS 242) on the Molonglo River at Yass Road**

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.31 | 6.84 | 7.1 | 6.9 | 6.7 | 6.9 | 6.6 |
| Chlorophyll 'a' | ug/L | 10 | 4.42 | 9.74 | 11 | 4.4 | 20 | 6.4 | 6.9 |
| Conductivity | uS/cm | N/A | 348.33 | 286.00 | 460 | 540 | 190 | 100 | 140 |
| Dissolved Oxygen | mg/L | >4 | 6.80 | 6.56 | 8.1 | 4.3 | 2.7 | 8.1 | 9.6 |
| Faecal Coliforms - Confirmed | cfu/100mL | 1000 | 365.48 | 753.00 | 25 | 90 | 52 | 600 | 3000 |
| Suspended Solids | mg/L | 25 | 12.20 | 16.50 | 16 | 9 | 3 | 38 | |
| Total Nitrogen | mg/L N | N/A | 0.47 | 0.48 | 0.47 | 0.5 | 0.45 | 1.7 | 1.2 |
| Total Phosphorus | mg/L P | 0.1 | 0.04 | 0.06 | 0.036 | 0.025 | 0.048 | 0.11 | 0.092 |
| Turbidity | NTU | 30 | 18.94 | 26.80 | 16 | 7.8 | 2.2 | 47 | 61 |
| | | 2009-2010 | | | | Nov | | | May |
| AUSRIVAS score | A,B,C,D | A;B | | | | C | | | B |

*Spring tufts of conspicuous green algae on a concrete culvert.*
*Poor riparian vegetation encourages compensatory growth of filamentous algae.*

### *Queanbeyan River (Site 769)*

The Queanbeyan River is sampled at the ACT border, after the water has come through the weir and long established urban area of Queanbeyan. For the maintenance of life, it is generally found that levels of Dissolved Oxygen greater than 4.0mg/L will suffice, but that thriving ecosystems have more than 6.0 mg/L. Very sluggish flows and poor riparian condition (the site and much of the reach upstream is dominated by exotic woody vegetation) lead to lower than optimum DO readings in the spring and summer, until the February rains. The AUSRIVAS scores reflect the stress the river is under at this site, but are moderately improved on 2008–2009.

**Table 33: Values Indicators sampled on Site 769 on the Queanbeyan River at the ACT Border**

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.37 | 6.72 | 6.7 | 6.4 | 7 | 6.9 | 6.6 |
| Chlorophyll 'a' | ug/L | 10 | 6.55 | 4.70 | 5.4 | 3.6 | 4.5 | 5.2 | 4.8 |
| Conductivity | uS/cm | N/A | 216.21 | 286.00 | 230 | 330 | 450 | 220 | 200 |
| Dissolved Oxygen | mg/L | >4 | 7.53 | 4.96 | 5.5 | 3.6 | 3.1 | 6.1 | 6.5 |
| Faecal Coliforms - Confirmed | cfu/100mL | 1000 | 665.74 | 106.00 | 50 | 180 | 40 | 180 | 80 |
| Suspended Solids | mg/L | 25 | 8.19 | 9.00 | 10 | 4 | 10 | 12 | |
| Total Nitrogen | mg/L N | N/A | 0.53 | 0.98 | 0.6 | 0.45 | 0.47 | 2.2 | 1.2 |
| Total Phosphorus | mg/L P | 0.1 | 0.04 | 0.05 | 0.049 | 0.028 | 0.041 | 0.067 | 0.06 |
| Turbidity | NTU | 30 | 7.27 | 9.10 | 9.8 | 2.1 | 7.7 | 9.9 | 16 |
| | | 2009-2010 | | | | Nov | | | May |
| AUSRIVAS score | A, B, C D | D;C | | | | B | | | C |

### *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.

The absence of results for December 2009 indicates that there was no water in the river below Riverlea homestead at that time. Flows in the Paddys River have been poor for most of 2008 and 2009 as the watershed had dried out in the drought. The samples in October and November are flow-based samples and reflect rain events. 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. The November storm associated elevation fits this pattern well.

**Table 34: Values of Indicators sampled on Sites 842 and 10 along Paddys River**

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.62 | 7.20 | 7.3 | 7.7 | | 6.9 | 6.9 |
| Chlorophyll 'a' | ug/L | 10 | 2.15 | 3.10 | 1.3 | 2.2 | | 1.8 | 2.2 |
| Conductivity | uS/cm | N/A | 87.95 | 89.50 | 83 | 110 | | 95 | 70 |
| Dissolved Oxygen | mg/L | >4 | 10.54 | 10.55 | 12.8 | 9.7 | | 7.9 | 11.8 |
| Faecal Coliforms - Confirmed | cfu/100mL | 150 | 637.98 | 652.50 | 160 | 1800 | | 520 | 130 |
| Suspended Solids | mg/L | 25 | 11.91 | 7.33 | 4 | 5 | | 13 | |
| Total Nitrogen | mg/L N | N/A | 0.45 | 0.91 | 0.36 | 0.4 | | 2.4 | 0.46 |
| Total Phosphorus | mg/L P | 0.1 | 0.05 | 0.05 | 0.034 | 0.042 | | 0.072 | 0.039 |
| Turbidity | NTU | 30 | 14.79 | 10.55 | 8 | 4.2 | | 17 | 13 |
| | | 2009-2010 | | | | Nov | | | May |
| AUSRIVAS band (10) | A,B,C,D | B;A | | | | C | | | 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) showed as B, significantly impaired, in both spring and autumn. The presence of quantities of sand and other fine sediments, obscuring or suppressing more varied habitat, may have lead to the absence of some expected organisms, although the large proportion of mayflies indicates the potential for biological diversity. Grazing disturbance, causing localised bank erosion, and low rainfall are probably involved in the fluctuations in biological condition.

**Table 35: Values of Indicators sampled on Sites 901 and 20 along the Gudgenby River**

| Indicator | Units | Regulation limits | Long-term average | Average 2009-2010 | Oct–09 | Nov-09 | Dec–09 | Feb–10 | Jun-10 |
|---|---|---|---|---|---|---|---|---|---|
| Acidity | pH | 6-9 | 7.71 | 7.12 | 7 | 7.3 | 7.5 | 7.2 | 6.6 |
| Chlorophyll 'a' | ug/L | 10 | 1.89 | 7.64 | 1.1 | 1.4 | 29 | 4.5 | 2.2 |
| Conductivity | uS/cm | N/A | 99.84 | 81.60 | 67 | 86 | 110 | 88 | 57 |
| Dissolved Oxygen | mg/L | >4 | 9.93 | 9.68 | 11.4 | 8.8 | 7.4 | 9.3 | 11.5 |
| Faecal Coliforms - Confirmed | cfu/100mL | 1000 | 333.78 | 206.40 | 410 | 84 | 58 | 340 | 140 |
| Suspended Solids | mg/L | 25 | 9.51 | 6.75 | 7 | 4 | 10 | 6 | |
| Total Nitrogen | mg/L N | N/A | 0.44 | 0.64 | 0.56 | 0.53 | 0.67 | 0.75 | 0.69 |
| Total Phosphorus | mg/L P | 0.1 | 0.05 | 0.06 | 0.056 | 0.047 | 0.078 | 0.058 | 0.068 |
| Turbidity | NTU | 30 | 10.86 | 9.34 | 12 | 3.5 | 8.6 | 4.6 | 18 |
| | | 2009-2010 | | | | Nov | | | May |
| AUSRIVAS score (20) | A, B, C, D | A;B | | | | B | | | B |

## Minor Waterways

These four waterways are monitored for bioassessment only. There is 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 http://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 autumn rain.

**Table 36: Values Indicators sampled on Site 15 on the Tidbinbilla River**

| Indicator | Units | Regulation limits | November 08 | April 09 |
|---|---|---|---|---|
| Conductivity | (µS/cm) | N/A | 70.3 | 59.9 |
| Acidity | pH | 6.5-9 | 8.18 | 8.0 |
| Alkalinity | (mg/L $CaCO_3$) | N/A | 35 | 50 |
| Dissolved Oxygen | (mg/L) | >4 | 8.87 | 11.18 |
| Turbidity | (NTU) | <10 | 6.8 | 74 |
| | | 2009-2010 | | |
| AUSRIVAS band | 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, as well as receiving water from Woden Creek and its tributaries. Water quality is in moderate condition with most stress coming from disturbance of the creek-line on Lanyon Drive in Hume, while new bridgework is completed. Biological condition remains poor, both for macroinvertebrates and habitat, and may continue until upstream and local riparian vegetation improves.

**Table 37: 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 | 459.4 | 391.6 |
| Acidity | pH | 6.5-9 | 8.21 | 8.4 |
| Alkalinity | (mg/L $CaCO_3$) | N/A | 200 | 190 |
| Dissolved Oxygen | (mg/L) | >4 | 7.75 | 0.98 |
| Turbidity | (NTU) | <10 | 19 | 19.1 |
| | | 2009-2010 | | |
| AUSRIVAS band | A, B, C D | C;B | C | C |

### *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. Conductivity, usually well above 250 µS/cm, has improved with the rains. With much of Yarralumla Creek confined to concrete drain lines, and the lower creek in horse paddocks, the severely impaired AUSRIVAS rating in May 2010 is unsurprising.

**Table 38: Values of Indicators sampled on Site 189 on Yarralumla Creek Downstream Curtin**

| Indicator | Units | Regulation limits | November 08 | April 09 |
|---|---|---|---|---|
| Conductivity | (µS/cm) | N/A | 111.9 | 258.4 |
| Acidity | pH | 6.5-9 | 8.44 | 8.62 |
| Alkalinity | (mg/L $CaCO_3$) | N/A | 230 | 280 |
| Dissolved Oxygen | (mg/L) | >4 | 3.3 | 4.9 |
| Turbidity | (NTU) | <10 | 8.1 | 6.5 |
| | | 2009-2010 | | |
| AUSRIVAS | A, B, C D | C;C | B | C |

*Yarralumla Creek, upstream of Cotter Road bridge with playing fields and Curtin in the distance*

### *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. Water quality at sampling times in this year was good, except for the alkaline pH.

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 spring 2009 was at severely impaired, it had risen to significantly impaired in autumn 2010, most probably in response to improved flow rate fluctuations and some related habitat rejuvenation as light sediments were flushed from the system.

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

**Table 39: 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 | 452.5 | 277.5 |
| Acidity | pH | 6.5-9 | 8.2 | 8.07 |
| Alkalinity | (mg/L $CaCO_3$) | N/A | 290 | 20 |
| Dissolved Oxygen | (mg/L) | >4 | 3.3 | |
| 11.67 | (NTU) | <10 | 8.1 | 6.5 |
| Turbidity | (NTU) | <10 | 8.1 | 6.1 |
| | | 2009-2010 | | |
| AUSRIVAS score | A, B, C D | C;B | C | B |

# SECTION 3: RESEARCH AND COMMUNITY ACTIVITIES

## Groundwater Resources in the ACT

Groundwater in the ACT is a rather small resource compared to surface water, because geologically the ACT sits on low yield fractured rock aquifers. 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.

The ACT Government has been rolling out more accurate groundwater assessments and broadening the extent of monitoring since 2002 as a response to a very substantial increase in demand and use of groundwater. 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, through abstraction, contamination or landuse change. 2010 will see an additional three monitoring bores constructed in Weston, Wanniassa and Kambah, recognised as areas coming under pressure.

DECCEW's Environment Protection and Water Regulation Branch currently maintains 14 dedicated monitoring bores, with information from another 6 sites coming from interested groundwater abstractors. These monitoring bores provide 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 that may enable us to quantify potential effects of changed rainfall patterns expected from climate change.

*Monitoring bores*

### *Urban Waterways Project*

The Canberra Integrated Urban Waterways project is funded by the ACT Government and the Commonwealth Government's Water Smart Australia Program. The Urban Waterways Project is delivered by DECCEW in partnership with the ACT Planning and Land Authority, and in collaboration with Territory and Municipal Services.

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 2011 with stormwater for irrigation. The project aims to meet a longer term target of 3 gigalitres per year of potable water substitution 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 and 2009-10. Development Application approvals were received for the construction of the Dickson and Lyneham Ponds in September 2010.

Three pilot projects have been identified to trial broad scale stormwater harvesting in the ACT:

- Inner North Stormwater Reticulation Network (Flemington Road Ponds and Dickson and Lyneham Ponds);
- Weston Creek Stormwater Reticulation Network (North Weston Pond); and
- Tuggeranong Stormwater Reticulation Network (Lake Tuggeranong and Isabella Pond).

The pilot projects 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.

2009 saw much engagement with the community, especially around the proposed stormwater harvesting ponds in the Sullivans Creek sub catchment located in Dickson and Lyneham. The construction and planting out of Banksia St Wetland in O'Connor has engaged the local schools and residents. Other initiatives include a package of curriculum material for schools on urban wetlands and their ecological and social implications.

### *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 MDB 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 (LCC) 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 LCC 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 previous years, were undertaken in 2009/10 including planting native tube stock, removing pine wildlings from the remaining ex-plantation areas, closure 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.

### *Threatened Fish in the ACT*

Monitoring of threatened fish species is conducted by the Conservation, Planning and Research unit of TAMS. Although 2009–2010 was the off-year for the biennial Murrumbidgee Fish Survey, fish surveying was completed on behalf of the Upper Murrumbidgee Demonstration Reach project, and as part of the environmental monitoring for the proposed Murrumbidgee to Googong (M2G) Water Transfer. Currently, joint research projects involving ACTEW, the University of Canberra (UC), the Australian National University (ANU) 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** (*Macquaria australasica*) were monitored in the Cotter River. Snorkelling surveys indicated higher larval numbers above Vanities Crossing, suggesting a breeding population has established above the Cotter Reservoir. UC is monitoring fish habitat, cormorant predation patterns and overall populations during the extensions to the Cotter Dam. Fluorescent marking trials have shown good numbers of year old young in Cotter reservoir.

**Trout Cod** (*Maccullochella macquariensis*) have been stocked in the ACT for the local conservation of the species since the 1980s. In 2009-2010, monitoring was undertaken on the Murrumbidgee River at Kambah Pool and the Cotter River at Bendora Reservoir. Juvenile fish were reported from Kambah Pool. One Trout Cod was recorded downstream of Bendora Reservoir, while both adults (one over 650mm long) and sub-adults were found in the reservoir.

**Two Spined Blackfish** (*Gadopsis bispinosus*) numbers were lower than 2008–2009, with this species found more frequently in the unregulated river above Corin Dam. In the unregulated section of the river recruits make up less than 6% of the catch. Ongoing low recruitment numbers remain a concern, even though the general population appears to be quite high. Higher percentages of recruits were found in the population below Bendora reservoir. UC research indicated that blackfish in Bendora reservoir are greater travellers than those in the river habitats, moving from sheltered habitats to feeding areas and back again in the night.

*PCL Staff backpack electro-fishing on the Cotter River in 2009. Photo Mark Jekabsons*

**Murray River Crayfish** (*Euastacus armatus*) are reported to be patchy in their distribution in recent reports from the ANU. Between 10 and 15 individuals were reported during recent instream work at Casuarina Sands (Murrumbidgee River) by Bulk Water Alliance/ACTEW.

As part of the Cotter Spillway Rescue in January 2010 during the Cotter Dam wall extension, 32 Macquarie Perch, 10 Murray Crayfish, 3 Murray Cod (*Macquaria peelii peelii*) and a number of turtles were rescued and moved to the Paddys and Murrumbidgee Rivers.

The Upper Murrumbidgee Demonstration Reach and M2G survey reported Macquarie Perch at Angle Crossing for the first time in five years. Year old young and adult Murray Cod were reported below Point Hut Crossing, together with Golden Perch (*Macquaria ambigua*) with a mean length of 400mm. Despite the good biodiversity of natives, European Carp (*Cyprinus carpio*) continue to make up 80–90% of fish biomass in the Murrumbidgee within the ACT.

The *Fish Stocking Plan for the Australian Capital Territory 2009-2014* was released in July 2009. The 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 plan includes information on the recovery and research of threatened species in the ACT.

## Upper Murrumbidgee River Demonstration Reach

The Upper Murrumbidgee River Demonstration Reach (UMDR) 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. Demonstration Reaches, usually having an emphasis on native fish and fish habitat, are part of the Commonwealth Government's *Caring for Our Country i*nitiatives.

The UMDR is releasing an implementation plan providing background for the reach, the major ecological assets within it, threats posed to them and measures for long term reduction of those threats. Those major ecological assets include: the native fish populations, notably those of several species nationally and regionally listed as under threat; riparian floodplain vegetation communities; threatened and migratory animals; aboriginal cultural heritage assets; and social, community and historic assets.

The primary threats presented include unsuitable environmental flow allocations, future diversions of water to support Canberra's growing population, reduced water yields in an arid landscape becoming more like rangeland with climate change, pollution,; and unsustainable use of surface and ground water.

Companion plans will include: a *Communications, Education, Participation and Awareness plan*; a *Monitoring and Evaluation* plan; and a *Carp Reduction plan*. A river based schools' education package, ***Sustaining River Life***, is ready for release.

### *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.

In 2009–2010 the UMCCC updated a very popular publication *Look After Your Natural Assets*, now in its third edition. Known throughout the region as the Landcare Book, it contains a wealth of information and contacts for rural and peri-urban landholders.

Two long-standing projects have been completed. *Willows Management – A Strategy for the Upper Murrumbidgee Catchment* and *UMCCC Peri-urban Weed Management Study – Exploring Agents of Change to Peri-urban Weed Management* are now available from UMCCC.

The UMCCC continues 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

Waterwatch is a nation-wide water quality monitoring program where the sampling and testing is done by community volunteers. 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 Governments, 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 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. And Waterwatch does more.

2009–2010 has been a very active year for the region. Out of involvement with the Upper Murrumbidgee Demonstration Reach program came the realisation that a Waterwatch Coordinator was needed in the Cooma area. Support from both ActewAGL and the NSW Department of Education and Training made this possible.

At least eight more sites were developed in the long established Catchment Group areas, and there are now close to 100 sites regularly monitored for water quality by a growing membership of volunteers. As usual, there were well attended volunteer training days and refresher days in both spring and autumn. Volunteers are accredited, and their data valued by the Territory Government and ACTEW/Bulk Water Alliance.

The three catchment groups with Waterwatch sites within the ACT now have so many reliable volunteers regularly sampling creeks and ponds, and the upper reaches of rivers throughout the region that they are producing Catchment Health indicator Reports, based on volunteer data. These reports can be found on the respective websites, or through links in the ACT Waterwatch website.

The Catchment Health indicators Program (CHiP) covers more than Water Quality, with inputs on riparian condition at sites, macroinvertebrate surveying in autumn and spring, Frogwatch data and a locally devised Conspicuous Algal Rating sent in from sites throughout the region. While limited by the basic equipment supplied to volunteers and constraints on their time, these CHiP reports provide a valuable background to the annual ACT Water Report. The public education program has also expanded in 2009–2010. Partnerships with the Scouting movement and the Australian National Museum have engaged many young people. The on-going schools and education program now offers a choice of 24 lessons that Waterwatch can bring to the class-room. There are now teacher's resources, storybooks to engage children's interest in water life, and information to support community on-ground programs.

*Engaging with children*

### *Platypus Count*

Platypus Count, a joint venture of Waterwatch with the Australian Platypus Conservancy, has been going for two years in the region. It has brought people from widely different backgrounds together, all contributing to Platypus Count (regular reports from specified sites), Platypus Watch (surveying potential sites for platypus and water rat populations) and Platypus Survey (gathering records from past encounters with platypus).

### *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 2009, well over 200 Frogwatch participants monitored frog populations at 161 sites, 117 within the ACT and 44 in the region. A total of 10 different frogs were detected in the region, with numbers and distribution of all but the Whistling Tree Frog being up on October 2008.

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 2009* offers detailed information about 10 of the local frog species, their populations and distribution as mapped during this reporting period.

### *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.