

Catchment Health Indicator Program

2016–17



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This report was written using data collected by over 200 Waterwatch volunteers. Many thanks to them.

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The views and opinions expressed in this document do not necessarily reflect those of the ACT Government or Icon Water.

For more information on the Upper Murrumbidgee Waterwatch program go to:

<http://www.act.waterwatch.org.au>

The Atlas of Living Australia provides database support to the Waterwatch program. Find all the local Waterwatch data at: <http://root.ala.org.au/bdrs-core/umww/home.htm>

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Executive Summary

Upper Murrumbidgee Waterwatch (Waterwatch) works with the community to monitor, raise awareness, educate, restore and protect our local waterways. Waterwatch has been running in the ACT region since 1995 and covers the Murrumbidgee catchment upstream of Burrinjuck Dam (with the exception of the Goodradigbee catchment). The total area monitored by Waterwatch is more than 11,400km².

Two primary functions of the Waterwatch program are to facilitate community engagement through the monitoring and care of local waterways, and to use the data (water quality, macroinvertebrate [water bug] and riparian condition) as an early warning system for aquatic ecosystem health issues. A key output of this program is the annual Catchment Health Indicator Program (CHIP) report, which provides a numerical score of catchment health displayed in individual reach report cards, using data collected by Waterwatch volunteers.

The 2016-2017 CHIP report is based upon 1,861 water quality surveys, 199 water bug surveys and 210 riparian condition surveys conducted by over 200 volunteers! The total number of sites surveyed has decreased from 243 to 222 with a total of 94 reach report cards produced. While there has been a reduction in surveys conducted, the variation has not been as substantial as in the three preceding CHIP reports when the report was growing. We are now seeing numbers plateau as we find the optimum numbers of sites within our current capacity and to satisfy the requirements of the CHIP methodology.

There were no new reaches created in this CHIP year and Castle Hill Creek in southern ACT was withdrawn. The key reach of CMM11 on the Murrumbidgee immediately downstream of the Molonglo River confluence near the new Ginninderry development on the ACT/NSW border was data deficient due to access issues, but will be reinstated during this coming CHIP period. A new reach for the Yass township has recently been set up on the Yass River and will feature in the 2017-18 CHIP report. The Yass catchment continues to be an area for growth for Waterwatch and its inclusion in the CHIP supports the notion that Waterwatch is a truly regional program.

Of the 94 reaches presented in this report (Table 1), five were scored as in 'excellent' condition. One reach in the Molonglo catchment plus two each in Cooma and Southern ACT. 45 reaches were scored as being in 'good' condition, six more than last year and is the most common health score given, with Cooma contributing the most reaches to this category. Forty-two reaches were in 'fair' condition, six down on last year, and only two reaches received a 'poor', one in Ginninderra and the other in Molonglo, which is four less than last year.

Table 1: CHIP results for 2016–2017.

CHIP Result	Cooma	Ginninderra	Molonglo	Southern ACT	Yass	Total
Excellent (A)	2	0	1	2	0	5
Good (B)	15	3	12	13	2	45
Fair (C)	6	9	12	12	3	42
Poor (D)	0	1	1	0	0	2
Degraded (E)	0	0	0	0	0	0

While it may be tempting to celebrate the general improvement in scores for CHIP 2016-17, it is important to remember that year-to-year variation (primarily driven by climatic processes) plays a major role in changes to CHIP scores. The very wet Winter and Spring and the follow-up rains of late Autumn would have had a significant positive impact on water quality data as well as the water bug scores. It is intended that presenting long term trends will become a key feature of future CHIP reports.

Another factor that may have played a small part in the improved scores was the improved water bug techniques adopted by the Waterwatch staff over the past year. The team were lucky enough to have coaching last October with water bug expert, John Gooderham, aimed at improving our knowledge and methods for conducting water bug surveys. On top of some great knowledge building, John helped show the staff some great techniques for negotiating the all too common issue of silted up urban wetlands. The Waterwatch staff are now managing to capture the bugs in the net while leaving the majority of silt/algal scum in the water body. This has greatly improved detection rates in some of our more degraded systems.

While the scores have improved, the upper Murrumbidgee catchment suffered, as it did during the same time last year, from low dissolved oxygen events during an extremely hot, dry spell in Summer and early Autumn. 46 reaches this year received a 'degraded' score for dissolved oxygen (DO) – the worst of any water quality parameter. Temperature and DO levels are intrinsically linked as the warmer the water gets, the less capacity it has to hold oxygen. This has potential to be a greater problem in waterways with poor streamside shading, as their temperatures fluctuate dramatically, and in warmer seasons, lead to significant drops in DO, potentially stressing aquatic life. Conversely, when a waterway is overloaded with nutrients and algae, the algae grows rapidly producing lots of oxygen in the process. This can result in super saturation with waterways sometimes measuring 120% DO saturation which is also considered 'degraded'. These can have a negative effect on our aquatic life and are all signs of waterway disturbance.

Issues such as weeds, the lack of both native riparian and in-stream vegetation in our rural and urban catchments as well as the importance of maintaining groundcover, are all major factors contributing to poorer health. Revegetation of river corridors, and maintaining groundcover on a broader scale, would not only reduce sediments and nutrients entering the system and stabilise dissolved oxygen levels, but provide valuable habitat for water bugs and other aquatic species.

The Rise of the CHIP

Waterwatch continues to work hard to promote the CHIP to government and community organisations involved in managing our waterways. The success of this is evident in the increased uptake of the CHIP, and the Waterwatch data more broadly, over recent years. Waterwatch data has gone from being an underutilised dataset on the fringe to one that sits within an integrated monitoring framework for the ACT region and the CHIP has played a major role in communicating that data. Some examples include:

- A successful \$100,000 NSW Environmental Trust Grant was obtained by the Snowy Monaro Regional Council in 2016 for restoration works on the Cooma Creek. The grant contained a combination of Platypus data obtained during Waterwatch's Platypus Month and the results on Cooma Creek from the CHIP report.
- The next ACT State of the Environment report is moving towards an international 'environmental accounting' approach. Waterwatch data is being used as a 'proof of concept' as the CHIP data analysis process is highly amenable to this kind of approach.
- The Capital Metro project used Waterwatch data to help establish a historic baseline along the project alignment; and
- Within the ACT Government's Environment Division, the Biodiversity, Research and Monitoring Program, the Conservation Effectiveness Monitoring Program as well as the draft ACT Integrated Water Monitoring Plan all include Waterwatch data.

The 2016-2017 CHIP report would not have been possible without the generous financial support from ACT government, in partnership with the Australian government, through the ACT Healthy Waterways Program and from Icon Water.

Thank you, as always, to the volunteers. This report would not be possible without their continued efforts to collect this important data on the health of our waterways. The CHIP continues to rise in profile and be used by more catchment managers and policy makers. The continued collection of large amounts of high quality data is a real credit to the dedication of the volunteers who have demonstrated that with support, they can make a significant contribution to the improvement of our waterways.



Introduction

Upper Murrumbidgee Waterwatch

Upper Murrumbidgee Waterwatch (Waterwatch) engages with the community to monitor, raise awareness, educate, restore and protect our local waterways. Waterwatch has been running in the ACT region since 1995 and covers the Murrumbidgee catchment upstream of Burrinjuck Dam, with the exception of the Goodradigbee catchment. The total area monitored by Waterwatch is more than 11,400km².

Four Waterwatch co-ordinators support volunteers in the major sub-catchments of Cooma, Molonglo, Southern ACT, Ginninderra and Yass (see Figure 1). Each of these sub-catchments will make up sections I – V of this report. This year Yass has five report cards, and will be an area of growth over the foreseeable future.

As at 30 June 2017, Waterwatch had 222 active sites being monitored by over 200 volunteers. Waterwatch thanks the generous funding from the ACT government, in partnership with the Australian government, through the ACT Healthy Waterways (Basin Project) as well as funding for the Cooma Region through Icon Water. The Atlas of Living Australia also provides support through the maintenance of the database used by the Waterwatch program. At the time of writing this report, the database houses over 23,000 Waterwatch records.

The purpose of the CHIP

The Waterwatch annual report card is called the Catchment Health Indicator Program (CHIP), based upon the data collected by volunteers throughout the preceding year. The purpose of the report is to give the community a better understanding of water quality and riparian health issues in the catchment as well as providing an ongoing baseline assessment of catchment health to assist natural resource managers and policy-makers in addressing some of these issues. The CHIP is recognised in the ACT Water Strategy 2014-44 as a way to *'Enhance knowledge and spatial planning for water and catchment management'*.

How does the CHIP work?

Waterwatch volunteers and co-ordinators collect data relating to water quality, water bugs (macroinvertebrates), and riverbank (riparian) vegetation. The frequency of this data collection is outlined in Table 2. These data sources provide the basis for a composite CHIP score that encompasses physico-chemical properties of water, in-stream water bug diversity and abundance, and riparian vegetation condition. When combined for an individual stretch of waterway (a reach), the data gives us a score that indicates the overall health of that reach. This CHIP score is linked with a colour to produce maps of reaches at both an individual and sub-catchment scale. Importantly, each individual reach map is accompanied by a report card written by the local co-ordinator. This provides further insight into the state of that reach and possible issues influencing the score. Data from other Waterwatch initiatives such as *Platypus Month* and *Carp Love 20°C* are also used in these report cards to provide greater context.

Technical details regarding the computation of CHIP scores is provided in Appendix II.

Table 2. Summary of data collected to produce the CHIP.

	Parameter	Frequency	Number of sites
Water Quality	pH	Monthly	All sites
	Electrical Conductivity	Monthly	All sites
	Turbidity	Monthly	All sites
	Phosphorus	Monthly	All sites
	Nitrate	Monthly	All sites
	Dissolved Oxygen	Monthly	All sites
	Temperature	Monthly	All sites
Macro-invertebrates	SIGNAL 2.0	Biannual (Spring & Autumn)	Key sites (min 1/reach)
Riparian Condition	RARC	Biennial	All sites

Figure 1. Overview of the Upper Murrumbidgee River catchment, outlining the five major sub-catchment areas represented in this report. Goodradigbee is not included in this report.



2016–2017 CHIP

The 2016-2017 CHIP report is based upon 1,861 water quality surveys, 199 water bug surveys and 210 riparian condition surveys conducted by over 200 volunteers! The total number of sites surveyed has decreased from 243 to 222 with a total of 94 reach report cards produced. While there has been a reduction in surveys conducted, the variation has not been as significant as in the three preceding CHIP reports when the report was in a period of growth. We are now seeing numbers plateau as we find the optimum numbers of sites that can be managed within our current capacity and to satisfy the requirements of the CHIP methodology.

Thank you, as always, to the volunteers. This report would not be possible without their continued efforts to collect this important data on the health of our waterways. The CHIP continues to rise in profile and be used by more catchment managers and policy makers. The continued collection of large amounts of high quality data is a real credit to the dedication of the volunteers who have demonstrated that with support, they can make a significant contribution to the improvement of our waterways.





Cooma Region Catchment Facts

The Cooma Region includes the upper Murrumbidgee River south of the ACT, the Bredbo, Numeralla, Kybayan and Badja River sub catchments. Landuse in the Cooma Region includes urban, rural residential, rural (grazing and cropping) and conservation. The lower lying, more fertile areas of the catchment are generally cleared and modified with more intensive landuse and limited native riparian vegetation.

Local landcare and fishing groups are working to restore river health in the Cooma Region via erosion control works, riparian planting, returning woody debris for fish habitat, native fish stocking and removing Carp. Groups involved include the Numeralla, Bredbo and Michelago Landcare Groups and the Numeralla and Bredbo Fishing Clubs.

The Actions for Clean Water (ACWA) Plan sets out a strategy for improving water quality (targeting turbidity) in the upper Murrumbidgee catchment. It identifies the Numeralla and Bredbo Rivers as high priority catchments where erosion risk was assessed to be very high. The plan also maps point source erosion sites throughout the catchment.

The Cooma Monaro LGA Comprehensive Koala Plan of Management also identifies the Numeralla, Badja and Bredbo River catchments as significant koala habitat. Riparian connectivity and ribbon gum stands are important elements of this habitat.

Small yet resilient native fish populations are also found in the catchment including Murray cod, Trout cod, Macquarie perch and Mountain galaxias. Macquarie perch are endangered yet occur in the Murrumbidgee River, and have been the subject a PhD research project investigating the habitat requirements and environmental cues for spawning in this species. The Upper Murrumbidgee Demonstration Reach (UMDR) initiative supports the recovery of native fish populations in the upper Murrumbidgee River with a focus on the upper Murrumbidgee River between Bredbo in NSW and Casuarina Sands in the ACT.

Waterwatch volunteers have been monitoring river health in the Cooma Region since 2010.



Cooma Catchment Health Summary

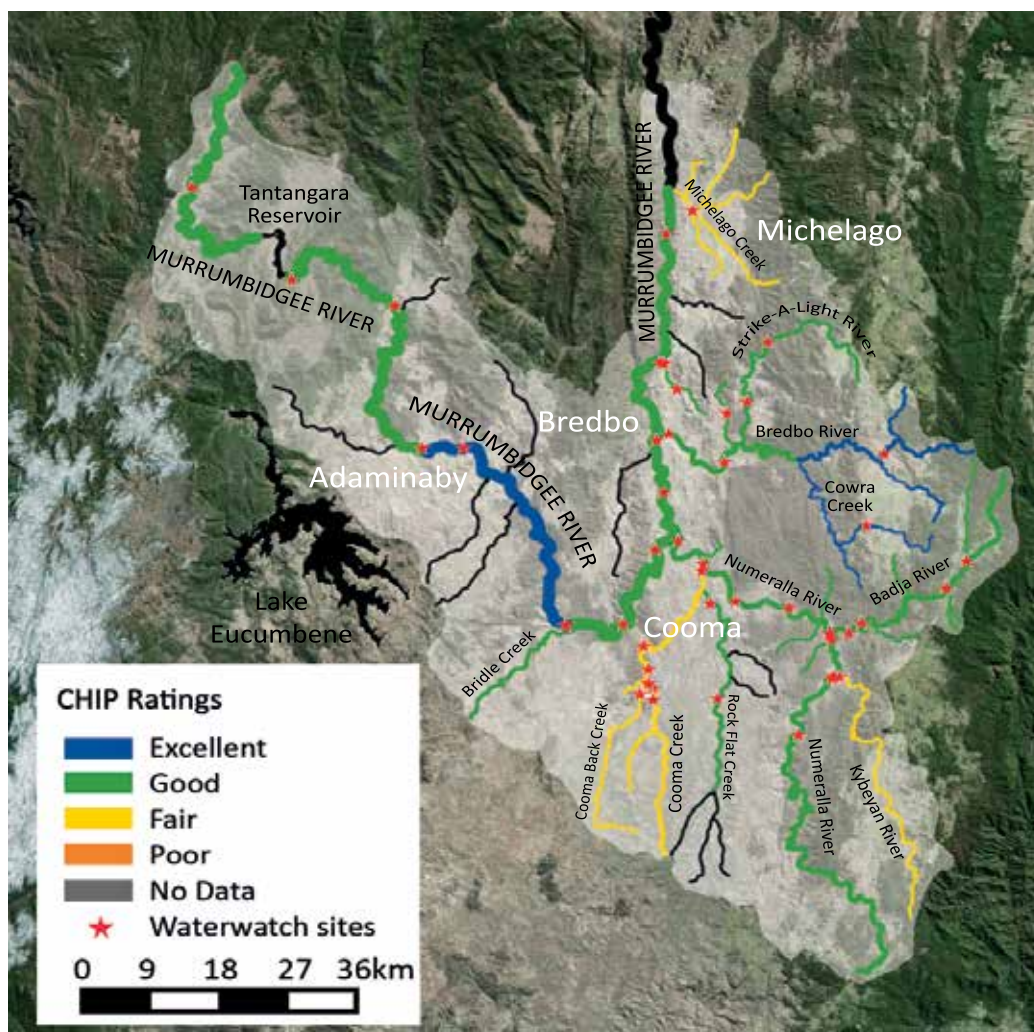
This year's results show that health scores have improved overall compared to last year. Notably the urban reach of the Cooma Creek has improved from poor to fair, although it still rates as the worst scoring reach in the Cooma Region. Four reaches recorded a decrease in catchment health indicator scores with notable decreases in BAD1 (Badja River above Undoo Creek) from excellent to good and KYB1 (Kybeyan River) from good to fair.

Seasonal conditions are likely to have partly influenced results. For example, a wet Spring ensured good stream flows supporting aquatic processes including abundance and diversity of water bugs. In contrast, dry conditions over summer showed low dissolved oxygen linked to warm temperatures and low flow conditions. The Autumn water bug surveys showed stoneflies were consistently absent in samples across the region until later in the survey season, which could have been linked to the dry, hot Summer. Our water bug surveys require the presence of stoneflies, mayflies and caddisflies to achieve an 'excellent' score.

Seasonality aside, our waterways are likely to show improvement in the coming years due to work being carried out in the catchment. The Upper Murrumbidgee Demonstration Reach (UMDR) Rivers of Carbon Upper Murrumbidgee River project is improving stream condition via woody weed control, fencing and riparian revegetation to protect and connect high quality native fish habitat downstream of Bredbo.

The Cooma creeks will benefit from the 'Improving Cooma Creeks' project, funded by the NSW Environment Trust, via woody weed control, stabilising an erosion site and revegetation which will also protect a known Platypus breeding site.

Our data is being enhanced thanks to the efforts of our hardy Platypus Month survey volunteers who participated in twelve surveys over four sites during August 2016. Ten individual Platypus and two native Water rats were recorded in total. Carp sightings continue to be recorded via FeralFishScan, capturing six Carp breeding events during Spring in the Cooma catchment. The Numeralla, Bredbo and Alpine Hotel Anglers fishing clubs continue to target Carp numbers at their local fishing spots via annual Carp Outs.



Badja River BAD1

Headwaters to Undoo Creek

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result A (Excellent)

Parameter	Rating	No. Survey
Water quality	Excellent	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Water bug	Good	3
Riparian condition	Good	2

Reach Facts

Reach network length: approx. 51km

Dominant land uses: Rural and conservation

This reach includes the headwaters of the Badja River down to and including Undoo Creek. The headwaters of the Badja River rise in the Badja Swamps Nature Reserve which include the nationally-listed Big Badja Swamps. The top of the reach flows through open, historically cleared country then on through steeper, uncleared areas with good native vegetation cover.



Reach Condition

Water quality was 'excellent' overall, reflecting the intact in-stream and riparian habitat found in this reach. The hot dry Summer reduced flows, lowered dissolved oxygen levels linked with warmer water and resulted in more concentrated levels of electrical conductivity and phosphorous.

This strong seasonal influence may also have been a driver for reducing water bug results for this reach, in turn affecting the overall CHIP score. The surveys found lower than expected stonefly numbers in the Badja River, but this reach remains notable for the abundance and diversity of other sensitive water bug types such as caddisflies and low numbers of very pollution-tolerant bugs.

Riparian condition was 'good' overall, due to native vegetation with shrub and canopy layers, high levels of ground cover and habitat features such as native tussocks and logs. Carp sightings are not recorded in this reach. Trout have been sighted.



Peppers Creek at PEP050.

Badja River BAD2

Undoo Creek to Numeralla River confluence

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B+ (Good)

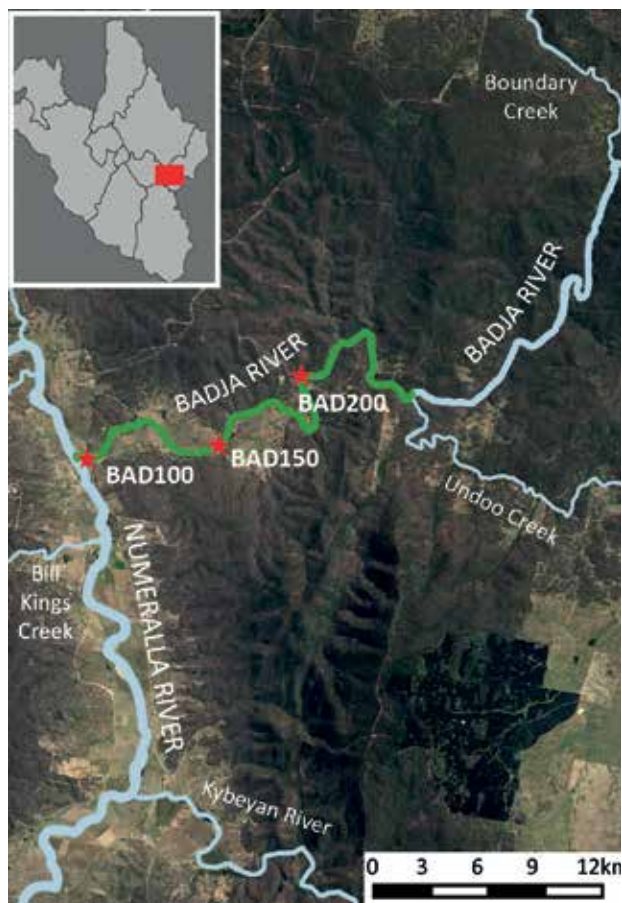
Parameter	Rating	No. Survey
Water quality	Excellent	29
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Good	3

Reach Facts

Reach network length: approx. 8.6km

Dominant land uses: Rural and rural residential

This reach includes the lower section of the Badja River from Undoo Creek to the Numeralla River confluence. It flows through open, cleared country used predominantly for grazing (sheep and horses) and some dryland cropping. Continuous native vegetation is found in the riparian zone on both sides of the river along the entire reach.



Reach Condition

Water quality continues to be 'excellent' in this reach, likely due to good in-stream habitat and riparian zones along this reach. A hot and dry Summer was associated with high water temperatures, low water levels, low dissolved oxygen and elevated electrical conductivity levels (130µS/cm - twice usual levels for this reach).

Water bug surveys were 'good' but show less diversity and abundance of the pollution-sensitive types such as mayfly and stonefly nymphs compared to the reach upstream – particularly during the Spring survey at the confluence (BAD100) when only seven bug types were caught. Both surveys had a dominance of the more tolerant fly larvae which may have benefited from the sandy deposits on the bottom of the main pools at the survey sites.

Willows and Blackberry have been controlled over the last two year by Numeralla Landcare and this has improved riparian condition.

The introduced Carp and Trout are regularly sighted in this reach but, in better news, so too are Platypus and Water rats.



Aerial shot of the Badja River at BAD100.

Bredbo River BRD1

Headwaters to Cowra Creek confluence

2015/16 CHIP Result A- (Excellent)

2015/16 CHIP Result B+ (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	13
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Water bug	Excellent	2
Riparian condition	Good	2

Reach Facts

Reach network length: approx. 33km

Dominant land uses: Rural

This reach includes the Bredbo River catchment down to and including Cowra Creek. This reach runs through a mix of unmodified vegetation and cleared, grazing country. Small areas of pine plantation have also been established in the catchment.

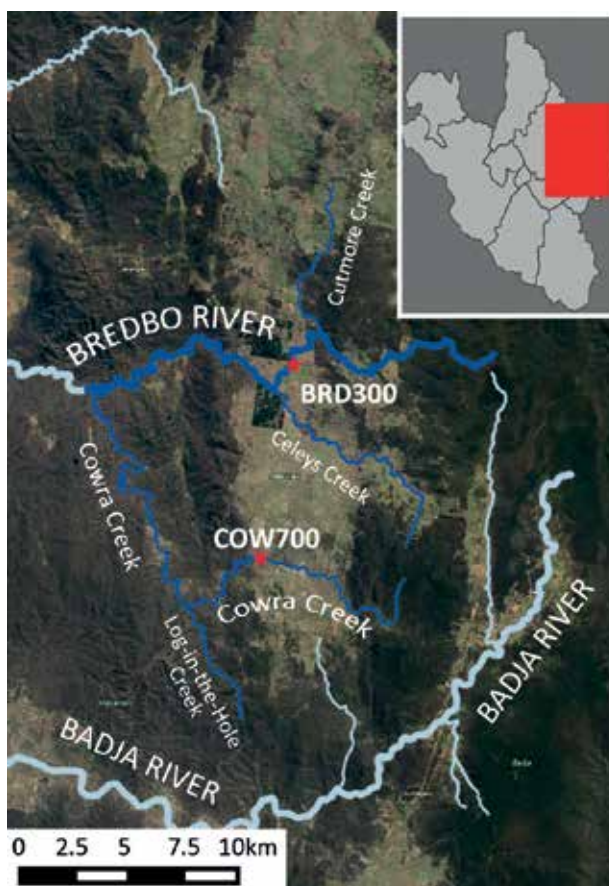
Reach Condition

Water quality continues to be 'excellent' for this reach. Volunteers here need to be of the hardy variety as a number of the waterways were reported as partially frozen over the Winter months. Cowra Creek was noted as being under 4cm of ice in June 2017!

Riparian zones with good native vegetation to the edge of the waterway provide a filtering and cooling effect. This is shown in water quality surveys which always observe the water to be 'crystal clear' and have better dissolved oxygen levels than other reaches with less vegetation. This is because cooler water has the potential to hold more dissolved oxygen.

The water bug surveys support the water quality findings, which found five different types of caddisflies and three types of mayflies. Such diversity within these two very sensitive bug types is an indication of excellent stream health.

Carp are recorded in the Cowra Creek catchment, but not in the upper Bredbo River. Platypus have been sighted.



Cowra Creek (COW700) at Peakview Rd - frozen over!

Bredbo River BRD2

Cowra Creek to Murrumbidgee River confluence

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	Good	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 25km

Dominant land uses: Rural including dryland cropping and grazing

This reach includes the Bredbo River from below Cowra Creek to its confluence with the Murrumbidgee River and includes a site on Cappauna Creek. The lower end of this reach has flat, wide floodplains which are used for dryland cropping and grazing. These areas are highly modified and native riparian vegetation is limited. This reach is a high priority ACWA catchment with five key erosion sites occurring in this reach.



Reach Condition

Degraded dissolved oxygen levels in this reach reflect limited shading and a shallow channel from sediment eroding from the catchment. This results in higher water temperatures which reduce dissolved oxygen levels. Electrical conductivity is high, in part due to the naturally high inputs of Cappauna creek (390-980µS/cm) as well as landuse in the catchment.

Riparian zones are dominated by exotic vegetation such as African Lovegrass, Blackberry, Poplars and Willows, which are more resilient to establish in modified sites. Large (native) reed beds are starting to establish in-stream which indicates that the reach is stabilising over time.

Introduced Eastern gambusia and Carp are reported in high numbers. The latter are the target of 'Carp out' events held by the Bredbo Fishing Club.

Bredbo Landcare is rehabilitating riparian zones at the bottom of this reach as part of their Two Rivers Wattle Park Drive project.



Autumn (obviously!) water bug survey on the lower Bredbo River at BRD010. (Photo: J.Koehler)

Cooma Creek C001

Headwaters to Banksia Lane

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C (Fair)

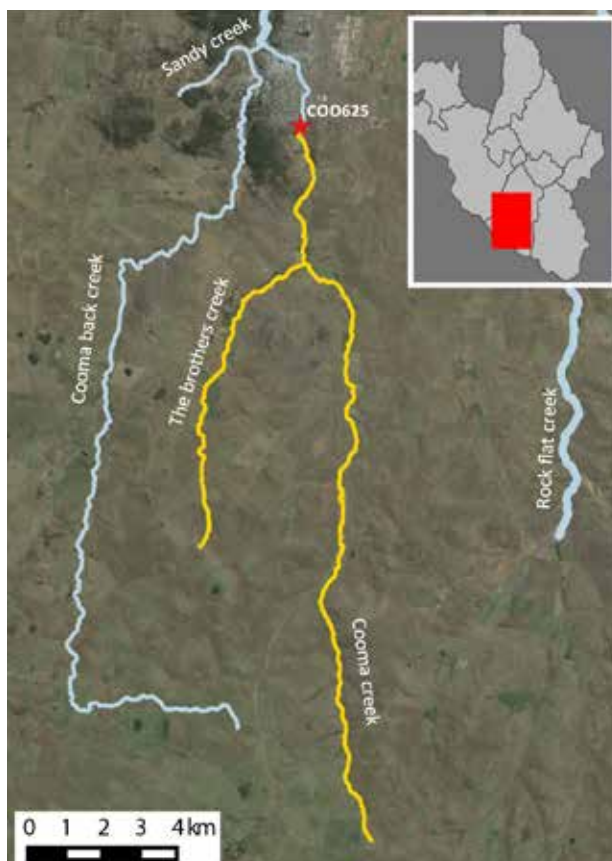
Parameter	Rating	No. Survey
Water quality	Good	11
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 22km

Dominant land uses: Rural and urban

The headwaters of Cooma Creek rise south of Cooma and flow through open, basalt country. The fertile floodplains in this reach are used for dryland cropping and grazing agriculture. Dense and extensive in-stream vegetation (reeds/sedges) that are beneficial for stability and nutrient retention, are largely absent in this reach.



Currently this reach is monitored at only one site at the bottom of this reach. An additional site upstream is desirable to increase data confidence.

Reach Condition

This reach has improved slightly from last year with electrical conductivity is naturally elevated due to the geology of the catchment.

Riparian condition throughout this reach is poor, lacking native vegetation. Stock has access to the waterway, which is also reducing in-stream vegetation. These factors are likely to have influenced water quality results.

Very tolerant water bug types such as fly larvae, segmented worms and snails were found in high numbers which indicate a site where organic matter (possibly from Willows at the survey site) has accumulated. Other bug types present were waterboatmen which are more tolerant due to the fact that they can fly away when conditions become unsuitable.

Despite the degraded habitat, no Carp have ever been recorded in this reach.



Cooma Creek adjacent to the Myalla Road.

Cooma Creek COO2

Banksia Lane to Cooma Back Creek confluence

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result D+ (Poor)

Parameter	Rating	No. Survey
Water quality	Fair	15
pH	Good	
Turbidity	Fair	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Poor	
Water bug	Good	2
Riparian condition	Degraded	2

Reach Facts

Reach network length: approx. 3km

Dominant land uses: Urban

This reach includes the section of the Cooma Creek that flows through the township of Cooma. Flood mitigation works have been carried out to protect urban assets in times of high flows. Stormwater from the town is discharged into the creek untreated. Litter from stormwater drains is an ongoing problem. There is a popular walking path along the length of this reach.



Reach Condition

This is the most urbanised reach and the low scores are likely due to the effects of stormwater sources which enters the creek untreated. The reach has consistently high phosphorous and nitrate scores which leads to the thick algal overgrowth observed in this reach during hot conditions. Electrical conductivity is high due to combined effects of catchment geology (natural) as well as urban runoff (indicating pollution).

Water bug surveys were dominated high numbers of freshwater snails, fly larvae and segmented worms which are known for their tolerance of organic matter pollution.

Litter is often sighted which could cause a risk for Platypus and Water rats which have been sighted in this reach.

Frogwatch surveys were conducted on this reach, which noted a decline in frogs calling after mowing occurred in the riparian zone.



Volunteer Matthew Kent on Cooma Creek clean up day - March 2017.

Cooma Creek C003

Cooma Back Creek to Numeralla River confluence

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

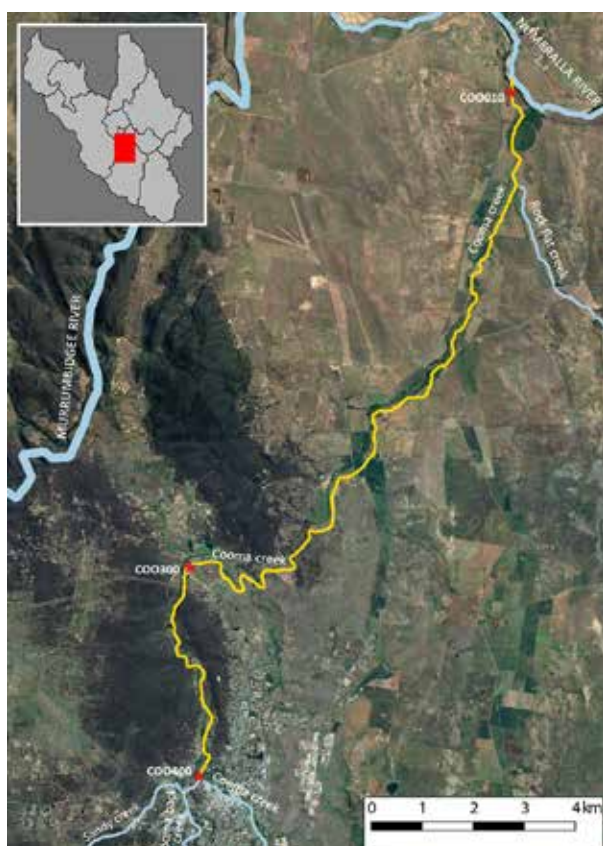
Parameter	Rating	No. Survey
Water quality	Fair	23
pH	Good	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Good	3
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 18km

Dominant land uses: Conservation, rural residential and rural

This reach includes the Cooma Creek downstream of Cooma to its confluence with the Numeralla River. The reach is flanked by the North Ridge Nature Reserve at its upper end, then flows through more open, rural residential holdings (in the Mittagang Road area) and finally through the open rural area of Bunyan which is dominated by river flats used for irrigated cropping.



Reach Condition

Water quality is consistently high in phosphorous, nitrate and electrical conductivity, influenced by the geology of the catchment as well as urban inputs upstream. Litter washed down from Cooma is now reported throughout the top of this reach.

The riparian zones are highly modified due to historic clearing, floodplain cultivation and stock access, especially at the lower end of the reach. This reduces buffering capacity of riparian zones and increases erosion risk which in turn adversely affects water quality.

There is a Platypus group survey site at the top of this reach. In surveys conducted last August as part of Platypus Month, there were confirmed sightings of two Platypus suspected to be a breeding pair. Riparian vegetation is being planted at the survey site as part of the 'Improving Cooma Creek' project, funded by the NSW Environmental Trust. Frogwatch surveys have also been conducted on this reach.

Schools of fingerling Carp have been seen midway up this reach.



Cooma Creek at Chakola.

Cooma Back Creek COB1

Headwaters to Cooma Creek confluence

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C (Fair)

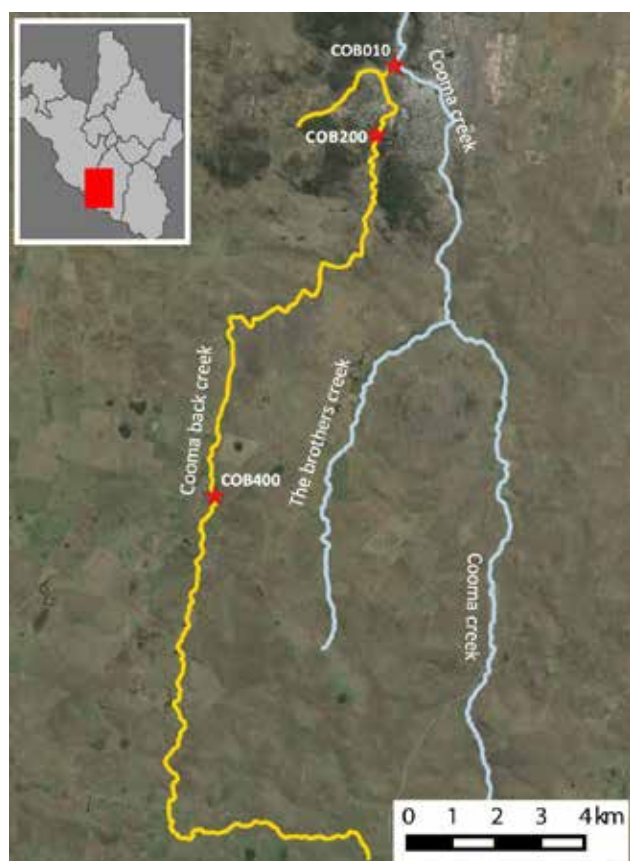
Parameter	Rating	No. Survey
Water quality	Good	21
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Poor	
Water bug	Good	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 30km

Dominant land uses: Conservation, urban, rural residential and rural

This reach includes the Cooma Back Creek and tributaries, including Jillimatong and Sandy Creeks. The upper sections of the reach are surrounded by predominantly rural landuse with open cleared country. The urban section of the reach (lower) includes the Lambie Gorge area which is a site of European and Aboriginal cultural significance.



Reach Condition

The water in this reach is always reported as very clear, but phosphorous levels can be elevated, especially at sites within Cooma. Volunteers report that at times there can be 'long (algal) streamers present' resulting from higher phosphorous levels. Litter is noted at the lower end of the reach.

Water bug surveys found that pollution-sensitive types such as stoneflies were low in numbers while snails, segmented worms and flatworms were in high numbers. The latter are known to thrive on high levels of organic matter likely resulting from the leaf fall of deciduous introduced trees, urban stormwater and reduced buffering of riparian zones.

The NSW Environmental Trust funded 'Improving Cooma Creeks' project will improve riparian zones via the removal of introduced trees and replanting native vegetation below Lambie Gorge.

Frogs are being monitored in this reach and Platypus have been sighted.



Volunteer Alison Howell monitoring at Kiah Ave at COB200.

Gungoandra Creek GUD1

Headwaters to Murrumbidgee River confluence

2016/17 CHIP Result B (Good)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	22
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Water bug	Excellent	2
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 9km

Dominant land uses: Rural and conservation

This reach includes the entire Gungoandra Creek which flows into the Murrumbidgee River downstream of Bredbo Gorge. The upper section of the creek has been cleared and is grazed, while the lower section runs through Bush Heritage Australia's Scottsdale Reserve. Revegetation is occurring on the Reserve in the creek's catchment area and stands of in-stream macrophytes are continuing to establish.



Reach Condition

Volunteers report that the water in this creek is usually 'crystal clear'. Phosphorous and nitrate are consistently low and electrical conductivity is consistently high, ranging between 480-1090 μ S/cm. As long standing volunteers Bob and Jenny Cooper have observed, electrical conductivity increases after rain which is the reverse of what is expected usually becoming more concentrated during low flows. This is due to groundwater flushing carbonates out of the soil geology of the catchment.

Thick stands of reeds and rushes have been establishing along the length of the creek throughout Scottsdale Reserve and this has very positive benefits for water quality. Good water bug scores and low algal growth throughout the year supports this.

Riparian areas will be improved resulting from the 'Rivers of Carbon Upper Bidgee' project planting at the bottom end of this reach. Platypus, Water rats, Eastern long necked turtles and small native fish have been sighted as well as the introduced Carp.



Volunteers Bob and Jenny Cooper at Gungoandra Creek.

Kybeyan River KYB1

Headwaters to Numeralla River confluence

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result B (Good)

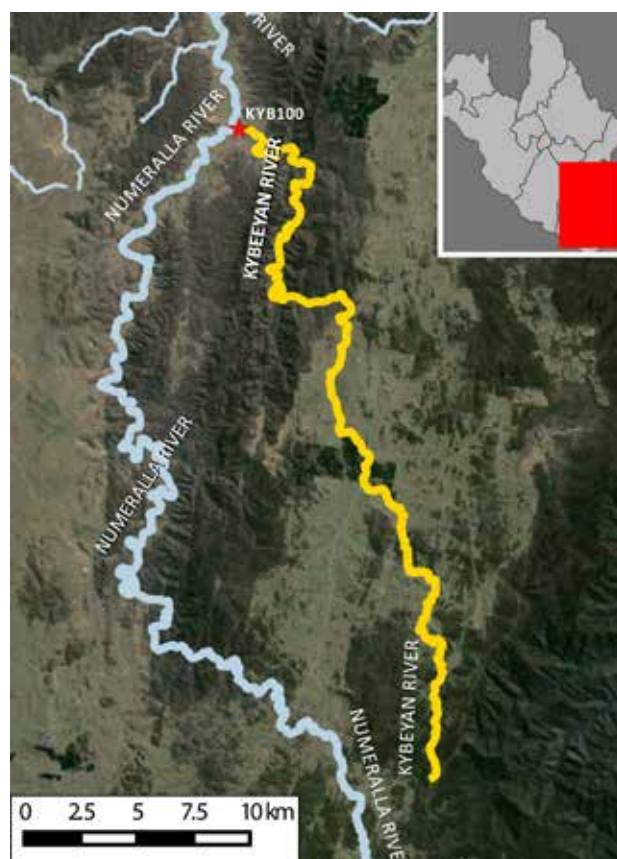
Parameter	Rating	No. Survey
Water quality	Good	9
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 49km

Dominant land uses: Rural

This reach includes the entire Kybeyan River catchment. This reach is characterised by both rural (grazing) country towards its headwaters, from where it flows through steep, unmodified country (including the Kybeyan State Conservation Area) to join the floodplains of the Numeralla River at its confluence. The lower floodplains of the reach are utilised for both grazing and cropping purposes.



Reach Condition

Reach condition has declined this year due to poor water bug and riparian condition scores recorded for the site. Water bug surveys found an absence of the very sensitive stoneflies in both spring and Fall, which was in contrast to other sites across the Cooma Region.

The hot dry Summer affected water quality in the Kybeyan River which showed electrical conductivity double their normal values, dissolved oxygen dropping and phosphorous increasing with low water levels.

Riparian condition is influenced by the presence of exotic canopy species such as Poplars. There is a small verge of native teatree and reeds establishing, however this is grazed where stock are allowed to access the stream.

There were very high numbers of juvenile Carp caught just upstream of this site during the Numeralla Fishing Club Carp Out in January. No Platypus sightings have been recorded for this year.



The Kybeyan River just above the confluence with the Numeralla River.

Michelago Creek MIC1

Headwaters to Murrumbidgee River confluence

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

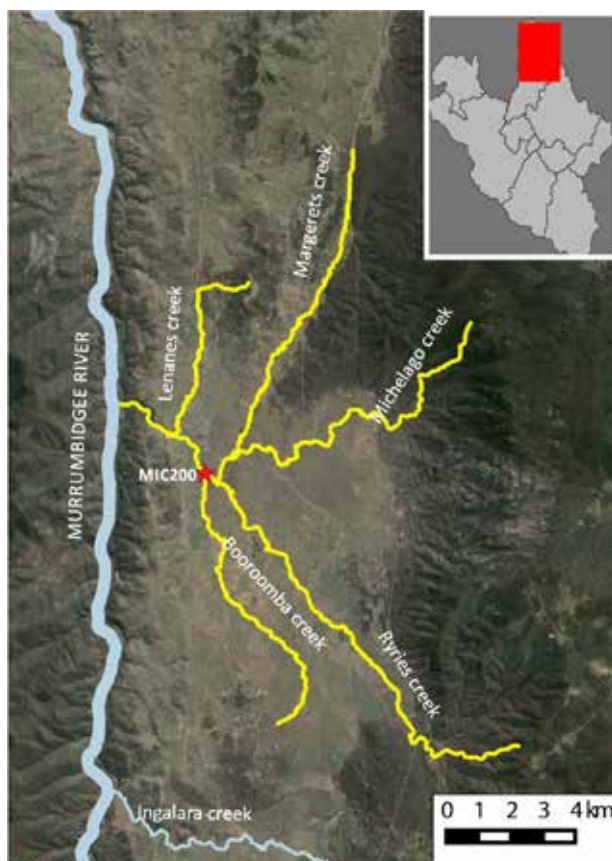
Parameter	Rating	No. Survey
Water quality	Good	7
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Fair	1
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 55km

Dominant land uses: Rural, rural residential and conservation

This reach includes the Michelago Creek catchment including the Margarets and Ryries Creeks. The upper reaches of these creeks retain native, unmodified vegetation. The lower reaches flow through open, historically cleared country predominantly used for grazing and rural residential purposes (in and around the village of Michelago).



Reach Condition

Water quality is influenced by high electrical conductivity values, which is partly related to the geology of the catchment. High algal growth is observed in-stream, especially during Summer and Fall.

Riparian zones have reduced native canopy vegetation and understorey, which is being addressed by the Michelago Landcare group via Willow control works, riparian plantings and streambank stabilisation along the Creek. Large reed beds are establishing in-stream and this is having stabilising and filtering effects. Where stock have uncontrolled access to the creek less in-stream vegetation is found and this will negatively influence water quality.

Carp have not been recorded along the Creek, however large numbers of the pest fish Eastern gambusia can be seen in the shallows in Summer. Small numbers of juvenile native Mountain galaxias were observed during water bug surveys.

This reach currently has only one site and we are looking for more volunteers to monitor upstream.



Michelago Creek - upstream of Michelago village.

Murrumbidgee River CMM1

Headwaters to Tantangara Dam

2016/17 CHIP Result B+(Good)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	7
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Poor	
Water bug	Good	3
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 53km

Dominant land uses: Conservation

This reach is the Murrumbidgee River from its headwaters to the Tantangara Dam wall and is wholly within Kosciuszko National Park. The reach is in the Australian Alps bioregion which is characterised by heaths, grasslands, bogs and subalpine woodlands. The catchment in this area is used for camping and touring accessed along unsealed fire trails. The area is closed due to snow between the June and October long weekends and is not monitored during this time.



Reach Condition

It is only when you survey rivers in this condition (and following good Spring flushes) that you appreciate what a healthy water bug population looks like. The Spring survey (aided by water bug expert John Gooderham) produced 170+ stoneflies from four different types and 220+ caddisflies from 11 different types! While this high abundance and diversity reflects a high quality alpine ecosystem, the overall score was pulled down due to the low diversity found in March – showing signs of stress after a dry, hot Summer. This highlights the need for multiple surveys a year to pick up seasonal variation.

The riparian zone is a healthy naturally occurring native tussock grassland, which helps to protect water quality. However, this only rated as 'fair', as the riparian assessment requires presence of native canopy, understorey and habitat features to achieve a high score.

Trout are regular sighted (by our fly-fishing volunteer) and large numbers of wild horses are also recorded.



Volunteer Kerryn Milligan monitoring in the snow at CMM990!

Murrumbidgee River CMM2

Tantangara Dam to Goorudee Rivulet

2016/17 CHIP Result B (Good)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Poor	
Water bug	Good	4
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 55km

Dominant land uses: Rural

This reach includes the Murrumbidgee River and its tributaries in the Yaouk area from below the Tantangara Dam wall. The influence of flow regulation is most evident in this reach. The catchment comprises of open valley floors (which would historically have contained tracts of swampy meadows) with a backdrop of steep unimproved country. Valley floors are now utilised predominantly for grazing purposes.



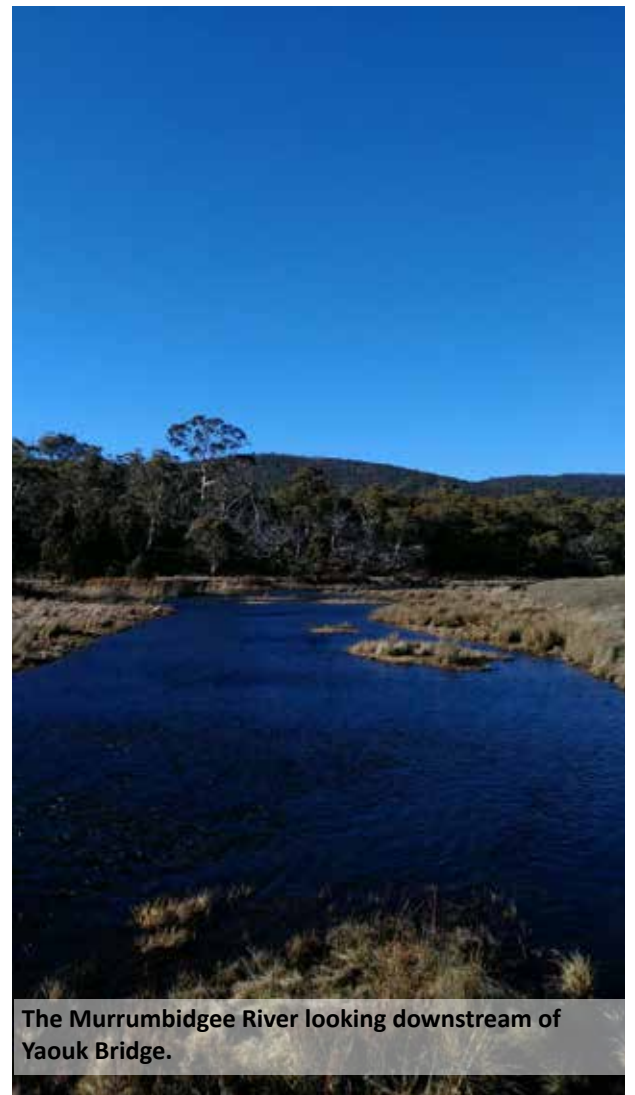
Reach Condition

Excellent water quality scores reflect the high quality of water released from Tantangara Dam which makes up the main flow at the upstream site in this reach. Dissolved oxygen levels were poor, due to hot, dry Summer conditions with low flows.

Water bug surveys showed lower numbers of pollution-sensitive bugs and an increase in very tolerant bug types such as segmented worms and flatworms than for the reach upstream. This reflects the ability of the water bug surveys to pick up the effects of factors such as stream flow regulation and surrounding landuse on the River's health.

Riparian zones in this reach were scored as poor, due to lack of native canopy and understorey, which is in part natural as well as influenced by riparian grazing in this reach.

Trout and Platypus are reported in this reach. No confirmed Carp sightings have been recorded.



The Murrumbidgee River looking downstream of Yaouk Bridge.

Murrumbidgee River CMM3

Goorudee Rivulet confluence to Bridle Creek confluence

2016/17 CHIP Result A- (Excellent)

2015/16 CHIP Result B+ (Good)

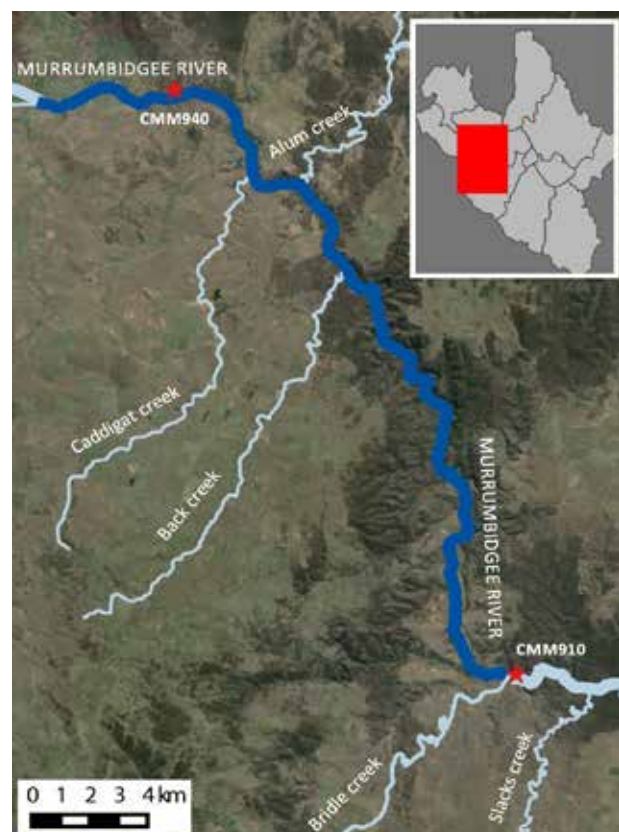
Parameter	Rating	No. Survey
Water quality	Excellent	17
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Poor	
Water bug	Excellent	2
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 43km

Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from Goorudee Rivulet down to the area known as 'Dry Plains'. Alum Creek is the major tributary which flows in from the north. Within this reach the river first flows through more open, undulating country which is used predominantly for grazing purposes and then through steeper gorge country dominated by woodland vegetation cover which remains largely unmodified.



Reach Condition

Excellent water quality results were found for all parameters with the exception being low dissolved oxygen levels during the hot, dry Summer. This, in part, can be contributed to limited shade allowing the water to warm up and not hold as much oxygen as well as a reduction in flow.

Water bug survey results were 'excellent' which elevated the final CHIP score for this reach. However, it is noted that lower abundance of sensitive species were observed than for upstream reaches, but more tolerant species were also lower in abundance overall.

The 'fair' riparian condition score reflects both 'poor' and 'good' scoring sites on the reach and this correlates with landuse and catchment topography present at the survey site.

The introduced fish Carp and Eastern gambusia are recorded in this reach. This area is thought to be current upstream limit of Carp distribution. Volunteer Kerry Milligan has noted seeing both Platypus and Water rats while doing her sampling.



The Upper Murrumbidgee River Reserve at CMM910.

Murrumbidgee River CMM4

Bridle Creek to Numeralla River confluence

2016/17 CHIP Result B (Good)

2015/16 CHIP Result B (Good)

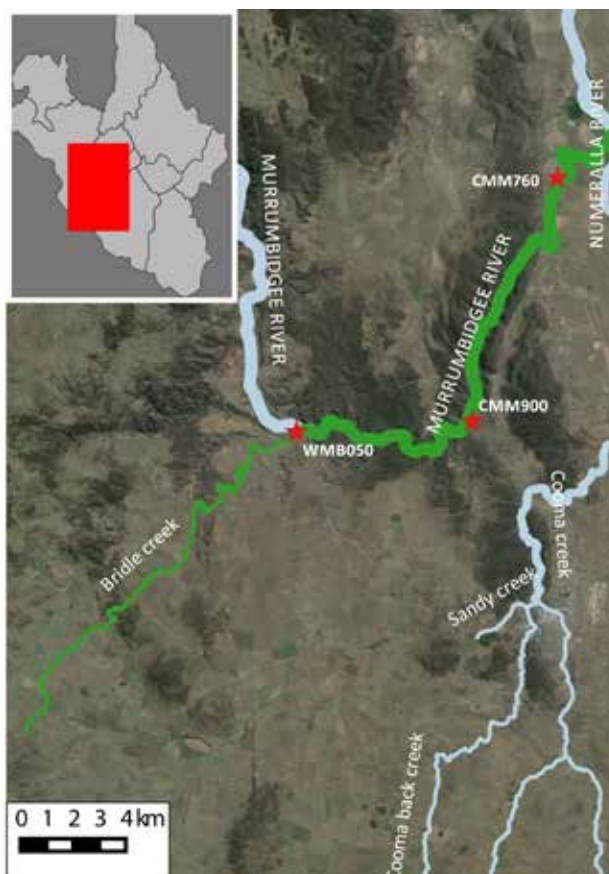
Parameter	Rating	No. Survey
Water quality	Excellent	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Water bug	Good	3
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 31km

Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from the Bridle Creek confluence to the Numeralla River confluence. The bottom section has open, cleared country used for predominantly grazing and cropping purposes while the upper section includes the Binjura Nature Reserve, where the 'Cooma Gorge' is found. Good quality riparian and aquatic habitat are found in this section.



Reach Condition

This reach includes long gorge sections, which have been the study area for the endangered Macquarie perch and for Carp movements in the last few years. In the gorge areas the River has intact native vegetation and deep pools which can provide refuge at times of low flows and warm conditions. These factors also assist to maintain good water quality which can be seen in the water quality survey results.

In contrast, the riparian condition scores reflect the modified state of riparian zones in the more open floodplain areas along the Murrumbidgee River, where mature Willows remain as the only canopy and there is little understory or in-stream vegetation, especially where stock have access to the river.

There is a Platypus survey site along this reach as part of Platypus Month (August 2016) where two Platypus and a Water rat were recorded. Carp are seen in large numbers in the more modified areas in the lower parts of this reach.



Murrumbidgee River below weir at Cooma Pumping Station.

Murrumbidgee River CMM5

Numeralla River confluence to Bredbo River confluence

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	14
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Go	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 12km

Dominant land uses: Rural

The section includes the Murrumbidgee River from the Numeralla River confluence to the Bredbo River confluence. Very limited native riparian vegetation remains. This is a priority ACWA catchment with two ACWA sites present.

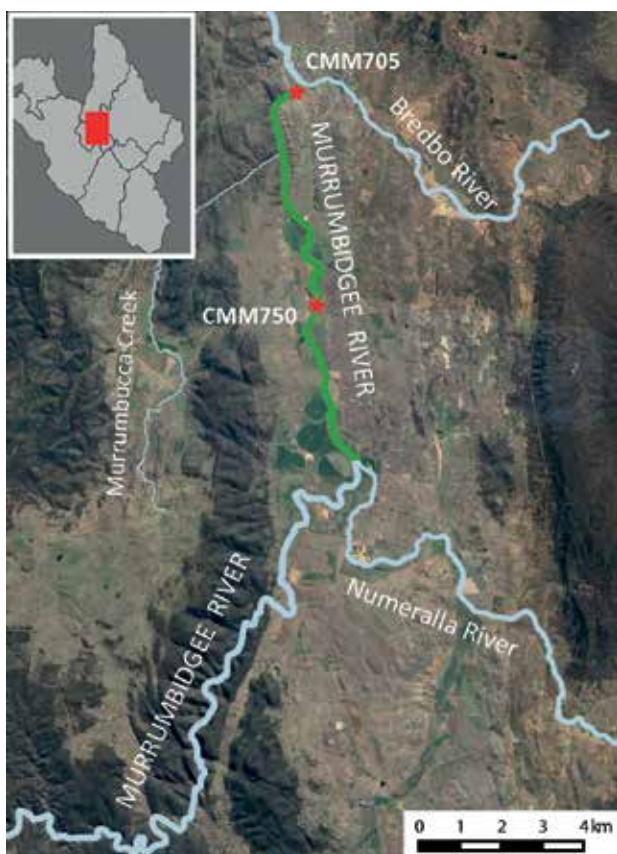
Large alluvial floodplain areas are found here and are extensively used for dryland and irrigated cropping (Lucerne) as well as grazing purposes.

Reach Condition

This reach is the point where the Numeralla River, one of the two major tributaries in the Cooma Region, enters the Murrumbidgee River and hence flows are significantly boosted. The reach is flanked by wide alluvial floodplains which have been historically cleared and continue to be cultivated today. Riparian zones are dominated by Willows which form dense stands and in-stream habitats have been simplified due to infilling by large historic deposits of sediment.

These factors influence water quality in this reach including raised levels of electrical conductivity and phosphorous which are mobilised during cultivation and from run-off. Water bug surveys found higher numbers of tolerant types such as fly larvae and waterboatmen. Turbidity also increases in association with high flow events, linked to inflows from the Numeralla catchment.

Feral fish such as Carp and Eastern gambusia are recorded in this reach. Platypus have also been observed. A stabilised ACWA site is being monitored along this reach.



Murrumbidgee River at Billilingra Rd crossing.

Murrumbidgee River CMM6

Bredbo River confluence to Michelago Creek confluence

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	24
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Water bug	Excellent	4
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 35km

Dominant land uses: Rural and conservation

This reach takes in the upper Murrumbidgee River from the Bredbo River confluence to Michelago Creek. This reach flows through the Bredbo and Colinton Gorges which form the upper and lower sections of the reach, and contains good quality riparian and aquatic habitat.

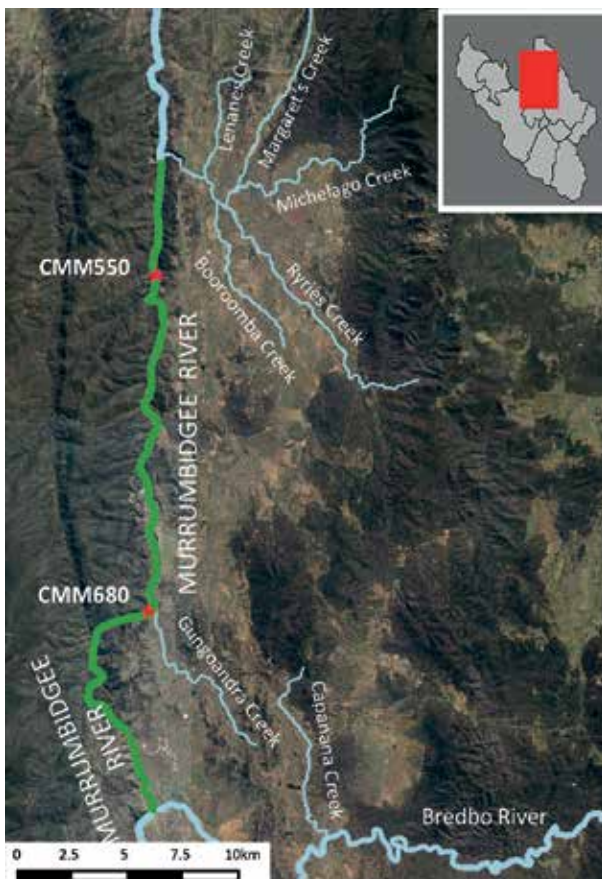
The middle section (Bumbalong Valley) contains more open, cleared country. This reach is the upper section of the Upper Murrumbidgee Demonstration Reach.

Reach Condition

This reach receives inflows from the Bredbo and Numeralla Rivers increasing discharge, but also influencing water quality. One example is a very high spike in turbidity (greater than 1,000NTU) due to a severe Summer storm in December, 2016. As a result, high turbidity was reported right down to the ACT, with Waterwatch volunteers recording a turbidity of 200NTU at Angle Crossing days after the event.

Reach condition is being improved as part of the UMDR Rivers of Carbon Upper Bidgee project via woody weed control and riparian plantings including at Bush Heritage Australia's Scottsdale Reserve. Water quality, water bugs and riparian condition are monitored at this site and should show future improvement as the result of the works.

Platypus surveys at Scottsdale recorded five Platypus and one Water rat in August, 2016 as part of Platypus Month. Carp were recorded this year including a spawning event.



Riparian restoration plantings on the Murrumbidgee River at Scottsdale Reserve.

Numeralla River NUM1

Headwaters to Kybeyan River confluence

2016/17 CHIP Result B (Good)

2015/16 CHIP Result B (Good)

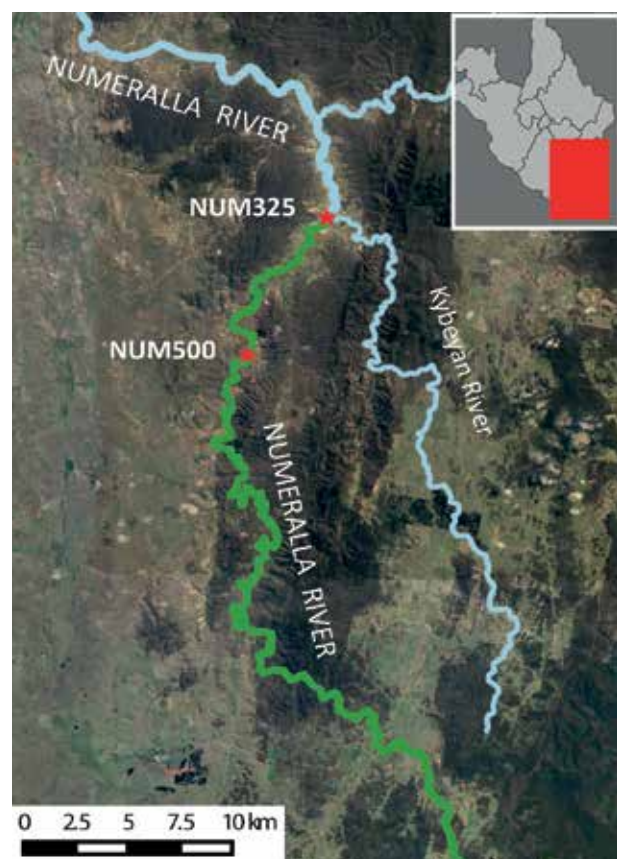
Parameter	Rating	No. Survey
Water quality	Excellent	15
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Water bug	Excellent	2
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 38km

Dominant land uses: Rural and conservation

This reach includes the Numeralla River upstream of the Kybeyan River confluence. Land use adjoining the reach includes use for dryland cropping and grazing agriculture in the mid to lower sections. Sections of the upper reaches retain native vegetation including the Dangelong Nature Reserve. This reach is a high priority ACWA catchment where erosion risk was assessed as very high.



Reach Condition

Low flows during Summer showed a rise in electrical conductivity. Summer also produced increased water temperatures, resulting in lower dissolved oxygen levels. Interestingly turbidity also increased slightly at this time which could have been due to high numbers of Carp stirring up the bottom. Turbidity can be high during run-off events in this reach indicating gully erosion or cultivated paddocks are present in this catchment. This would not have been the case during this Summer however, with rainFall being well below average.

This highlights the importance of well vegetated riparian zones along the river and tributary gullies as well as in-stream vegetation to provide filtering effects. Riparian surveys show that despite the lack of canopy vegetation, in-stream vegetation is establishing along the Numeralla River where stock access is controlled along the stream.

There are two ACWA works sites stabilising streambank erosion at the bottom end of this reach. Monitoring shows these sites continue to be stable and revegetation is establishing.

Platypus have been sighted in this reach.



Numeralla River at Mt Forest Rd crossing.

Numeralla River NUM2

Kybeyan River confluence to Badja River confluence

2016/17 CHIP Result B (Good)

2015/16 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	18
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Fair	3
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 40km

Dominant land uses: Rural and conservation

This reach includes the Numeralla River downstream of the Kybeyan River confluence to the Badja River confluence. The Numeralla River in this reach is flanked by wide floodplains used for agriculture, including dryland cropping and grazing. This reach is a high priority ACWA catchment where erosion risk was assessed as very high.

Reach Condition

Water quality has improved overall this year in this reach, although turbidity can be high at times during run-off events indicating gully erosion or run-off from cultivated paddocks.

This reach is fenced from stock which is resulting in the establishment of reeds and Teatree in-stream, providing additional stabilising, shading and filtering effects which helps to protect water quality and create habitat for aquatic fauna such as bugs and frogs. Riparian revegetation activities by the Numeralla Landcare group include planting native canopy trees which are lacking along this reach. These works are being complimented by the Numeralla Fishing Club who are restoring snags in-stream for fish habitat, revegetating banks at snag sites and stocking the River with native fish.

A Carp spawning event was recorded in October 2016, as part of the 'Carp Love 20°C' campaign and large numbers of Carp were caught during the Numeralla Fishing Club Carp Out in January.

Volunteer Mark Shurbert noted a juvenile Platypus while monitoring in late January – around the time Platypus are known to leave their burrow for the first time.



Volunteer Mark Shurbert monitors the Numeralla River at 'Deepwater'.

Numeralla River NUM3

Badja River confluence to Cooma Creek confluence

2016/17 CHIP Result B (Good)

2015/16 CHIP Result B (Good)

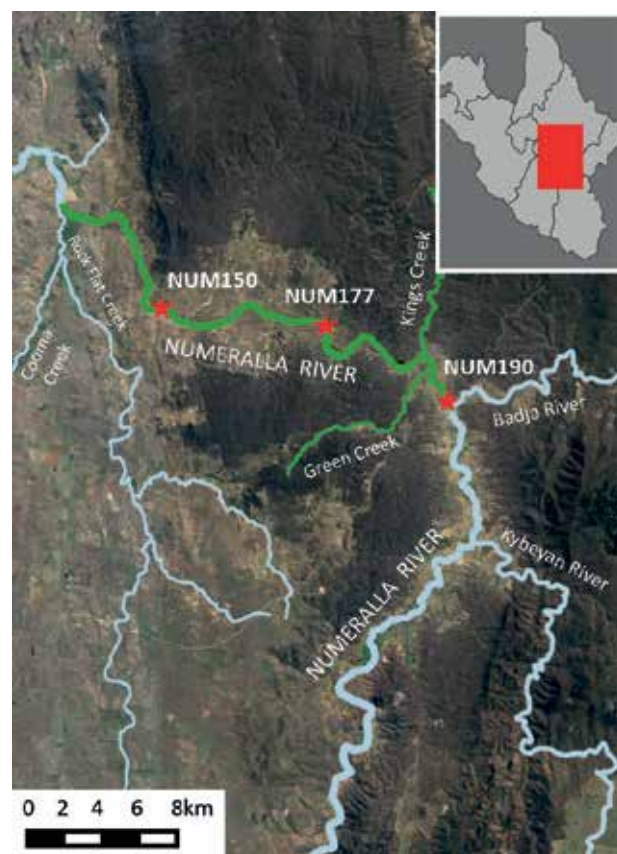
Parameter	Rating	No. Survey
Water quality	Good	25
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Fair	3

Reach Facts

Reach network length: approx. 14km

Dominant land uses: Rural and rural residential

This reach runs from below the Badja River confluence down to the confluence with Cooma Creek. The reach is characterised by floodplain areas used for agriculture including dryland cropping and grazing. This reach is a high priority ACWA catchment where erosion risk was assessed to be very high. Tributaries feeding into the Numeralla River have retained good native vegetation.



Reach Condition

Water quality is poorer than that in NUM2 due in part to the agricultural practices of the surrounding floodplains, especially at the lower end of this reach. Electrical conductivity is lower in this reach than upstream and this is possibly due to immediate inflows from the Badja River, which has excellent water quality. Turbidity can be high during run-off events, indicating gully erosion or run-off from cultivated paddocks.

Water bug surveys recorded sensitive bug types, although these were in lesser numbers than the tolerant bugs such as the true fly larvae, which dominated the sample. Mucilage (sludge) and algal fringes could be observed covering rocks and underwater vegetation. This can affect water bug habitat by, for example, clogging the gaps in the rocks along the bottom of the river where the sensitive bug live thus reducing their overall numbers.

Carp spawning events have been observed every year in the Rose Valley area and Eastern gambusia are seen in large numbers in Summer.



Numeralla River upstream of Rose Valley crossing.

Numeralla River NUM4

Cooma Creek confluence to Murrumbidgee River confluence

2016/17 CHIP Result B- (Good)		
2015/16 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Good	15
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Water bug	Good	2
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 17km

Dominant land uses: Rural

This reach includes the lower section of the Numeralla River from Cooma Creek to its confluence with the Murrumbidgee River. The catchment includes wide floodplain areas on both sides of the Numeralla River which are used for agriculture including grazing, dryland and irrigated cropping. Riparian zones are highly modified and sediment deposition is widespread in the river.



Reach Condition

Water quality is lower than the upstream reaches due to the cumulative influences from the catchment as well as cropping and grazing landuse along this reach. Turbidity can be high during high run-off events indicating gully erosion present in catchment or from cultivated paddocks. Stream bank erosion is also found.

Water bug surveys mirror the water quality results, with surveys dominated by the more pollution-tolerant types such as fly larvae and lesser numbers of very sensitive types present such as stoneflies and caddisflies. These results are influenced by riparian condition of this reach which is poor, lacking in native species, with limited canopy and understorey present. In areas where stock have uncontrolled access to the stream this is seen to be exacerbated. In-stream reed beds are establishing which provides water bug habitat and filtering effects on the water quality.

Large numbers of Carp are reported, including 'spawning runs' up the Numeralla River past Chakola.



Numeralla River above the confluence with the Murrumbidgee River

Rock Flat Creek ROC1

Headwaters to Cottage Hill Road crossing

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	13
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Water bug	Good	2
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 42km

Dominant land uses: Rural

This reach includes the entire Rock Flat Creek from the headwaters down to its confluence with the Cooma Creek. The catchment flows through predominantly open basalt country, which is used for grazing and cropping agriculture. Wide floodplains at the bottom end of the reach have been historically prized for cropping and hence riparian zones are highly modified in this catchment.

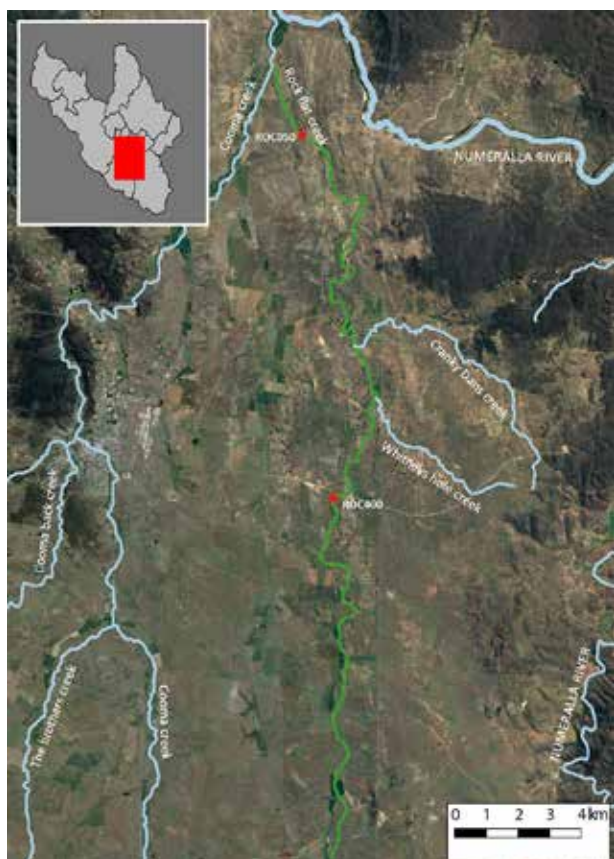
This reach is an ACWA catchment with moderate erosion risk and includes a high priority ACWA site just downstream of the Cottage Hill crossing.

Reach Condition

The water in this stream is usually clear, however abundant algal growth is often seen in Fall and Spring indicating nutrients are available in the water. Electrical conductivity is naturally high due, in part, to the geology of the catchment. While turbidity scored 'excellent', there were some higher scores recorded. These are partially caused by gully erosion, cultivated paddocks on the floodplain and stock access to the Creek.

Although water quality was excellent overall, the water bug surveys found small number of sensitive bug types and high numbers of tolerant bug types such as fly larvae, segmented worms, snails and water boatmen. These results are consistent with the poor condition of riparian zones which lack native vegetation, dense groundcover and in-stream vegetation especially where there is uncontrolled stock access. These factors reduce habitat for the water bugs and compromises the filtering capacity of the riparian zones.

High Carp numbers are reported throughout this reach which was once a renowned Trout stream.



Rock Flat Creek upstream of Cottage Hill Road.

Strike-A-Light River STR1

Headwaters to Bredbo River confluence

2016/17 CHIP Result B (Good)		
2015/16 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	17
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Water bug	Good	4
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 38km
Dominant land uses: Rural

This reach includes the entire Strike-A-Light River catchment from its headwaters down to its confluence. The catchment includes cleared open country, utilised predominantly for grazing agriculture at the top and bottom ends of the reach. In these areas riparian vegetation has been modified. The middle of the reach is largely native vegetation with intact riparian areas and good in-stream habitat.



Reach Condition

Water quality results show electrical conductivity, pH and turbidity are better at upstream sites in this reach. This is consistent with landuse and vegetation of the catchment which varies from light grazing and intact native vegetation upstream, whereas the lower areas have been historically cleared.

Water bug surveys at the downstream end of the reach found both sensitive and tolerant types, with numbers of segmented worms especially high. Segmented worms process high levels of organic matter, present at the site due to a dense stand of Poplars upstream. High loads of organic matter in streams can reduce dissolved oxygen levels as it degrades and this affects ability of sensitive species to survive.

Carp are reported only at the bottom end of the reach, possibly confined by a waterFall below STR200. Water rats and the native fish - Mountain galaxias - have been reported in the upstream sections of the Strike-A-Light River.





Ginninderra Catchment Facts

Over 42% of ACT residents live in Ginninderra Creek catchment making it the most urbanised in the ACT. It carries substantial urban water runoff from both established and newly developing suburbs directly into the Murrumbidgee River.

Ginninderra Creek itself begins in the upper reaches of Gungahlin within the Mulligans Flat Nature Reserve and enters the Murrumbidgee after passing through the catchment's most significant and best preserved remnant ecosystem; the Ginninderra Gorge including the spectacular upper and lower falls. Gooromon Ponds Creek joins Ginninderra Creek near Dunlop and captures run off from much of the NSW land around Wallaroo and also includes Hall Creek.

Steady development in Canberra's north has impacted significantly over the past 30 years with sediment from development sites and weeds the two most significant issues. The riparian zone for most of the creek is dominated by exotic grasses with a mix of native and exotic mid-storey and canopy. Some notable exceptions are areas where Landcare groups have been working for many years such as Evatt, Umbagog District Park, Macgregor and Dunlop.

Ginninderra Waterwatch Volunteers have been monitoring this catchment since 1997.

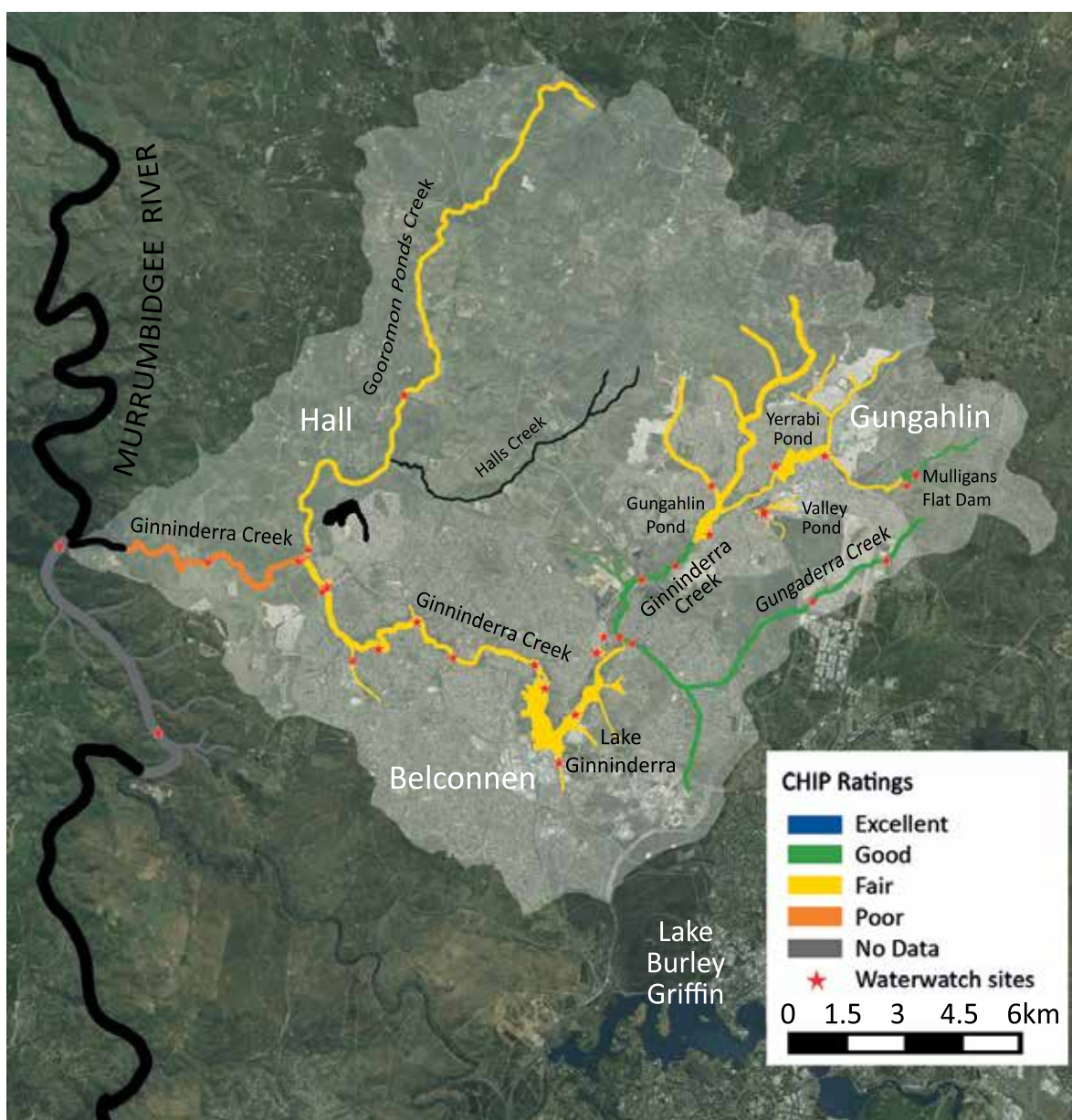


Ginninderra Catchment Health Summary

This year we are reaching a landmark in Ginninderra Waterwatch, as volunteers have been monitoring their catchment for 20 years (1997-2017). We would like to thank the great effort volunteers have been putting into the project and highlight that this is one of the longest-running citizen science projects in the ACT.

The majority of reaches scored 'fair' this year, with eight reaches remaining the same, one reach has declined from 'fair' to 'poor' (GIN5), and four reaches scores slightly improved. The general improvement is likely, in part, due to a wet Winter and Spring providing a good flush to the system. GUN1 was data deficient for water quality this year, consequently its overall 'fair' score was based only on bug survey and riparian condition, which could have scored higher if water quality was present. GIN5 score has probably declined as the site in the most intact section of the reach above the confluence with Murrumbidgee River (GIN050) is no longer being monitored. Not only Mulligans Flat Dam (MFL1) scored 'good' this year, but also GIN1 and GDC1. Better results on riparian condition and water bugs have contributed to an improved overall score on GIN1 and GDC1.

It is important to point out that in most of the sites electrical conductivity and dissolved oxygen scored 'poor' and 'degraded', and the very hot and dry summer had a great influence on these two parameters. Some concerns have been observed in the catchment, such as extreme erosion along the river bank at GIN5 following the Spring floods in 2016, and a fish die off in GIN4, which was reported to the Environment Protection Authority (EPA).



Ginninderra Creek GIN1

Crace to Giralang Pond

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C- (Fair)

Parameter	Rating	No. Survey
Water quality	Good	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Fair	3

Reach Facts

Reach network length: approx. 5km

Dominant land uses: Urban

Starting at the outflow of Gungahlin Pond this reach includes the stormwater inflow from Nicholls and Crace. The middle of the reach receives runoff from the CSIRO field test facility. The downstream section flows through the Old Palmerville township historic site 12 and Landcare Forest. The end point for this reach is Giralang Pond which is the only small stream pond present on Ginninderra Creek.



Giralang Pond in flood - September 2016.

Reach Condition

As with last year, higher electrical conductivity readings and low dissolved oxygen observations drove down the water quality score. The catchment has been urbanised for many decades, which results in high runoff from the many impermeable surfaces which warms the water and carries lots of urban pollutants with it. Dissolved oxygen readings varied (35 – 101% saturation) with a significant reduction over the summer months, due to a combination of high water temperatures, poor shading and low water levels.

Low canopy cover is present throughout this reach, although there are some significant patches of native grasses and groundcover, plenty of in-stream reeds and some evidence of good habitat in the form of fallen logs, which is unusual for such a highly populated and urbanised catchment.

Feral fish are frequently sighted throughout this reach. When the dissolved oxygen levels got low in January, a local resident at Giralang Pond observed introduced Weatherloach coming to the surface to draw oxygen from the air.



Ginninderra Creek GIN2

Lake Ginninderra

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	25
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 9km

Dominant land uses: Urban

Starting below Giralang Pond and finishing at the Lake Ginninderra Dam wall, this reach covers the main city centre of Belconnen. The main inflow is from Ginninderra Creek from the north-east, which includes the new development suburb of Lawson. The other inflow is at the southern end of the Lake and is mostly urban stormwater that flows into the recently redeveloped Eastern Valley Way wetland.



Reach Condition

Water quality observations are reflective of the previous year, with no improvements in electrical conductivity and dissolved oxygen readings. Higher electrical conductivity is often observed in the new wetland, and dissipating throughout the lake downstream, indicating it is functioning appropriately as a method of controlling nutrients and sediments.

The riparian vegetation condition remains 'poor', as the reach is characterised by grassy recreational areas and cultivated parks. As such there is little natural debris to serve as habitat, and very little native understorey and ground cover.

The water bugs observed fell mostly in the tolerant categories, although overall numbers of bugs were markedly increased during the Autumn sampling. In particular, high populations of shrimp, backswimmers and water boatmen were present.

Rubbish, ducks and kayakers are frequently sighted by volunteers on Lake Ginninderra.



Lake Ginninderra at GIN010.

Ginninderra Creek GIN3

Dam wall to Ginninderra Drive

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	37
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 4km

Dominant land uses: Urban

Starting below the Lake Ginninderra spillway this reach sits entirely within established suburbs with high urban stormwater inflow. This reach has good reed cover and wide, well grassed buffer zones in most areas. During rain events the water in this section runs very clear and turbidity is only seen when overflow from Lake Ginninderra occurs. Two new wetlands are to be built in this reach through the ACT Government Healthy Waterways (Basin Project).



Reach Condition

There were 37 water samples taken in this reach from three locations owing to the great effort from our volunteers. Although the overall 'good' water quality, dissolved oxygen saturation has shown very low levels, especially during January (39%), February (12%) and March 2017 (21%). It was a hot and dry Summer, with little to no flow in this reach with yabby holes along the bank becoming exposed.

Besides the great effort of Ginninderra Catchment Group and ACT Government tree unit to replace poplars with native species in this reach, the overall riparian condition was still remains 'poor'. It should still take a few years for the benefit of this management strategy to be reflected in the riparian condition scores.

Interestingly, volunteers have spotted a water dragon, black cockatoos and ducks, and calls from the Striped Marsh Frog *Limnodynastes peronii*.

People fishing on Ginninderra Creek downstream of Lake Ginninderra. (Photo: Luke Wensing)



Algal bloom in Ginninderra Creek (GIN009) on November 2016. (Photo: Luke Wensing)

Ginninderra Creek GIN4

Ginninderra Creek at Umbagog District Park

2016/17 CHIP Result C+(Fair)

2015/16 CHIP Result C+ (Fair)

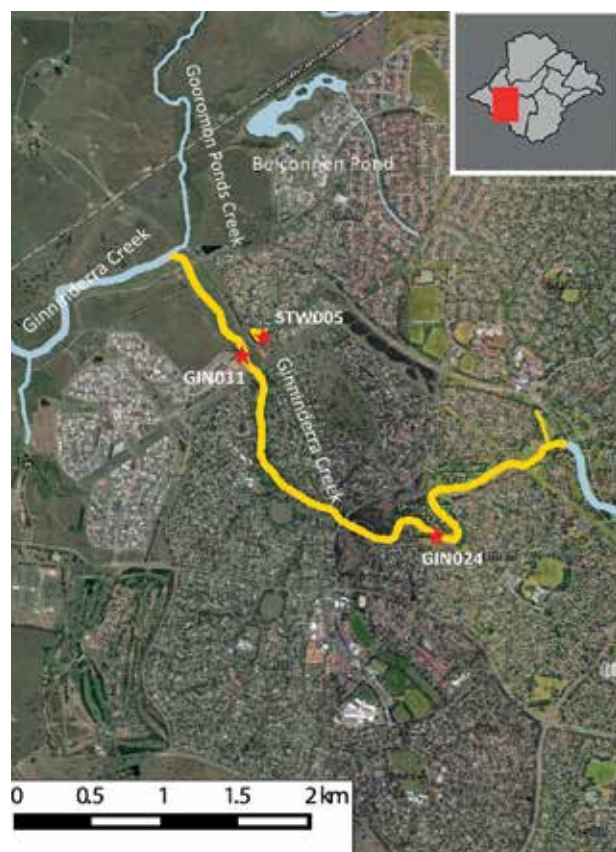
Parameter	Rating	No. Survey
Water quality	Good	38
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 6km

Dominant land uses: Urban

This reach starts downstream of Ginninderra Drive and flows through the Umbagog District Park, ending at the confluence with Gooromon Pond Creek. This reach is well vegetated with good native riparian zone and wide grassland buffers in many sections. Previous creek restoration projects by the Ginninderra Catchment Group and Umbagog and Macgregor Landcare Groups have improved riparian condition and water quality.



Reach Condition

Rubbish has been noted in several occasions and our volunteers have helped relentlessly to clean this section of Ginninderra Creek. A fish die off was reported to the Environment Protection Authority (EPA) by the volunteer in January 2017.

Although water bugs scores were only 'fair' which can reflect the many impacts of suburban waterways, pollution-sensitive mayfly nymphs and caddisfly larvae were found, albeit in small numbers.

Umbagog District Park has good native understory cover and the restoration work done by Landcare groups have improved habitat values. The rest of the riparian zone in this reach, however mainly consist of exotic plants.

Volunteers recorded an array of fauna, including King Parrots, Kookaburras, Reed Warblers, Buff-Rumped Thornbills, Red-Browed Finches and Pobblebonk tadpoles.



Ginninderra Creek at GIN011. (Photo: David Fitzsimmons)

Ginninderra Creek GIN5

Gooromon Ponds Creek confluence to Murrumbidgee River confluence

2016/17 CHIP Result D+ (Poor)

2015/16 CHIP Result C+ (Fair)

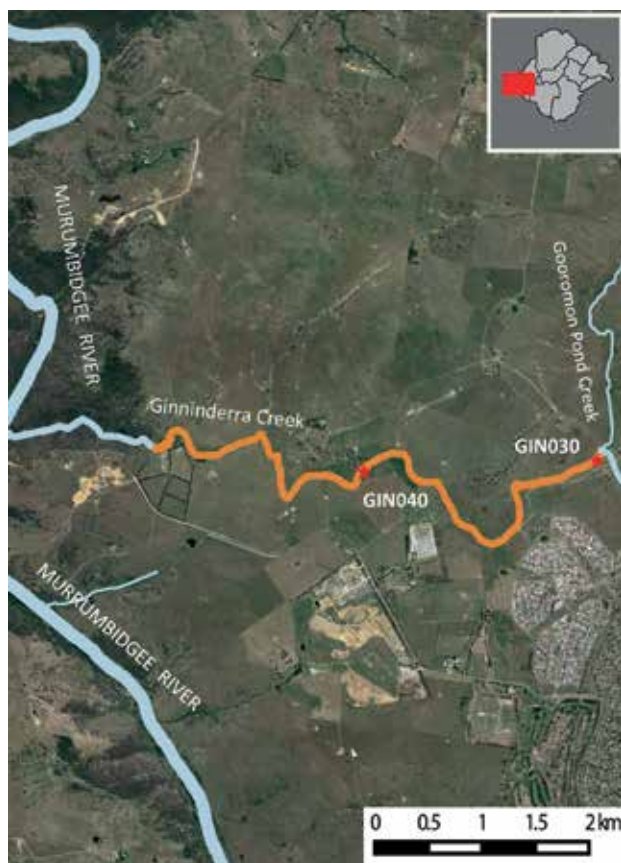
Parameter	Rating	No. Survey
Water quality	Good	18
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Water bug	Degraded	3
Riparian condition	Degraded	3

Reach Facts

Reach network length: approx. 10km

Dominant land uses: Urban/Rural Fringe

This reach runs from the confluence with Gooromon Ponds Creek to the confluence with the Murrumbidgee River. The upper section has significant bank erosion and the lower section contains the high conservation value area of the Ginninderra Falls and Gorge. Ginninderra Catchment Group,



Greening Australia and the Riverview group have undertaken a Willow removal and native regeneration project in the mid-section.

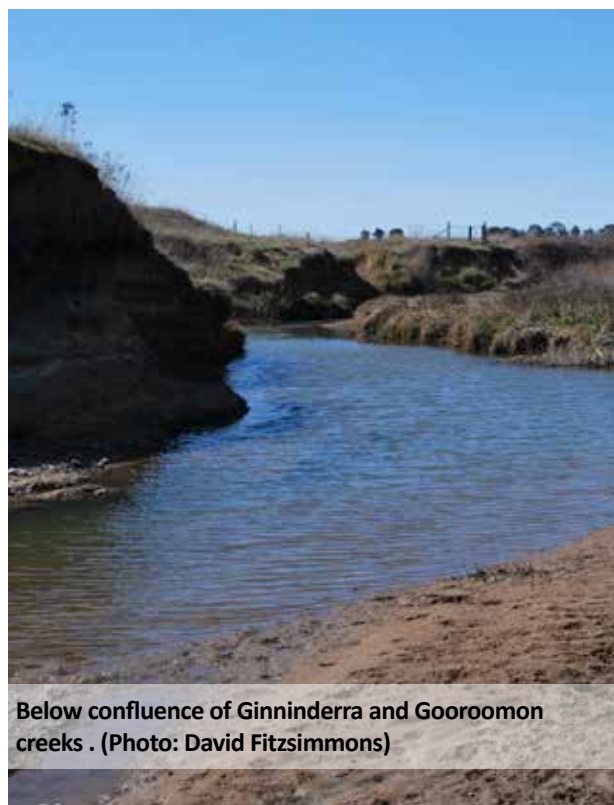
Reach Condition

The inflow from Gooromon Creek contributes to the elevated readings of electrical conductivity in this reach (270 - 600 $\mu\text{S}/\text{cm}$). Kilby Homestead, a rural site on Ginninderra Creek downstream of the Belconnen suburbs, was observed to be little more than an isolated pool during the warmer months.

Extreme erosion has been recorded following the Spring floods in late 2016. Approximately 5 metres of erosion was observed following these rains by the volunteer at the site. This reflects the unstable riverbanks with limited canopy and understorey present as well as the historical impacts of cattle. ACT Government is planning on addressing the severe erosion through a series of restoration works.

The lack of in-stream vegetation and removal of a site down at the Ginninderra Creek and Murrumbidgee River confluence contributed to the 'poor' CHIP score.

Many adult Carp were observed in large numbers at GIN030 during October and November.



Gooromon Ponds Creek GOO1

Headwaters to confluence with Ginninderra Creek

2016/17 CHIP Result C- (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	14
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Degraded	1

Reach Facts

Reach network length: approx. 17km

Dominant land uses: Rural

Flowing through the rural land surrounding Hall and Wallaroo, the Gooromon Ponds Creek is a mostly ephemeral creek with intermittent pools. This Creek contains sections of moderate erosion and extensive areas with low habitat value.



Reach Condition

Electrical conductivity has historically shown elevated results in this reach and is most likely influenced by the geology of the region and historical land use. Every record with the exception of one, fell into the degraded category ($>404\mu\text{S}/\text{cm}$) with levels as high as $1000\mu\text{S}/\text{cm}$ in May 2017. Rubbish along the creek has been observed after floods, and when conditions are drier, green and brown algae are frequently recorded.

Water bug abundance was greatest for shrimp (that do particularly well in waters with high electrical conductivity), segmented worms, and fly larvae. That said, some pollution-sensitive bugs were found in Autumn including mayfly nymphs and small type of caddisfly known commonly as 'micro-caddis'.

This reach represents a typically impacted farmland region and not surprisingly this lowered the riparian condition scores. The lack of native canopy cover and consequently no leaf litter and native canopy regeneration reduce soil stability and can cause erosion.



Gooromon Creek at Jaramlee Crossing (GOO009) during a dry period in 2017 (top) and after heavy rains in 2016 (Photos: David Fitzsimmons)

Gungaderra Creek GDC1

Gungahlin to Giralang Pond

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C- (Fair)

Parameter	Rating	Survey
Water quality	Good	11
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Fair	3
Riparian condition	Fair	3

Reach Facts

Reach network length: approx. 10km

Dominant land uses: Urban

This reach starts in the southern suburbs of Gungahlin, flows through the Gungaderra Grassland Reserve and into Ginninderra Creek at Giralang Pond just upstream of Lake Ginninderra. The reach also includes a stormwater channel from the University of Canberra and Canberra Stadium and has moderate urban stormwater inflow.



Reach Condition

A period of high rainfall during the Spring of 2016 resulted in a 200 NTU turbidity result below the gross pollutant trap at Giralang Pond. High turbidity was also noted during late Winter and traced back to construction works in Franklin. This was reported to the EPA. This reach then endured a long, hot summer where dissolved oxygen levels dropped to 11% saturation in January 2017. Finally in June electric conductivity readings reached their highest (500 $\mu\text{S}/\text{cm}$) as this particularly dry month resulted in a higher concentration of salts and minerals in the water.

An improvement in the riparian vegetation assessment score can be attributed to a small increase in native understorey and groundcover in the upper sites – Gungaderra Creek Pond and Mother Theresa Primary School Dam.

A marked enhancement is evident in the water bug score this year, which was influenced in part by an increase in data collection across this reach. The good flushes of rain throughout Spring and Autumn would also have helped.

A water rat was sighted by the volunteer at the Giralang Pond. The first time they have been noted there in many years.



Turbid water from Gungaderra Creek meets the stormwater channel from Bruce.

Gungahlin Pond GUN2

Headwaters of Ginninderra Creek north arm to Gungahlin Ponds

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	12
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Fair	3
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 6km

Dominant land uses: Urban/Rural Fringe

The north arm of Ginninderra Creek originates in the rural lands surrounding the northern suburbs of Gungahlin and joins the east arm in Gungahlin Pond. The upper section is mostly ephemeral creeks fragmented by stock dams and flowing into the sediment control pond of Gungahlin. The reach receives a high inflow of urban stormwater from surrounding suburbs and new developing suburbs.



Reach Condition

Electrical conductivity has shown 'degraded' levels ($>404\mu\text{S}/\text{cm}$) on six occasions during the past year. In January 2017, dissolved oxygen saturation was low (54%), which could be a consequence of a dry spell and elevated water temperatures. Algal fringes and stoneworts have been recorded throughout the year, and it's positive to note the record of frog calls and several bird species, such as ducks, swans, ibis and swamp hens.

The riparian condition in this reach reflects the limited presence of native trees and native understory. These highly urbanised areas that are regularly mowed to the water's edge, makes the regeneration of native plants difficult.

Despite a highly urbanised reach, water bugs have shown a range of species, although the bulk of samples were pollution-tolerant bugs such as true bugs and shrimp – the latter do particularly well in waters with high electrical conductivity.



Stormwater Drain (STW006) near Gungahlin Pond.

Kippax Creek KIP1

Headwaters to Ginninderra Creek confluence

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C- (Fair)

Parameter	Rating	No. Survey
Water quality	Fair	12
pH	Excellent	
Turbidity	Good	
Phosphorus	Poor	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 2km

Dominant land uses: Urban

Kippax Creek is now mostly a system of stormwater drains and drainage lines. The remaining “natural” creek section is only a 400m stretch from the last gross pollutant trap to the confluence with Ginninderra Creek. This reach does offer a great opportunity to study the impacts of a catchment that is heavily urbanised with limited water quality improvement infrastructure.



The lower section sits within an important native grassland at the Umbagog District Park. Significant erosion is evident towards the confluence.

Reach Condition

Water quality has deteriorated in this reach. Phosphorus received two readings considered to be very high (0.2 and 0.125 mg/L) and were reported to the Environment Protection Authority (EPA). In addition, nitrate scores (as high as 20mg/l in June) are believed to have been influenced by runoff from a building site near Southern Cross Drive.

Despite the decline in water quality, water bugs scores improved slightly. There was an increased sampling effort this year and the Autumn sample produced a much greater diversity of bugs ranging from the sensitive mayfly nymphs through to tolerant bugs such as fly larva and nematodes. Tadpoles were caught during the Spring bug survey and Pobblebunks were noted by the volunteer as calling in November.

Riparian condition has improved due to the increase in regeneration of native canopy species and the presence of reeds along this reach. A lot of rubbish was recorded in the creek.



Kippax Creek.

McKellar Wetlands MCW1

Designed habitat wetland system, McKellar

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C- (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	6
pH	Good	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Water bug	Poor	2
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 500m

Dominant land uses: Urban

The two McKellar wetlands are designed primarily for frog habitat, with humans as secondary users. This is evident in the significant reed growth in both wetlands, and the connecting channel linking the two wetlands, which is heavily vegetated to facilitate frog movement. As it is situated in an established suburb, nutrient inputs are from human activity such as gardening and leaves from deciduous trees.



Reach Condition

There was a significant improvement in dissolved oxygen and electrical conductivity readings this year. The volunteer was only recruited in Autumn and so the water quality results do not represent season variation. There may be a different story to tell next year with a year's worth of data.

Interestingly, the two wetlands in this reach show a range in water quality values that seems to indicate the top wetland is acting as a filter for the one closest to Ginninderra Creek. This is particularly the case for electrical conductivity which produced results in the lower wetlands as little as one eighth of the measurements upstream.

Riparian condition has been influenced by the low levels of canopy and understory cover, although ground cover results are considered good. The wetlands in this reach are typical of urbanized areas in Canberra, with manicured grasses and low number of trees.

There is an improvement in the water bugs score, with a good diversity of bugs found though not in large numbers overall. The bugs found were mostly of the pollution-tolerant types such as fly larvae and snails.

The volunteer Alex Dudley has recorded a high number of fish and waterbirds in this reach.



Mulligan's Flat Dam MFL1

Headwaters of Ginninderra Creek to Mulligan's Flat Dam

2016/17 CHIP Result B (Good)

2015/16 CHIP Result B+ (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	19
pH	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Water bug	Fair	1
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 2km

Dominant land uses: Conservation

Mulligan's Flat Dam was originally an old farm dam, now repurposed as an ecological habitat for aquatic life, bird life and native fauna and flora. The Mulligan's Flat Nature Reserve was established in 1995 to protect the box-gum grassy woodlands and fauna situated in the Gungahlin area. The Dam is normally filled with rainwater that is grass-filtered, and is a popular spot for bird watchers. The site play hosts to a number of conservation projects.

Reach Condition

Mulligans Flat continues to score well on CHIP this year, which probably reflects the protected native habitat within the Nature Reserve and low influence of urbanisation. Interesting to note that this is one of only two reaches in the Ginninderra catchment where electrical conductivity rated higher than 'poor' or 'degraded'.

Water bugs were only surveyed in Autumn and while the diversity of water bugs species was not high, it did contain pollution-sensitive water bugs such as mayflies, caddisflies and water mites.

Riparian vegetation showed a reduction in scores from 'good' to 'fair', from the last survey to this year, which was influenced by lower native understory regeneration and native canopy cover results. Mulligans Flat's main habitat is grasslands and there are high levels of native ground cover vegetation which promote soil stability and provide habitat for small vertebrates. It is important to note that it takes many years to establish trends and the variation in the riparian scores will even out over time.

The reserve provides good habitat for aquatic animals, as noted by the volunteer Gregg Berry by the records of several frog species calling.



Large dam at Mulligan's Flat.

Murrumbidgee River CMM11

Molonglo River confluence to Ginninderra Creek confluence

2016/17 CHIP Result DD (Data Deficient)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	No Data	0
pH		
Turbidity		
Phosphorus		
Nitrate		
Electrical Conductivity		
Dissolved Oxygen		
Water bug	No Data	0
Riparian condition	No Data	0

Reach Condition

There was no data collected for this reach during the 2016/17 CHIP year due to access issues.

Waterwatch is currently working with landholders to reinstate active sites for the next CHIP period.

Reach Facts

Reach network length: approx. 7.1km

Dominant land uses: Conservation, rural

Starting below the confluence of the Molonglo River this reach includes mostly rural land and Murrumbidgee River Reserve to the confluence with Ginninderra Creek. The reach also includes some sections of gorge country and the upper section of the reach receives the outflow from the Lower Molonglo Water Quality Control Centre.



Murrumbidgee River (CMM11) just beyond the ACT border.

The Valley Ponds GUN1

Wetland to Gungahlin Town Centre

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result D+ (Poor)

Parameter	Rating	No. Survey
Water quality	Data Deficient	4
pH		
Turbidity		
Phosphorus		
Nitrate		
Electrical Conductivity		
Dissolved Oxygen		
Water bug	Fair	2
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 2km

Dominant land uses: Urban

Originally an old farm dam and artificial seepage grassland, this site was a unique habitat for this catchment. The site has since been redeveloped into urban wetland for the Gungahlin town centre and parts of Palmerston. It is now a high quality education and recreation wetland.

Reach Condition

The data density threshold for water quality was not reached this year, consequently the CHIP result for this reach was based on water bugs and riparian condition only. However, the water quality data that was recorded showed some elevated electrical conductivity readings (670 and 560 $\mu\text{S}/\text{cm}$) and algal fringe was a common finding at the Valley Ponds Dam site.

Water bugs were characteristic of suburban wetlands, with the majority of species being pollution-tolerant types. These included large numbers of beetle larvae (150+) and dragonfly nymph (100+) that live in slower flowing waters in vegetation along the edge of wetlands.

There were low levels of native canopy cover and regeneration in this urban reach, although reeds were a common feature in the ponds.

Volunteers have observed Swamp Hens, black swans and cygnets and a turtle carcass has been noted.



The Valley Ponds.

Yerrabi Pond YER1

Headwaters of Ginninderra Creek to Yerrabi Dam Wall

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result D- (Poor)

Parameter	Rating	No. Survey
Water quality	Good	8
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Water bug	Fair	2
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 10km

Dominant land uses: Urban/Rural Fringe

The east arm of Ginninderra Creek originates in the rural lands surrounding the northern suburbs of Gungahlin. It includes the former rural lands, now significant woodland reserve, of Mulligans Flat Sanctuary. The upper section is mostly ephemeral creeks fragmented by stock dams and flows into the sediment control pond of Yerrabi.



The reach receives a moderate inflow of urban stormwater from surrounding suburbs.

Reach Condition

The CHIP score has increased significantly for the 2016 – 2017 CHIP report as water quality was data deficient for the last report and did not contribute to the score. Riparian assessments and water bugs tend to drag overall scores down as they are less transient than water quality.

Rubbish is often observed at Yerrabi Pond, along with a distinct odour. Volunteers have also noted the presence of aquatic weed species such as ribbon weed and alligator weed.

Riparian vegetation overall score was largely influenced by the outflow of Yerrabi Pond, which backs onto a concrete channel connected to a main road. The other areas that did contain riparian vegetation were mainly defined by exotic species, especially in the ground cover section.

Water bug scores improved in comparison to last year, although the results are still dominated by pollution tolerant bug types such as fly larvae and flatworms (100+ in Autumn). Like with so many of the Ginninderra Waterwatch sites, water bugs numbers and diversity would be improved by a more intact, native riparian zone.



Yerrabi Pond at YER001.

Molonglo Catchment Facts

The Molonglo catchment extends from the Murrumbidgee River, just downstream of Uriarra Crossing, to the headwaters of Molonglo and Queanbeyan Rivers and Jerrabomberra Creek, an area of about 2,000 km²

This diverse catchment includes the urban areas of Queanbeyan and inner Canberra, villages such as Captains Flat and rural residential areas and farmland including Burra, Royalla and Carwoola. Non-residential areas include native and pine forests, wetlands, national parks and the foreshores of Googong Dam, which supplies some of Canberra's and Queanbeyan's water.

Lake Burley Griffin is on the Molonglo River and collects stormwater and runoff from Queanbeyan, much of north Canberra and Fyshwick industrial area, as well as treated output from the Queanbeyan sewerage treatment plant. Lake Burley Griffin water quality is monitored by the National Capital Authority and can be found at <http://www.nationalcapital.gov.au/WaterQuality/index.php/en/>.

The Molonglo catchment has a large population with urban waterways flowing in concrete channels. This is a key issue in urban catchments where there is little riparian vegetation and habitat to slow down flows and capture and absorb nutrients and sediments.

Of the six priority sub-catchments in the ACT Healthy Waterways (Basin Project), four are in the Molonglo catchment. These sub-catchments will be the focus of treatment works such as wetlands and water-sensitive urban design aimed at improving water quality.

Though water quality across the Molonglo catchment is generally good, upper Sullivan's Creek and Weston Creek have some of the lowest quality. When taking all our catchment health indicators into account (water quality, water bugs and riparian condition), it is the highly urban catchments and rural creeks with largely cleared vegetation that are in the poorest condition.



Molonglo Catchment Health Summary

With good flows in the catchment following record rainfall in Winter and Spring 2016, water bugs were more diverse and there were more sensitive and flow dependent types present in the surveys. Eight reaches had water bug ratings of 'good' or above, compared to only three last year.

This improvement in water bugs resulted in more reaches having overall CHIP ratings of 'good', with half the Molonglo Catchment reaches this year rated 'good' or 'excellent' (13 reaches) compared to only one third last year (9 reaches).

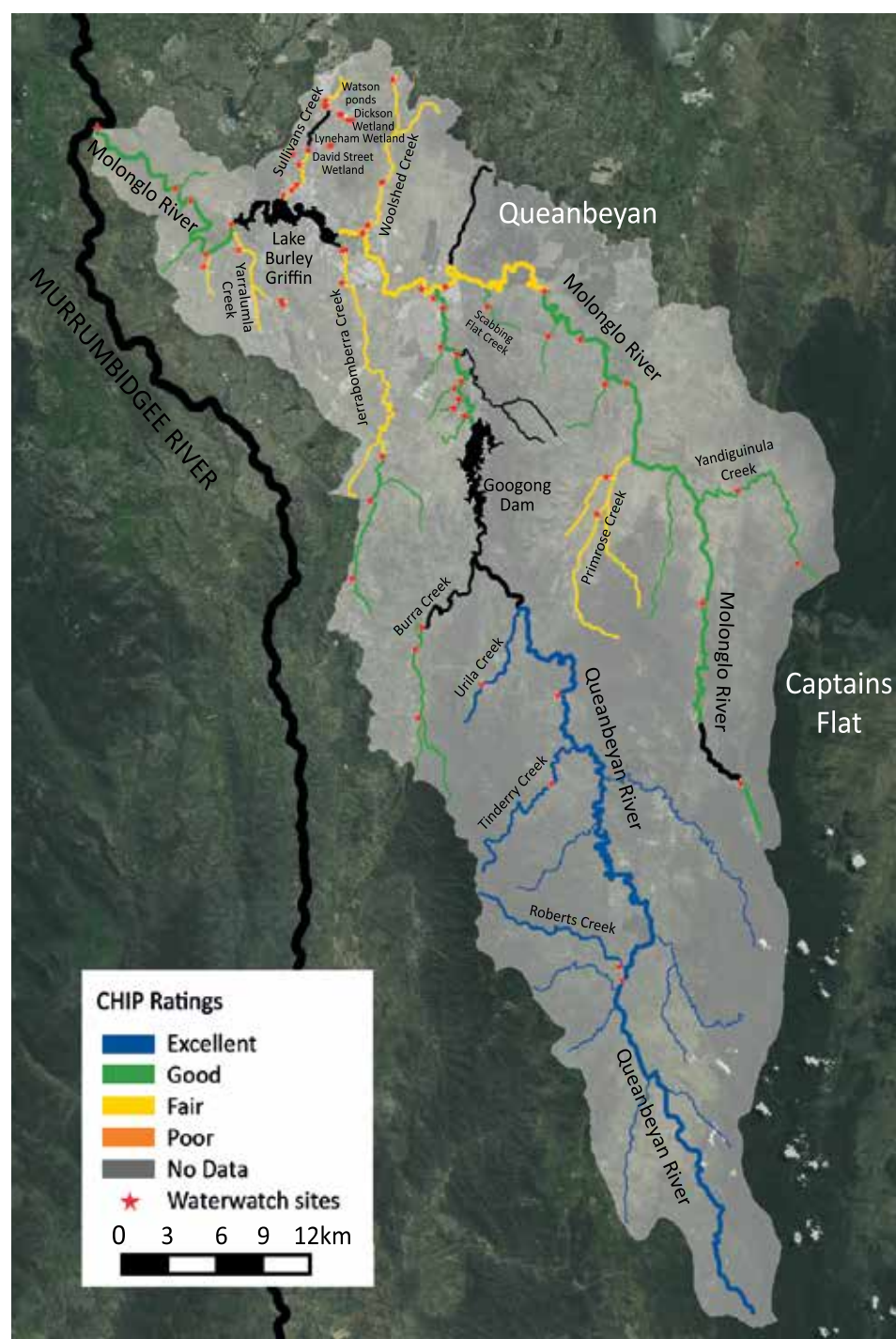
Despite increased flows for a large part of the year, dissolved oxygen rated as 'degraded' in more reaches this year, with 16 reaches affected. This is due in part to the extremely hot dry Summer.

Development sites continue to put stress on our waterways, both in the ACT and NSW, and governments need sufficient resources to monitor these high risk areas, as well as issue warnings and impose fines when breaches are found. We should not consider turbidity an inevitable part of development, when we know

control of sediment is possible if managed correctly.

Waterwatch volunteers play a vital role in keeping an eye on waterways and reporting unusual water quality readings to the relevant authorities. They are our eyes on the ground (or on the water, in this case). Some unusual nitrate readings in Queanbeyan and high turbidity in Watson and downstream of the Googong development on the Queanbeyan River were all reported by our volunteers in the past year.

We thank the many Landcare and Parkcare groups for continuing to work hard to improve our waterways in the Molonglo catchment. We also anticipate the positive impacts from the ACT Healthy Waterways projects, which will begin construction in four key areas in this catchment in the coming year.



Banksia Street Wetland SUW2

Sullivans Creek in O'Connor

2016/17 CHIP Result D+ (Poor)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Data Deficient	2
pH		
Turbidity		
Phosphorus		
Nitrate		
Electrical Conductivity		
Dissolved Oxygen		
Water bug	Degraded	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 0.2Ha
Dominant land uses: Urban, recreation

Banksia St is an artificial 'off-line' wetland constructed in 2010 which includes an ephemeral section. Low flows are diverted from the westerly arm of Sullivans Creek concrete channel, pass through the wetland, then overflow back into the westerly channel when water levels are sufficiently high.

Reach Condition

Without a water quality score, the combined water bug and riparian condition scores made this the worst CHIP score in the Molonglo Catchment this year. However this does not reflect the healthy waterplants and edge plants, the diverse habitat, and the surrounding native vegetation. The riparian condition score only just missed being in the 'good' category.

Water levels are often low in this wetland and, in common with SUW1 David St wetland, dense algal growth made sampling water bugs very difficult. So it is likely that the water bug score is not representative of water quality or habitat health in this loved and well-visited wetland.

The Autumn water bug survey found a Needle Bug - quite a sinister looking large water bug - and five baby yabbies, amongst other types. There were also frogs calling and different types of dragonfly and damselfly adults were seen flying around although no larvae were found in the water bug sampling.

An Eastern long-necked turtle has also been spotted in the wetland.



Volunteers Tania and son Callum at Banksia Street wetland.

Burra Creek BUR1

Headwaters to Burra Road

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Good	16
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 30km

Dominant land uses: Native bush, grazing, rural

Burra Creek arises in the north-western edge of the Tinderry Mountains and flows into the Queanbeyan River just upstream of Googong Dam. This reach comprises the top half of the creek and flows through rural subdivisions and includes the outlet of the pipeline from the Murrumbidgee to Googong water transfer scheme. Riparian vegetation is largely absent or dominated by Willows, but has some extensive reed beds.



Reach Condition

Burra Creek is often subject to low flows and the water bugs can be highly influenced by flow conditions. Winter and Spring rainfall saw higher flows for an extended time giving the Creek a good flush and producing a range of sensitive water bugs in the bug surveys. These included four types of both pollution-sensitive caddisfly and mayfly, as well as a 45mm dragonfly nymph! Both the Spring and Autumn surveys produced a good diversity and number of bugs overall.

There was a slight improvement in electrical conductivity despite it being rated as 'poor', and the lower readings were related to higher flows as the salts and minerals are diluted in the system.

There are still large sections of the Creek with erosion problems, and stock continue to access the Creek in some places. With sodic soils (those high in sodium) in the reach, there is also potential for water logging and salt outbreaks. Thus it is pleasing that revegetation projects and erosion control workshops are continuing, with the aim of improving catchment health and water quality over time.



David Street Wetland SUW1

Sullivans Creek catchment in O'Connor

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	20
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	No Data	
Water bug	Degraded	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 0.21Ha

Dominant land uses: Urban, recreation

David Street Wetland is the second 'offline' wetland along the westerly branch of Sullivans Creek which flows in a concrete stormwater channel. This wetland was constructed in 2001 and takes low flows which pass through the wetland then overflow back into the westerly concrete channel just before it joins the main northern branch.



Reach Condition

This was the only inner urban wetland in the Molonglo catchment to have 'excellent' water quality this year. The result may be influenced by the lack of dissolved oxygen data, which is likely to have reduced the water quality score but it would still be the best result in the urban wetlands.

Water bugs were extremely difficult to sample with the dense algal growth throughout the water and around water plants, so the 'degraded' water bug score probably doesn't do justice to this wetland and its available habitat for water bugs. Algae are an important part of a functioning ecosystem, and excessive algal growth is not always a bad thing, with different types of algae indicating different states of health. The volunteers often reported seeing a type of algae called "snotballs" (Nostoc is a genus of cyanobacteria).

The water plants around this small wetland are diverse, and there are big branches in the water providing more habitat for water bugs, but we were not able to sample them adequately this time.

There was one native Western carp gudgeon found in the Autumn bug survey amongst the many feral Eastern gambusia.



Member of the Parks and Conservation team helping out at O'Connor Wetlands during Autumn Bug Blitz.

Dickson Wetland DIC1

Sullivans Creek catchment

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	16
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Fair	1

Reach Facts

Reach area: approx. 1Ha

Dominant land uses: Urban

Dickson Wetland was constructed in 2011 and is on the lower western slopes near Mt Majura. A large concrete stormwater channel is fed into the constructed wetland, but during high rainfall events the wetland is bypassed. Water from the wetland flows back into the concrete channel and through to Lyneham Wetland just upstream of the confluence with Sullivans Creek.



Reach Condition

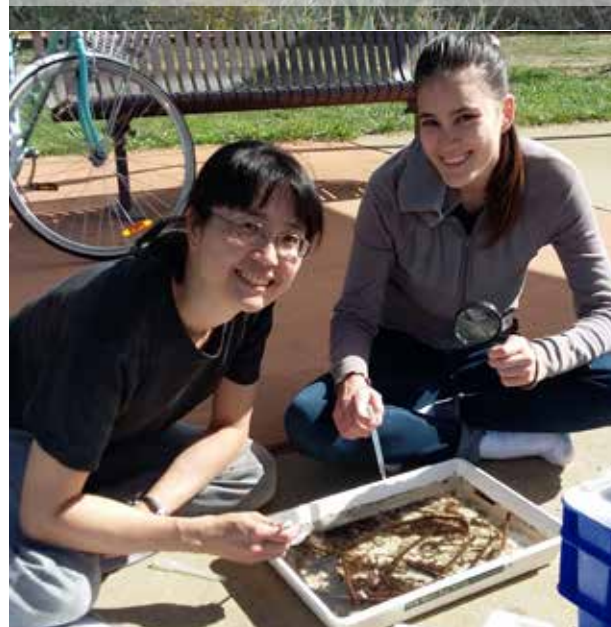
Dickson is a well-loved wetland, with Dickson Wetland Carers regularly weeding and clearing out rubbish. It is often busy with walkers, dogs and children.

This large off-line wetland avoids the high flows from heavy rain. Water quality scored near the lower end of the 'good' category, with nitrate levels in the wetland that are concerning at times. Phosphorus levels are generally very low so algae is less of a problem.

This wetland has an excellent range of habitat types from reed beds, rushes and sedges, to shallows with partly submerged logs to muddy and rocky bottoms. It appears to be establishing well and regularly supports a good diversity of water bugs. Bug surveys revealed several pollution-sensitive types and some unusual finds such as freshwater sponges and small jellyfish.



Dickson Wetland and volunteers Sharon and Ginny identifying bugs (below).



Googong Creek GGG1

Headwaters to Queanbeyan River confluence

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B+ (Good)

Parameter	Rating	No. Survey
Water quality	Good	14
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Water bug	No Data	0
Riparian condition	Good	2

Reach Facts

Reach network length: approx. 1km

Dominant land uses: Native bush, grazing, urban, infrastructure, rural residential

Googong Creek arises in the developing township of Googong, and runs into the Queanbeyan River downstream from Googong Dam. It passes through a stormwater holding dam on the edge of Googong township and crosses a pipeline access track.

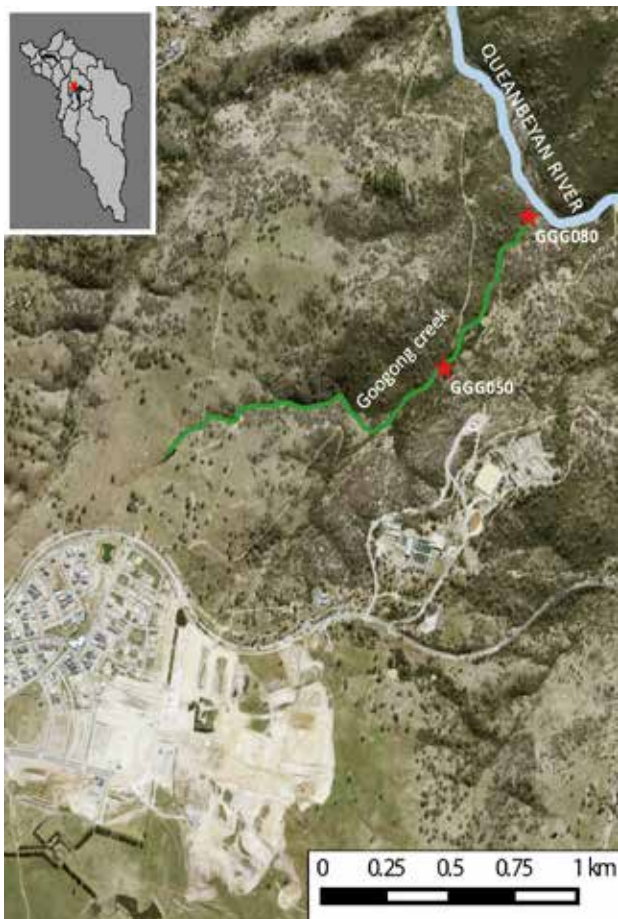
This creates another dam on the creek before reaching the Queanbeyan River upstream of Wickerslack Lane. Googong Creek flows intermittently but now takes discharge from the Googong water recycling plant.

Reach Condition

Though too ephemeral to sample water bugs in, Googong Creek has one of the best vegetation scores in the catchment. Despite serious issues with a range of weeds, it is surrounded by healthy native bush and good in-stream habitat.

Overall, the water quality just missed being in the 'excellent' category. It was very similar to the previous year, with a small improvement in electrical conductivity, slightly worse dissolved oxygen, and nitrate showing occasional high spikes. These changes may be attributed to higher rainfall and the relative contribution that groundwater makes to the lower site on the reach.

Sue the Waterwatch volunteer saw signs of disturbance from pigs around the creek, and regularly saw Platypus feeding in the Queanbeyan River near the confluence with Googong Creek.



Soil disturbance by pigs on Googong Creek. (Photo: Sue Gibson)

Jerrabomberra Creek JER1

Headwaters to Fernleigh Drive

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 15km

Dominant land uses: Native bush, Rural residential,

Jerrabomberra Creek arises in the hills surrounding the rural residential area of Royalla along the south-east side of the ACT border. It has a number of small creeks flowing into it along this section of the creek. The creek channel has some healthy riparian vegetation before flowing into rural subdivisions with very little riparian vegetation.

Reach Condition

Following the wet Winter and Spring in 2016, flows were maintained in both the water bugs surveys. There was a high diversity and a good representation of pollution-sensitive water bugs including stoneflies, mayflies and caddisflies. Because of an improvement in the water bug score, the reach had a better overall CHIP score.

Electrical conductivity (EC) is likely to remain 'poor' in this catchment in the near future because of long term land clearing, with the potential for water logging, salt sites, and also due to sodic soils which are highly erodible. With a relatively small catchment size, arising around Royalla, the Creek is subject to low flows and high temperatures at times, and hence to low dissolved oxygen.

Some plantings are occurring along this reach , thanks to Waterwatchers Peter and Deb who are implementing erosion improvement works with funding through the Molonglo Catchment Group. Improved vegetation cover and riparian plantings should not only see the EC levels improve over time, but the resultant shading will help regulate stream temperature thus even out the dissolved oxygen results. Plus - it will improve the riparian scores over time as well!



Jerrabomberra Creek looking downstream of JER065
- Spring 2016.

Jerrabomberra Creek JER2

Fernleigh Park to Molonglo River confluence

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Fair	30
pH	Excellent	
Turbidity	Fair	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 19km

Dominant land uses: Rural residential, light industrial, urban, conservation, recreation

This reach flows from Fernleigh Park rural residential area and runs past the suburb of Jerrabomberra, the Environa development and the Hume industrial estate. It then flows through Jerrabomberra Grassland Reserve, through some rural land with little riparian vegetation, and then through to Jerrabomberra Wetlands.



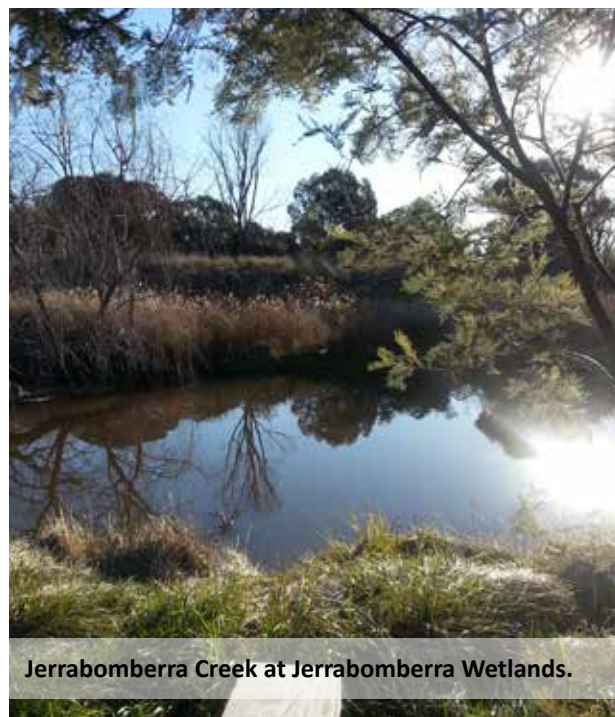
These largely artificial wetlands adjoining the Fyshwick industrial area, capture runoff and stormwater flowing into the creek. The reach also includes the ephemeral Woden Creek and Kelly's Swamp. The water in the bottom part of this reach is backed up and slowed down by Scrivener Dam, which contains the waters of Lake Burley Griffin.

Reach Condition

With the worst water quality score in the catchment, lower Jerrabomberra Creek will have works done as part of the ACT Healthy Waterways project. There will also be work done on improving Fyshwick stormwater flows into Jerrabomberra Wetlands, and these measures together should improve water quality. Stock still have access to the Creek in places which may continue to have an adverse impact.

The worsened water quality score this year was largely due to the phosphorus rating. Kelly's Swamp, however, had a disproportionate influence on this score as it gets very warm and shallow in the Summer months and is subjected to large amounts of poo from water birds. Electrical conductivity at Kelly's is regularly in the four digits, getting as high as 1920µS/cm in March this year after a long dry spell. Most of the water quality parameters at other sites in this reach rated as 'fair' or worse.

Overall water bug numbers were fairly low, despite some excellent in-stream and edge vegetation. Poor water quality is the most likely cause.



Jerrabomberra Creek at Jerrabomberra Wetlands.

Lyneham Wetland LYN1

Sullivans Creek catchment off Wattle Street Lyneham

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Good	5
pH	Excellent	
Turbidity	Good	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Water bug	Degraded	2
Riparian condition	Fair	1

Reach Facts

Reach area: approx. 1Ha

Dominant land uses: Urban

Lyneham Wetland is a large artificial wetland constructed in 2011–12 and is fed by stormwater from surrounding suburbs, including Dickson, and from the large concrete stormwater channel which flows from Dickson Wetlands. Unlike Dickson Wetlands however this is an 'online' wetland which takes all runoff including high flows following storms. Lyneham Wetland overflows into Sullivans Creek when water levels are sufficiently high.



Reach Condition

With low water levels, many edge plants were above the water line, reducing the habitat available for water bugs, which have very limited diversity of habitat in this wetland. This resulted in a 'poor' water bug score, with sample trays greatly dominated by pollution tolerant small crustaceans such as seed shrimps and Daphnia which live mainly in soft sediment and feed on detritus.

Unlike some "off-line" wetlands, Lyneham Wetland receives all the stormwater from a large area including Dickson, and much of Ainslie, Hackett and Downer. Every hard surface that can't absorb water - including roofs, roads, carparks, and pavements - produces runoff that flows into gutters and stormwater channels, along with every bit of rubbish or pollution along the way. This produces a significant challenge for life in Lyneham Wetland. There were at least two major clean ups at this wetland in early 2017 filling dozens of large rubbish bags both times. The deciduous trees adjacent to the wetland put large amounts of leaf litter into the water as well.



Lyneham Wetland with the inlet from the Dickson concrete channel.

Molonglo River MOL1

Headwaters to Captains Flat

2016/17 CHIP Result B (Good)

2015/16 CHIP Result C- (Fair)

Parameter	Rating	No. Survey
Water quality	No Data	0
pH		
Turbidity		
Phosphorus		
Nitrate		
Electrical Conductivity		
Dissolved Oxygen		
Water bug	Excellent	2
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 3.5km

Dominant land uses: Conservation, grazing, rural residential

From its origins in the north western section of Tallaganda National Park in the Great Dividing Range, the Molonglo River flows north through grazing properties to Captains Flat. Apart from the uppermost section of the reach, which is wet sclerophyll forest, it is largely cleared rural land with little or no riparian vegetation.



Reach Condition

This reach had the highest water bug score in the catchment this year. The river is small this far upstream but for a small site it had large numbers and diversity of pollution sensitive water bugs, with 3 different families of mayfly recorded and 4 caddisfly families. Freshwater mussel shells were also spotted here. You will not find these filters feeders downstream of the Captains Flat mine as they cannot cope with the metals in the water.

Despite there being very little riparian vegetation upstream, there is healthy native bush in the sub-catchment surrounding the headwaters, and at the water bug sampling site there is a large remnant native tree as well as a good variety of in-stream vegetation and habitat.

We do not currently collect water quality data, and would still like to recruit a volunteer, to give us important information on water quality upstream of any impacts from Captains Flat mine.



Volunteer Jacob and Woo identifying bugs in Autumn 2017.



Molonglo coordinator Deb Kellock collecting bugs on the Upper Molonglo River - November 2015.

Molonglo River MOL2

Captains Flat to Travelling Stock Reserve

2016/17 CHIP Result B (Good)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	11
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Good	1

Reach Facts

Reach network length: approx. 10km

Dominant land uses: Grazing, rural residential, mining (historical)

The upstream section of this reach of the Molonglo River begins below the Captains Flat Dam. Leachate from a mine closed in the 1960s continues to contaminate the river with acid minewater and potentially with heavy metals. The Molonglo flows through mostly modified rural land and finishes at the Travelling Stock Reserve (TSR) at 'Foxlow'.



Reach Condition

While much of this reach is modified rural land, the riparian condition score is equal highest in the Molonglo catchment. It contains a small but important refuge on the Molonglo River that connects a nearby higher altitude nature reserve to the river corridor.

Water bugs always tell an interesting story on this reach, with diverse habitat provided in sections of riffle, pool and run, and a variety of in-stream and edge vegetation. There were diverse water bugs but they produced a lower score than would be expected from the available habitat, and there were fewer sensitive types despite stonefly nymphs being found in both the Spring and Autumn surveys. Two unusual types of damselfly nymphs are regularly found here that are rare elsewhere in the Molonglo catchment.

Volunteers Wendy and Steve continue to monitor frogs here and to champion weed control along this reach.



Molonglo River at Travelling Stock Reserve.

Molonglo River MOL3

Downstream of Travelling Stock Reserve near 'Foxlow'

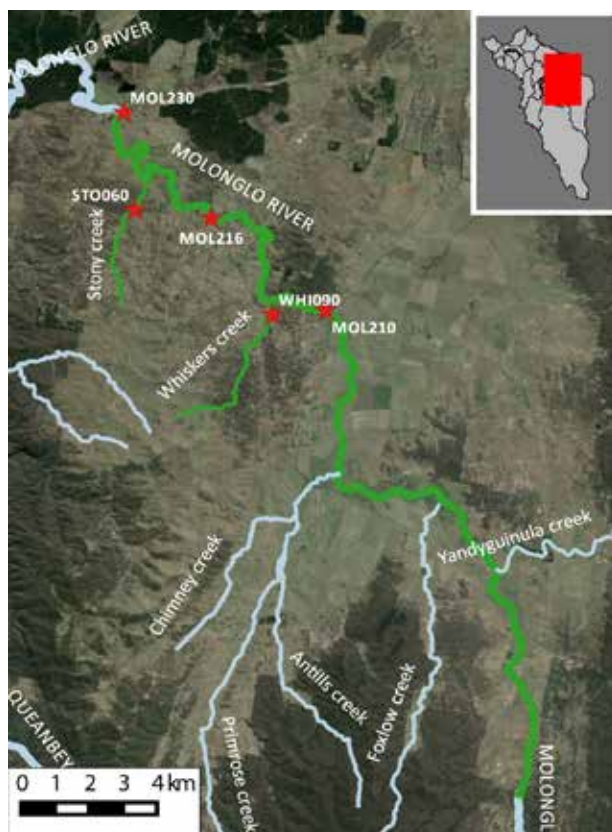
2016/17 CHIP Result B- (Good)		
2015/16 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Good	55
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Poor	5

Reach Facts

Reach network length: approx. 54km

Dominant land uses: Grazing, rural residential

This reach of the Molonglo River extends from below the Travelling Stock Reserve south of 'Foxlow' to Burbong Bridge on the Kings Highway and flows through modified rural land and rural subdivisions. The reach includes Plains Creek, Whiskers Creek and Stony Creek, with runoff from the Hoskinstown Plain, which is largely treeless due to being a frost hollow. Whiskers Creek and Stony Creek are adjacent to small rural subdivisions.



Reach Condition

Although similar to the reach upstream, a slightly better water quality score and water bug score were pulled down by the 'poor' riparian condition score on this section of the Molonglo River. Despite years of revegetation work by local groups, this reach has long sections cleared or dominated by exotic vegetation and accessed by stock.

With five diverse sites on this reach, two of them creeks which often drop to low flows, water quality was fairly consistent with last year and with the reaches upstream and downstream.

Water bugs scores were some of the best in the Molonglo catchment. The pollution-sensitive bug types, such as stonefly, mayfly and caddisfly larvae, were sampled in both Spring and Autumn, but numbers overall were down in Autumn. Despite the dominance of exotic trees amongst the riparian plants, there was reasonable diversity of bug types reflecting some good, if not diverse, edge and in-stream habitat. Whirligig beetles are commonly seen here and there are large numbers of feral Eastern gambusia fish.



Molonglo River below Briars Sharrow Rd crossing.

Molonglo River MOL4

Downstream of Burbong Bridge to Queanbeyan River confluence

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

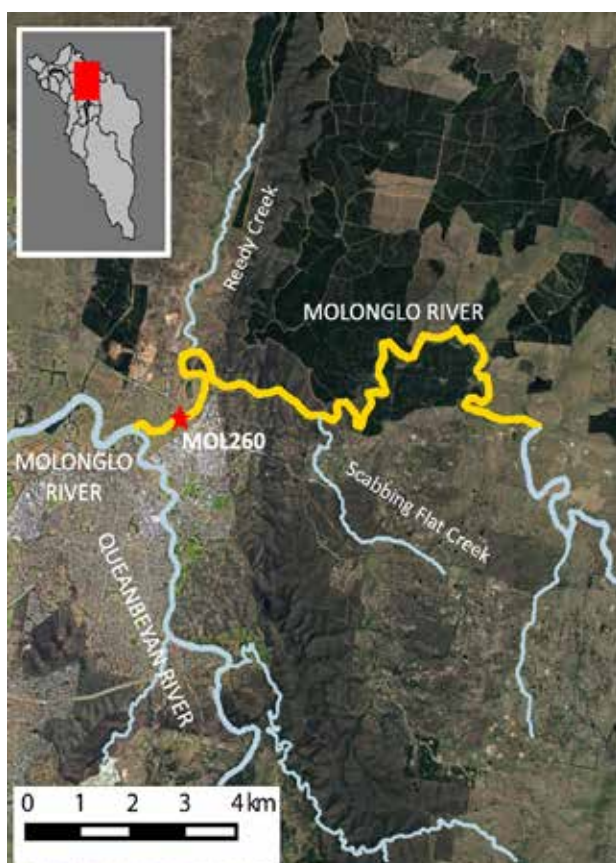
Parameter	Rating	No. Survey
Water quality	Good	11
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 16km

Dominant land uses: Grazing, rural residential, forestry, conservation, urban

This reach begins downstream of the Kings Highway at Burbong Bridge on the NSW/ACT border, passes through the southern section of Kowen Forest pine plantation, and through Molonglo Gorge with its intact native vegetation, and ends above the Molonglo River's confluence with the Queanbeyan River at Oaks Estate.



Reach Condition

Although there is plenty of edge vegetation in the single site monitored on this reach, it has very little diversity. The largely cleared rural land upstream has a mix of native and exotic vegetation and riparian weeds are an ongoing issue.

Further upstream, Molonglo Gorge has a positive impact from its healthy native riparian vegetation and fast flows through rocky, steep sections of the River, which adds oxygen to the water.

It was a nice surprise to find a small number of pollution-sensitive stonefly larvae during the Spring survey. There were other sensitive species too and it probably resulted from the unusual, extended, wet weather that preceded the survey, providing a good flush to the system. Artificial cobbles at the Waterwatch site provide useful habitat for stonefly larvae if flow and water quality are good enough.

Three of our most common feral fish: Carp, Redfin perch and Eastern gambusia, have all been sighted in this reach in the past year.



Volunteer John Bisset looking for water bugs (top) and Molonglo River above Yass Road bridge (bottom).

Molonglo River MOL5

Upstream of Lake Burley Griffin

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	16
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 10km

Dominant land uses: Urban, industrial, horticulture, grazing

This section of the Molonglo River begins at its confluence with the Queanbeyan River at Oaks Estate, continues on past Fyshwick industrial estate and Pialligo nurseries, close to Canberra airport, then passes an extensive turf growing business. It forms the northern boundary of Jerrabomberra Wetlands Nature Reserve before entering Lake Burley Griffin.



Much of the water in this part of the Molonglo River is backed up and slowed down by the presence of Scrivener Dam at the bottom of Lake Burley Griffin.

Reach Condition

Water quality was slightly down this year compared to last, with dissolved oxygen being the main difference and frequently very low this year. Despite the 'poor' Electrical conductivity, it is notably lower by an average of 100-200µS/cm than the reach upstream. This is due to the much cleaner Queanbeyan River diluting the Molonglo River at Oaks Estate.

Water bugs were dominated in the Spring survey by pollution-tolerant types such as 300+ 'true bugs' (Hemiptera). There was also a limited diversity of bug types which matched the limited habitat diversity. At the 'water ski area', where water bugs are sampled, logs and other structures in the water are actively removed, reducing potential habitat.

Platypus and Water rats continue to be regularly spotted in this reach, albeit in small numbers. This area is also popular with kayakers.



Exotic trees dominate the riparian zone along the Molonglo Reach.

Molonglo River MOL6

Lake Burley Griffin to Murrumbidgee River confluence

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result B- (Good)

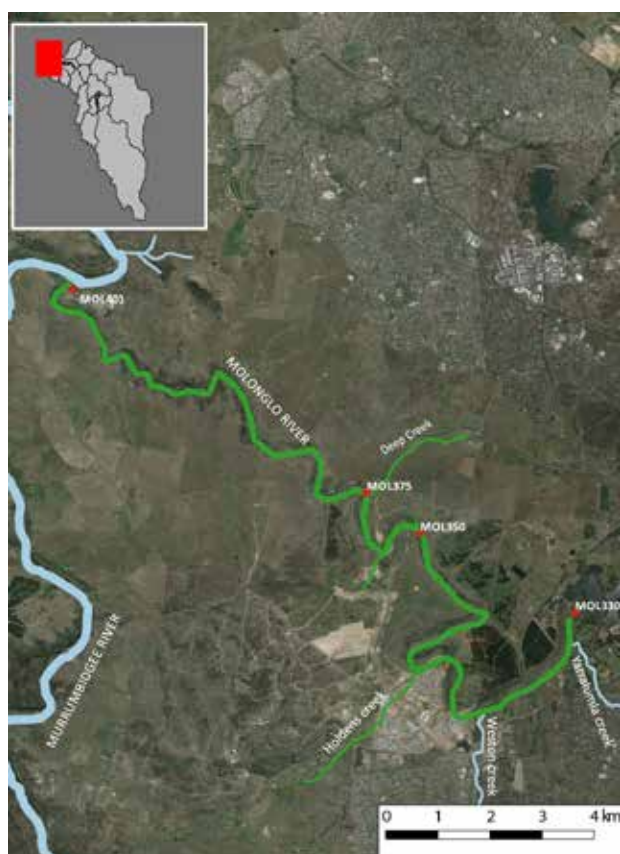
Parameter	Rating	No. Survey
Water quality	Excellent	27
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Water bug	Fair	3
Riparian condition	Poor	5

Reach Facts

Reach network length: approx. 26km

Dominant land uses: Urban, grazing, conservation

This reach on the Molonglo River extends from directly downstream of Lake Burley Griffin to the Murrumbidgee River confluence. It includes the new and future Molonglo Valley urban developments, the new Molonglo River Reserve, Coppins Crossing picnic area and the Lower Molonglo Water Quality Control Centre (LMWQCC) just above the confluence.



This reach will be targeted by the ACT Healthy Waterways (Basin Project) with works aimed at improving water quality.

Reach Condition

With flows determined by how much water is released from Scrivener Dam, as well as high runoff from Woden Valley during rainfall events, this reach has its share of pressures. The relative contribution of each sampling site to the water quality scores is also highly variable, with only one water quality record from the site below the LMWQCC this year. This meant water quality was much better this year, with dissolved oxygen and nitrate showing improvements.

Spring high flows on this downstream reach made sampling water bugs difficult and Summer sampling was necessary. There was reasonable diversity of water bugs but numbers overall were fairly low.

The feral fish Carp, Eastern gambusia and Redfin perch have all been sighted in this reach. On the upside, there were a couple of native Western carp gudgeon caught in the Spring bug survey.

Platypus were seen several times during the year in this reach with a young one sighted in late December – probably having recently left its burrow for the first time.



Molonglo River near Deep Creek at MOL375.

Primrose Creek PRI1

Headwaters to Molonglo River confluence

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

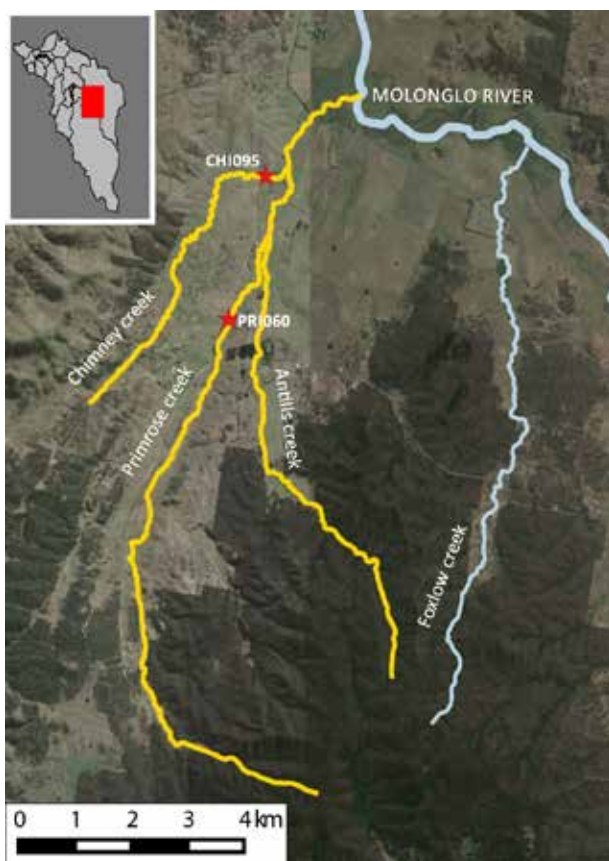
Parameter	Rating	No. Survey
Water quality	Excellent	10
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Water bug	Fair	1
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 34km

Dominant land uses: Conservation, grazing, rural

Primrose Creek is a chain of ponds with headwaters in Yanununbeyan State Conservation Area and Mount Foxlow. It includes Chimney Creek and Antills Creek, and flows into the Molonglo River near Carwoola. The lower section of Primrose Creek is actively eroding. There is little or no riparian vegetation except at the headwaters of Primrose Creek and Antills Creek. The reach flows mostly through rural land.



Reach Condition

This small creek system often has low flows but is important in the area and supports a surprising amount of life in its pools. Water quality is slightly better than last year, with only electrical conductivity pulling it down from 'excellent' across all the water quality parameters measured. The high electrical conductivity (210-920µS/cm) likely results from both underlying geology and widespread historic land clearing.

This cleared land has resulted in the riparian condition score in this reach being amongst the worst in the Molonglo catchment, with only a few water plants and very scattered areas of exotic vegetation present.

Given the little edge and in-stream vegetation providing habitat, the water bugs were surprisingly diverse and there were large numbers of some sensitive types including 500+ mayfly nymphs!



Primrose Creek looking downstream of PRI060.

Queanbeyan River QUE1

Upstream of Googong Dam

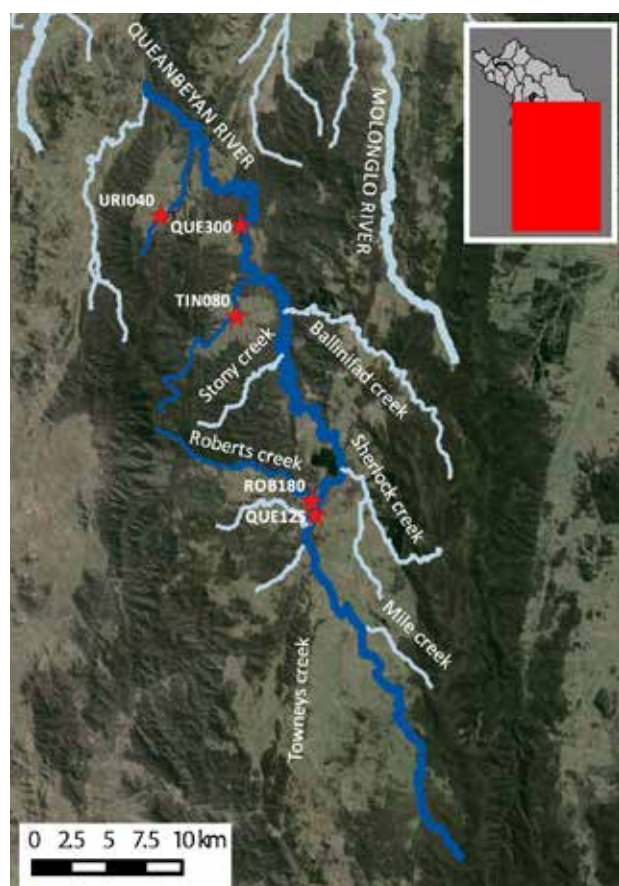
2016/17 CHIP Result A- (Excellent)		
2015/16 CHIP Result A- (Excellent)		
Parameter	Rating	No. Survey
Water quality	Excellent	44
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Water bug	Good	2
Riparian condition	Good	5

Reach Facts

Reach network length: approx. 143km

Dominant land uses: Conservation, grazing, rural residential

The upper section of the Queanbeyan River is a extensive stretch of river that runs from its origins on the southern slopes of the western Tinderry Ranges to Googong Dam. The reach includes Sherlock Creek, Urialla Creek, Tinderry Creek, Roberts Creek and Bradleys Creek.



Reach Condition

This reach had the best overall CHIP score in the Molonglo catchment, and once again it is the only reach to gain an 'excellent' score.

Water quality and water bugs are both intrinsically linked to vegetation condition and quality of habitat, and this upper catchment shows all the signs of good health. This is also evident in the flows in this reach continuing for longer after decent rain and not rising as suddenly when there is heavier rain. This happens when water is absorbed into the landscape and released slowly.

Water quality was slightly lower this year, with electrical conductivity and dissolved oxygen slightly down on last year. Volunteer Sandy at QUE300 was concerned with unusual white foam on the river, but we were able to confirm that it had natural causes, resulting from high flows washing old organic material (leaves, bark and twigs) out of deep pools.

Sandy said in September 2016: "River still very high and strong. Tracks in wet sand tell it all - large and small wombat, kangaroos, deer and water birds in abundance."



Roberts Creek ROB180 in the upper Queanbeyan catchment.

Queanbeyan River QUE2

Downstream of Googong Dam to city of Queanbeyan

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	38
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Water bug	Good	2
Riparian condition	Fair	5

Reach Facts

Reach network length: approx. 6.7km

Dominant land uses: Urban, rural residential

This section of the Queanbeyan River extends downstream from Googong Dam to the edge of Queanbeyan city. Googong, Montgomery and Gorge Creeks near the Googong township, feed into this reach as well as Valley Creek flowing out of Cuumbuen Nature Reserve. Googong Creek (GGG1) is treated as a separate reach in this report.

Reach Condition

Although this reach has the best water quality in the Molonglo catchment this year, there have been some serious sediment events in the Queanbeyan River downstream of the developing Googong township. These events have often occurred between monthly sampling times but have been witnessed by one of the volunteers, Sue, who lives on the River. Sue is continuing to request better sediment control during development and building at Googong.

High turbidity events have been recorded in this reach over the past four years and have the detrimental effect of clogging up the gaps in and around submerged plants and rocks where water bugs live. Given that Platypus eat up to a third of their body weight every day in water bugs, one must assume this places an added pressure on them as well.

There was an interesting period of unexpected high flows in Gorge Creek when flows in most of the catchment had dropped considerably in late Summer. It coincided with high flows in another small subcatchment nearby and was probably caused by groundwater flows joining up following an unusually wet Winter and Spring.



Sue testing Gorge Creek at GOR090.

Queanbeyan River QUE3

Queanbeyan city to Molonglo River confluence

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	28
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Excellent	
Water bug	Good	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 9.4km

Dominant land uses: Urban

This section of the Queanbeyan River extends through the city of Queanbeyan to its confluence with the Molonglo River. It takes in runoff from Queanbeyan and its suburbs (including a golf course), the Cuumbuen Nature Reserve and the eastern slopes of Mt Jerrabomberra. The reach includes Barracks Creek and the Queanbeyan Weir.



Reach Condition

Apart from a unusual sediment event in March (37NTU), turbidity was 'excellent' in this reach. There were persistently high nitrate readings in Barracks Creek, but the source is unknown. The good Winter and Spring rains gave this River a good flush and nitrate improved in this reach as did the water quality score overall.

Montgomery Creek experienced high flows and slightly lower electrical conductivity in late summer when flows in the catchment were generally very low and electrical conductivity was increasing. This occurred in a nearby sub-catchment on the other side of the ridge too, and investigation suggested that slow moving groundwater was the likely water source.

Water bugs were diverse, with some sensitive types present, but numbers overall were low. Platypus and Water rats are present in good numbers in this reach and Waterwatch host a Platypus Walk here every year during Platypus Month (August).



Queanbeyan River (QUE495) under railway bridge.

Scabbing Flat Creek SCA1

Headwaters to Kings Highway

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result DD (Data Deficient)

Parameter	Rating	No. Survey
Water quality	Good	5
pH	Fair	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	No Data	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	No Data	0
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 5.1km

Dominant land uses: Conservation

Scabbing Flat Creek is an ephemeral creek which arises in Cuumbeun Nature Reserve. Most of the creek catchment is in the Nature Reserve, which is high value Grassy Box Woodland, bisected by Captains Flat Road. The Kings Highway marks the northern edge of the reserve and the creek flows in a concrete culvert under the Kings Highway, where it eventually flows into the Molonglo River beyond this reach.



Reach Condition

This creek is often dry, and is too small for sampling water bugs, but this year it flowed often enough to gain a water quality score. A suspect nitrate test kit meant three months nitrate data was discarded, so that parameter did not meet the data threshold.

Although water quality was 'good' overall, flows have a strong impact on water quality in such a small creek. Low flows and warmer water were closely related to higher electrical conductivity, lower dissolved oxygen and lower pH.

Even when decent rainfall events were recorded, this creek ran crystal clear, reflecting a healthy and intact catchment upstream. Riparian condition improves upstream, further into Cuumbeun Nature Reserve.

The volunteer here, John, has recorded yabbies, leeches and tadpoles in the creek during water quality sampling.



Scabbing Flat Creek near the Kings Highway.

Sullivans Creek SUL1

Headwaters to Randwick and Flemington Road Pond, Mitchell

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result D+ (Poor)

Parameter	Rating	No. Survey
Water quality	Data Deficient	4
pH		
Turbidity		
Phosphorus		
Nitrate		
Electrical Conductivity		
Dissolved Oxygen		
Water bug	Fair	2
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 6km

Dominant land uses: Conservation, grazing (historical), industrial

Sullivans Creek originates in Goorooyarroo Nature Reserve, flows through historical grazing land then into a concrete channel. It then flows through the new suburb of Kenny, west of Watson, and adjoins the industrial area of Mitchell where it includes the stormwater channel from Exhibition Park (EPIC) and flows through two constructed wetlands.



Reach Condition

There were interesting water bug results this year. In both Spring and Autumn surveys, microcaddis larvae - in their small silken purse-like cases - were found, as well as a type of bivalve known as pea shells. There was a good diversity of water bug types overall, as well as some sensitive types, although the less sensitive water bugs predominated such as snails, fly larvae and water beetles.

This diversity of water bugs is testament to the fairly diverse habitat available in this pond/wetland, including "snags" (old trees or branches) lying in the water, different depths, and a diversity of edge vegetation. Despite this, surrounding vegetation is patchy, and the upstream site is on a concrete channel, resulting in a 'poor' overall riparian condition score.

There was insufficient data this year to provide a water quality score, but phosphorus levels are increasing over time, and a lot of algae floating on the surface and around the edge vegetation made water bug sampling difficult.

An Eastern long necked turtle was seen in Flemington Pond, as were a variety of water birds.



View across Flemington Pond towards SUL018.
(Photo: Michael Burton)

Sullivans Creek ANU SUL3

Lyneham Wetland to Lake Burley Griffin confluence

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	Good	33
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 3.7km

Dominant land uses: Urban, recreation

This section of Sullivans Creek flows into a concrete channel through playing fields and parklands in O'Connor and Turner. It crosses under a number of minor roads and through the Barry Drive gross pollution trap before entering ANU campus. It passes Toad Hall pond, before continuing through the campus and flowing into Lake Burley Griffin.



Reach Condition

Water quality remained just within the 'good' category this year, but very high phosphorus (as high as 0.4mg/L) remains a concern. It can only be assumed that the high volume of deciduous leaves that are washed down from the established suburbs upstream are contributing to this but levels fall into the 'degraded' category all year round. Not surprisingly, there were frequent reports of algae from volunteer, Tim. While the turbidity results were 'excellent' overall, there were a number of results >16 NTU.

The downstream site where water bugs are sampled has water quality strongly influenced by Lake Burley Griffin, which backs up water into the Creek. No pollution-sensitive water bugs types were found, however, despite good diversity overall and patches of edge vegetation.

We saw Carp spawning during the Spring bug survey, with much splashing! There were also many Eastern gambusia seen - another significant pest fish species. On the upside, a small Eastern long necked turtle and a native Western carp gudgeon were caught during the Autumn survey.

The riparian condition score has dropped now that all three sites have received a riparian score. A development site next to the creek has the potential to impact water quality and habitat health.



The ever-reliable Tim Yiu of ANUgreen Sustainability who monitors all 3 sites on SUL3.

Watson Wetlands and Ponds WAT1

Justice Robert Hope Park to Aspinall Street

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	Good	25
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Poor	4

Reach Facts

Reach network length: approx. 1.4km

Dominant land uses: Conservation, urban

Watson Wetlands and ponds on the lower western slopes of Mt Majura comprise a drainage line, with two dams in remnant yellow box/red gum grassy woodland which overflow during high rainfall. Further down, a small constructed wetland receives runoff from the adjacent suburb, and a small wetland “soak” takes overflows at the bottom of the reach, with water then flowing via pipes into Sullivans Creek.



Reach Condition

The factors affecting the different sites on this reach are quite different, with only the prevailing weather being a common factor. North Watson is seeing further development, and sediment-laden runoff was evident in many stormwater drains and in the wetland and “soak” at the bottom of the reach from March onwards with turbidity readings exceeding 200NTU three months in a row at WAT030.

Water quality has dropped slightly this year, largely due to the above-mentioned turbidity. With water bugs and riparian condition the same as last year, the poorer water quality pushed the overall CHIP score down slightly.

Water bugs were not very diverse and most were pollution tolerant types, perhaps not surprising given the limited habitat available in the pond being sampled. There was dense algae present for both samples, and high sediment evident during the Autumn sample.



Volunteer Richard Larson at WAT040 near Aspinall Street.

Weston Creek WES1

Headwaters to Molonglo River confluence

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Fair	14
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 6.7km

Dominant land uses: Urban

Weston Creek reach includes drainage from the western side of Mt Taylor, and Stirling Ridge. It flows in a concrete stormwater channel through the Canberra suburban area of Weston Creek before entering ponds south-east of the new Molonglo development. It then passes close to the new Molonglo development's eastern side and on to the confluence with the Molonglo River.



Reach Condition

Weston Creek had identical scores to last year. It had one of the worst riparian condition and worst water quality scores in the Molonglo catchment. With most water flowing through concrete channels, and two large sediment ponds with accumulated nutrients, only the final section of the Creek, which has reeds and some natural streambank, provides any good habitat or any function to filter out pollutants.

Phosphorus continues to be a concern in this reach, with variable but often very high readings (up to 0.18mg/L in December/January). This phosphorus contributes to the eutrophic conditions that make algal "blooms" and smelly or even toxic water much more likely. Despite the 'excellent' turbidity rating, there were mixed results with a 150NTU spike in February.

Water bugs reflect the water quality and limited habitat, being reasonably diverse overall, but in low numbers, with a dominance of pollution-tolerant types such as black-fly larvae.



North Weston Pond in the new Molonglo development.

Woolshed Creek WOO1

Headwaters to Molonglo River confluence

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Good	18
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Degraded	3

Reach Facts

Reach network length: approx. 19km

Dominant land uses: Rural, urban, site of Majura Parkway

Woolshed Creek originates at a farm dam situated over a spring at the top of the catchment. It flows through highly modified rural land with some native riparian vegetation in the higher section and some significant waterholes. Two short sections of the creek were moved to make way for Majura Parkway.



The creek joins the Molonglo River near Fairbairn Avenue, just upstream of Lake Burley Griffin. Lower Woolshed Creek has an important fossil site.

Reach Condition

Water quality was identical to last year with both electrical conductivity (EC) and dissolved oxygen continuing to be a problem. The middle section of this creek has particularly high EC, which is associated with historic land clearing, and such salt accumulations are exacerbated by the hydrogeology of the valley. When flows are high, which is rare in this small creek, EC is much lower as it becomes diluted.

The bottom site on this reach (WOO090), where water bugs were sampled, has faced challenges from the Majura Parkway road works and continuing high traffic flows. There is often rubbish accumulated downstream, and dust and fumes are very evident. There is some good in-stream and edge vegetation and some varied habitat supporting a diversity of water bugs, but pollution-tolerant bug types dominate such as snails and fly larvae.

With a 'degraded' riparian condition rating, this reach could do with some riparian plantings to improve its current sorry state. Greening Australia is working with various landholders in this catchment and have conducted some plantings along the creek corridor.



Woolshed Creek at WOO090 near Fairbairn Avenue.

Yandyguinula Creek YAN1

Headwaters to Molonglo River confluence

2016/17 CHIP Result B (Good)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	22
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Good	2

Reach Facts

Reach network length: approx. 18km

Dominant land uses: Conservation, grazing, wetlands

Yandyguinula Creek is an ephemeral tributary of the Molonglo River, with the confluence on 'Foxlow' near Hoskinstown. It arises in Tallaganda National Park on the western side of the Great Dividing Range, and flows into modified rural land with little or no riparian vegetation other than Willows. Near its confluence with the Molonglo River, it passes through an extensive wetland area which supports a significant bird population.



Reach Condition

The Yandyguinula Creek catchment is still largely intact, with only the lower portion of the reach being cleared rural lands with exotic vegetation. The riparian condition score reflects this, being one of the best in the catchment.

Water quality this year was slightly better than last, with the electrical conductivity rating improved to 'excellent'. There is, however, a marked contrast in electrical conductivity between the upstream site ($\leq 60\mu\text{S}/\text{cm}$) and downstream site ($\leq 470\mu\text{S}/\text{cm}$), highlighting the effects of modified rural land on our waterways.

With dense in-stream and edge vegetation at the downstream water bug site, there were large numbers of water bugs and good diversity, but not all sensitive types were found. Scuds or side-swimmers (Amphipoda) are commonly found here in large numbers, but rare across the Molonglo catchment.

Juvenile Brown trout and large numbers of yabbies have been seen in the very clear water by volunteer John.



Yarralumla Creek YAR1

Headwaters to Molonglo River confluence

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	26
pH	Excellent	
Turbidity	Fair	
Total Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Fair	3

Reach Facts

Reach network length: approx. 9km

Dominant land uses: Conservation, urban

This is one of two main creek systems draining into the Molonglo River below Scrivener Dam. Yarralumla Creek includes three drain lines, one along the west side of Mt Mugga Mugga, one from Farrer to Phillip, and one from Long Gully to Garran. These drain lines run largely in concrete channels.



Yarralumla Creek then runs parallel with Curtin in a concrete stormwater channel then down through a deeply incised channel to the Molonglo River immediately below Scrivener Dam. The reach includes East O'Malley Pond. Yarralumla Creek is a priority catchment for the ACT Healthy Waterways (Basin Project) with works aimed at improving water quality.

Reach Condition

It's great to have a new volunteer family take over the bottom site on this important reach, and to have continued support from our dedicated volunteer Mike at East O'Malley pond.

Water quality reflects a highly urbanised reach with little opportunity for natural filtering with all the kilometres of concrete channel that carry water in this reach. Electrical conductivity levels were high during the low flows in February at O'Malley Pond (850µS/cm) as well as at YAR400 at the bottom of the catchment (600µS/cm).

There are some diverse water plants immediately upstream of the bottom site near Cotter Rd, which support water bugs, and the volunteers saw a Water rat there. However conditions are challenging at times because water levels can rapidly rise by one metre or more due to the amount of impervious surfaces in the catchment.



Yarralumla Creek looking upstream of YAR400.

Southern ACT Catchment Facts

For this CHIP report, the Southern ACT area is divided into subcatchments based around 7 main rivers/lake systems in the region which are Murrumbidgee River, Naas River, Gudgenby River, Cotter River, Paddy's River, Lake Tuggeranong and Point Hut Ponds.

The Naas and the Gudgenby River systems are the highest in the ACT and originate in the mountains of the Namadji National Park. The Cotter River provides our main drinking supply and flows north adjacent to the Brindabella Ranges. Paddy's River is a smaller rural water way flowing to the west of the Bullen Range past forestry land and grazing properties to the immediate west of Canberra. The Lake Tuggeranong and Point Hut Ponds systems comprise predominately urban waterways flowing from the east of the ACT into the two lakes at their western ends. The Lake Tuggeranong inflows are extensively engineered with pipes and concrete channels. The Point Hut Ponds inflows are younger and feature upstream wetlands and terraced, vegetated stormwater channels.

All of these waterways join the Murrumbidgee River in the ACT, which flows north from Angle Crossing near Tharwa to Uriarra Crossing just before the Molonglo River confluence in the north west corner of the ACT. The Murrumbidgee River from Angle Crossing to Casuarina Sands is part of the Upper Murrumbidgee Demonstration Reach (UMDR).



Southern ACT Catchment Health Summary

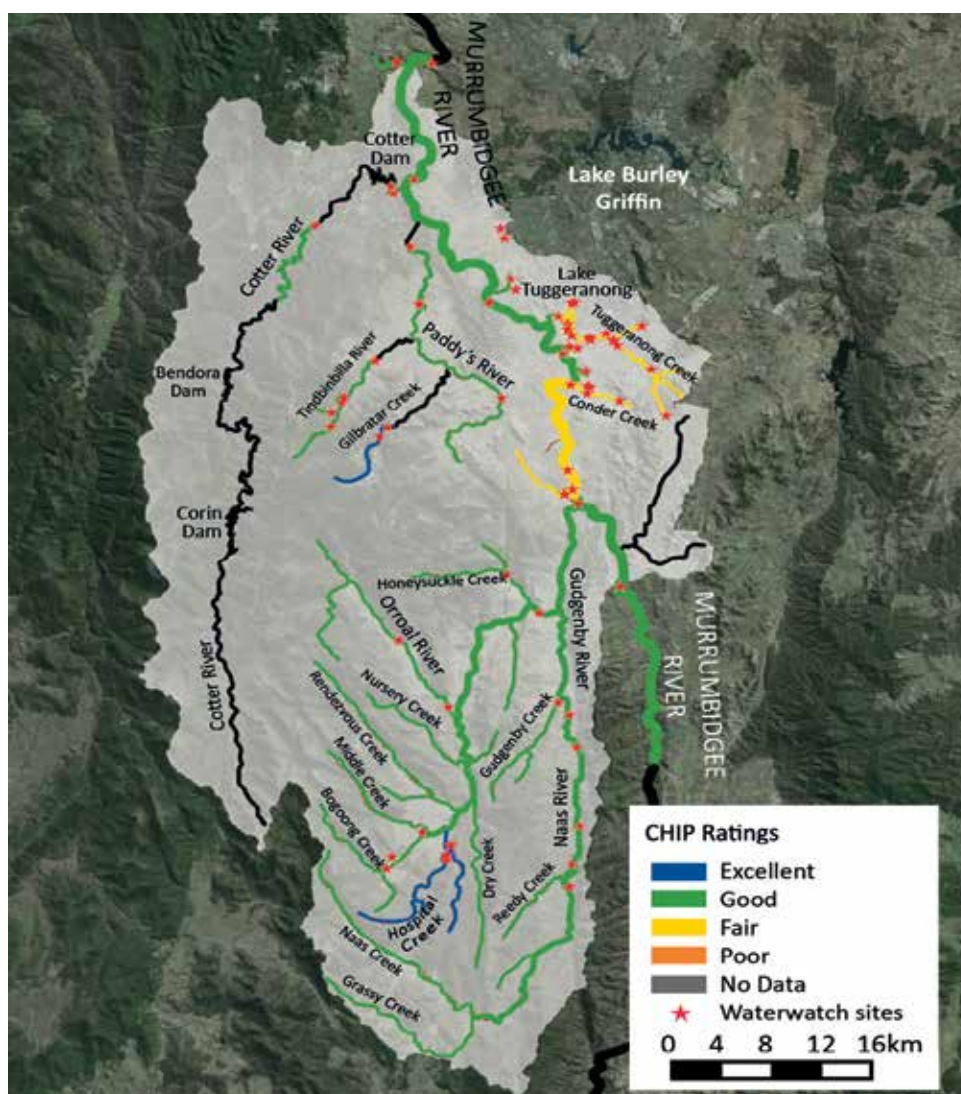
A quick look at the CHIP scores across the Southern ACT catchments gives the reasonable impression of improved waterway health in the last twelve months. Jumping up a grade were Hospital Creek in Namadji National Park and Barney's Gully in Gordon as well and the lower stretches of the Murrumbidgee River and parts of Tuggeranong Creek.

Very wet months over Winter and Spring 2016 as well as in late Autumn 2017 no doubt had a part to play in this improvement with groundwater tables being replenished and continuous flows being seen even in our concrete drains.

The Spring rains prior had a positive effect on bug surveys as many sensitive aquatic invertebrates respond well to improved flows. The good falls in March however were not quite enough to support reasonable populations of highly sensitive bugs, in particular stonefly larvae, as has happened in previous years.

The good falls were in sharp contrast to the extremely hot and dry months we endured at the start of the year. Many waterways became quite stressed through being nearly dry or oxygen deprived. The water levels in our urban lakes were below their weirs from January to March.

This April saw the beginning of major works in the Lake Tuggeranong catchment with the draining of Isabella Pond as part of a major wetland improvement under the joint Australian and ACT government funded 'Healthy Waterways' initiative. More projects will be implemented across the Tuggeranong catchment over the next year ACT. The pond draining was also used to conduct a comprehensive Carp removal of two connected urban lakes by ACT Government's Conservation Research team. Samples collected from this are providing valuable information on the nature of urban Carp populations which will be essential for planning around the implementation of the Carp herpes virus if it is eventually released.'



Barney's Gully MMB1

Woodcock Drive, Gordon to confluence with Murrumbidgee River

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Good	11
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 1km

Dominant land uses: Peri urban, conservation and recreation

Barney's Gully is an ephemeral creek off Woodcock Drive, Gordon. This natural creek is connected to the suburban stormwater system of the suburb of Gordon and flows into the Murrumbidgee just over a kilometre downstream of Point Hut Crossing.

Reach Condition

With a healthier CHIP score this year, Barneys Gully continues to show improvements as the work from the 'POSM' Parkcare group makes a positive impact.

Warm water temperatures kept oxygen levels low over summer but the leaky weirs and erosion control works along the creek have meant a major increase in water retention since Southern ACT Waterwatch Coordinator, Martin Lind, first worked there with Calwell High School students back the late 90's. Back then, the gully used to be mostly dry all year apart from after significant rain. There are now numerous permanent pools of water.

As the vegetation grows around the Gully and planted trees begin to provide more shade, the water temperature fluctuations will decrease and the microclimate of the gully will provide a valuable haven for aquatic life. The Gully continues to record elevated electrical conductivity readings through dissolved minerals leaching from the soil, as was the case 20 years ago. At the time, Martin recorded finding large crystal of salt deposited along the water's edge which, thankfully, is no longer the case.



Barney's Gully - October 2015. (Photo: D. Kellock)

Bogong Creek Catchment CGB1

Headwaters to Yankee Hat trail bridge

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B (Good)

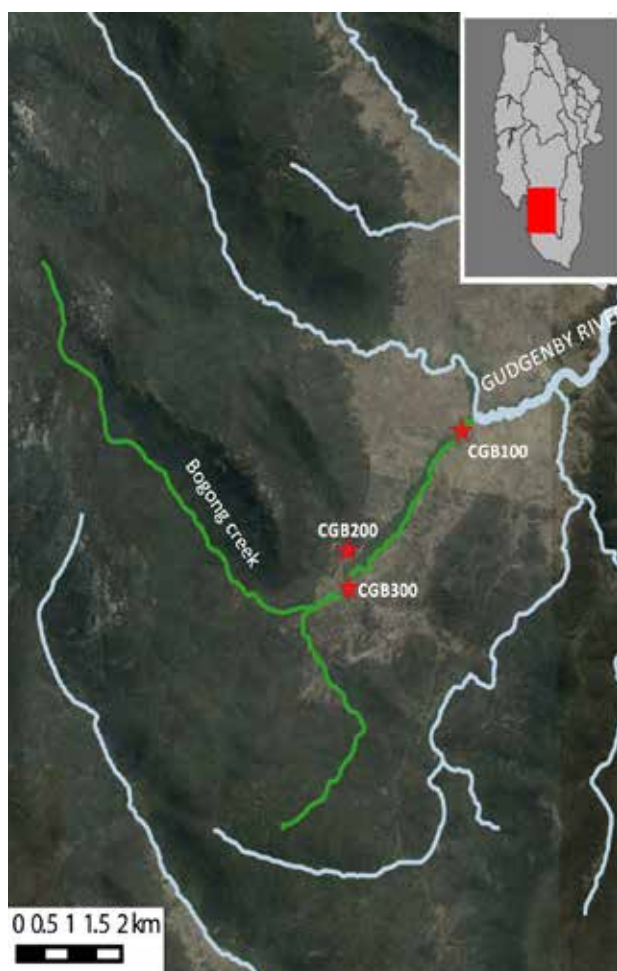
Parameter	Rating	No. Survey
Water quality	Excellent	24
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Water bug	Excellent	2
Riparian condition	Fair	3

Reach Facts

Reach network length: approx 13km

Dominant land uses: Conservation

Part of the Gudgenby River catchment. At its downstream end Bogong Creek is a wide and mostly treeless upland creek/bog flowing north-east in the middle of Namadji National Park.



Reach Condition

The Brindabella Venturers began bimonthly monitoring last December, to complement that of the Gudgenby Bush Regenerators Parkcare group, so we received 50% more data this period. The slightly improved health score may, to some extent, be attributed to this greater scrutiny.

A very wet season kept the volunteers locked out of Namadji National Park for much of spring last year. This ensured, however, that plenty of highly sensitive water bugs were found in November with 60 stoneflies and 100+ mayflies recorded.

Over summer this reach, like many, suffered badly from the extremely dry conditions. Much of Bogong Creek was reduced to isolated pools which pulled down the dissolved oxygen levels. Good March rain saw dissolved oxygen increase as the water cooled down and the flows returned.



The Gudgenby Bush Regenerators conducting the Spring bug survey at Bogong Creek (CGB100).

Coolleman Ridge Dams RAN1

Two dams on Coolleman Ridge

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C- (Fair)

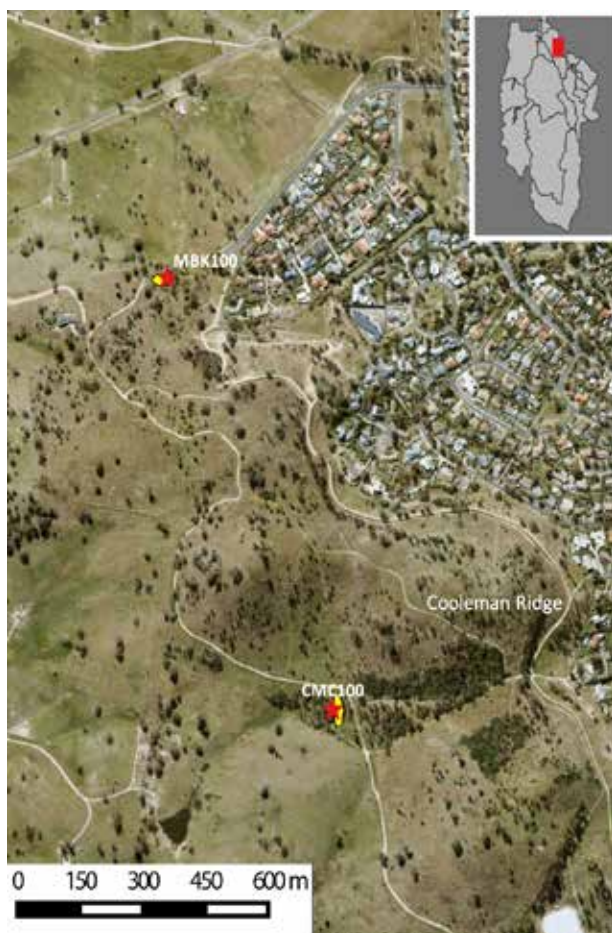
Parameter	Rating	No. Survey
Water quality	Good	24
pH	Fair	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Water bug	Poor	2
Riparian condition	Poor	2

Reach Facts

Reach network area: approx. Kathner Street Dam 0.05Ha, Old Dam 0.15Ha

Dominant land uses: Suburban reserve

Kathner Street Dam is a small dam in Coolleman Ridge Nature Park. It was built to provide water for horses as part of the bicentennial horse trail. The 'Old Dam' is on the eastern slopes of Coolleman Ridge.



Reach Condition

The ever present high turbidity and moderately high nutrients fed a very green blue/green algal bloom in both monitored dams in November. The pH of the dams dropped below the critical level of 6 for most of the summer. Turbidity at both dams continues to be a problem – particularly at Kathner Street dam where the turbidity results were at degraded levels all year, ranging between 30-70NTU.

Kathner Street dam excited a large combined group of Mt Taylor and Stromlo Forest Scouts last Spring as they searched for water bugs. The order Hemiptera (true bugs) provided the greatest number (280+) and diversity with two species of backswimmers, water boatmen and an impressively large water scorpion. A couple of yabbies and leeches added to the total of eight bug types. While the survey was entertaining for the Scouts, the overall score did not reflect a healthy water body.



Volunteer Pat Ryan sampling at Coolleman Ridge.

Cotter River MCC1

Cotter Dam to Murrumbidgee River confluence

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	18
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Water bug	Good	3
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 2.5km

Dominant land uses: Recreation

This reach covers the relatively short stretch of the Cotter River below the Enlarged Cotter Dam. It includes the confluence with the Paddy's River at Blundell's Flat and terminates at the confluence with the Murrumbidgee River. Water flowing through this reach is heavily influenced by water from the Murrumbidgee River that is regularly pumped from the Cotter Pumphouse to the base of the dam wall.



Reach Condition

The lower stretch of the Cotter River had a fairly big flood event in July last year, which cleared away lots of debris, according to the volunteer's notes and produced a rare turbidity spike (45NTU) for this reach.

The water bug survey under the Cotter bridge in Spring was most likely affected by these constant high flows and while stonefly, mayfly and caddisfly larvae were found, they were only there in small numbers. That stonefly were there at all, suggests the flushing events in Winter and Spring benefited the reach as they are not found as regularly here as in other streams with similar catchment health. The Autumn water bug survey was better with nine bug types found and high abundance all round.

In May the Namadji School Waterwatch team recorded a mildly acidic pH of 5.5 under the Cotter bridge. This was confirmed by a matching pH reading by Icon Water below the Cotter Dam in the same period.



Paddy's River group help out on the Cotter River bug survey.

Cotter River MCC2

Pipeline Road Crossing to Vanity's Crossing

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	12
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Water bug	Good	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 11km

Dominant land uses: Drinking water catchment, Conservation

This reach runs along the stretch of the Cotter River between the Cotter and Bendora Dams. Vanity's Crossing is the only current Waterwatch site and sits just upstream of the tail of the Enlarged Cotter Dam. This section of the Cotter has restricted access for vehicles and is heavily monitored and managed by Icon Water and the ACT Government.



This is due to this area being a significant part of the ACT's water utility as well as having a remnant population of the endangered Macquarie perch.

Reach Condition

The water level at Vanity's Crossing peaked at 1.5 m at the start of October after the very wet Winter and Spring. After Summer, regular releases from Bendora Dam produced monthly increases of 0.7 to 0.9 metres in the river level. This may have helped abate some of the health issues arising through increased water temperature and lack of flow seen in other rivers in the southern ACT.

In May, however, there was a drop in water pH to mildly acidic levels (pH 5) in this stretch of the Cotter, matching closely values found below the Cotter Dam. Low pH can at times be an issue below dams when water is released from low in the water column. Bacteria in the deep water layers of a dam are known to use up oxygen and in turn produce acidic by-products. This can have adverse impacts on aquatic arthropods by weakening their exoskeletons.



Fishway on the Cotter River at Vanity's Crossing - December 2016.

Gibraltar Creek GIB1

Headwaters to Woods Reserve

2016/17 CHIP Result A (Excellent)

2015/16 CHIP Result A+ (Excellent)

Parameter	Rating	No. Survey
Water quality	Excellent	24
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Water bug	Excellent	2
Riparian condition	Good	3

Reach Facts

Reach network length: approx. 8.5km

Dominant land uses: Recreation and forestry.

Gibraltar Creek is a small stream running from near Corin Dam and flowing east to Paddy's River. The upper sections have stretches of upland bog habitat. Most of the surrounding land was used for softwood plantations up until the 2003 bushfires.



Reach Condition

Gibraltar Creek weathered the hot summer well with good riparian canopy providing essential shade. The Creek had a consistent flow of water with stable temperatures and good levels of dissolved oxygen. The majority of this Creek also has a healthy bed of rocks and snags providing plenty of aquatic habitat complexity, so the 'excellent' water bug scores were not surprising.

Last Spring, all the orders of water bugs in the 'highly sensitive' category were found in the survey, including the only scorpion fly larvae Southern coordinator, Martin Lind, has ever found. Eleven bug types were found in total. At Gibraltar Falls in Autumn there were also eleven bug types, including stonefly, mayfly, caddisfly and alderfly larvae (known as toe biters!). Fly larvae were abundant as well. These were mostly blackfly larvae which are found in fast-flowing waters.



Spring bug survey at Woods Reserve.

Goodwin Village Pond RAN2

Small Pond at Goodwin Village Monash

2016/17 CHIP Result C- (Fair)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	12
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Water bug	Degraded	2
Riparian condition	Degraded	1

Reach Facts

Reach network area: approx. 0.4Ha

Dominant land uses: Recreation

Goodwin Village Pond is a small pond built into a natural drainage line at the southern end of the suburb of Monash. Its primary purpose is to provide recreational space and visual amenity for the residents of Goodwin Village retirement home.



Reach Condition

Oxygen levels in Goodwin Village Pond suffered as a result of hot, dry conditions in Summer, but all other measures were 'excellent'. Its overall catchment health score is affected by the fact that it is a small body of still water with small quantities of edge vegetation and almost no trees.

Last Spring only three water bug types were found. Interestingly this is one of two sites that recorded Isopods (fresh water slaters). In Autumn, the survey had better results but still only 6 types with water boatmen (Hemiptera) making up the majority of the haul with 185+ bugs.

The site is home to a small floating 'wetland'. The plants growing on this have done well and the resident exotic duck population enjoy using it as a personal pontoon. The manicured nature of the Pond's surrounds, however, guarantees that health score of this 'reach' is unlikely to improve in the near future, even with this unique feature.



Gudgenby River Catchment CGG1

Headwaters of small creeks and Orroral River to the Murrumbidgee River confluence

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B- (Good)

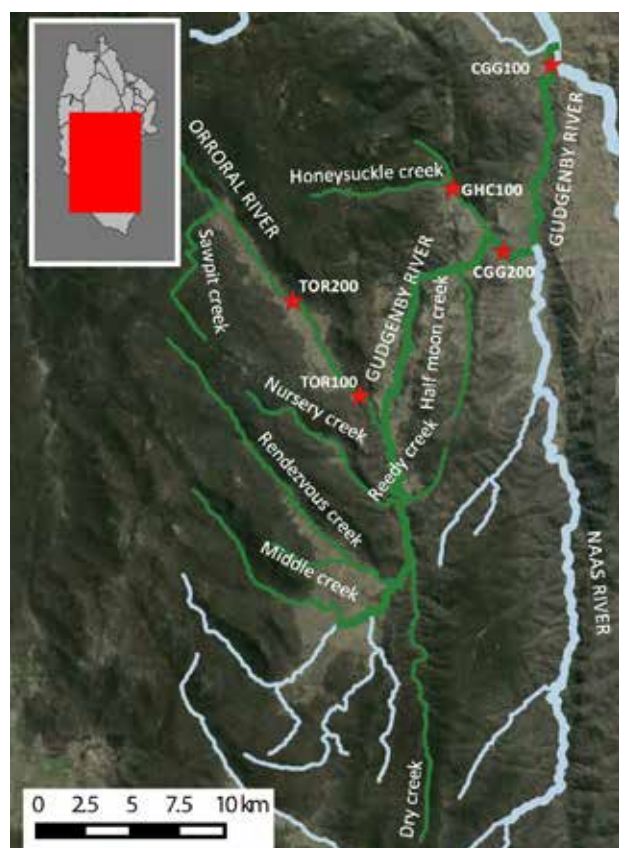
Parameter	Rating	No. Survey
Water quality	Excellent	40
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Water bug	Excellent	2
Riparian condition	Poor	5

Reach Facts

Reach network length: 22.7km

Dominant land uses: Conservation and rural grazing

This reach includes three branches. The main arm is the lower stretch of Gudgenby River, running mostly through rural cattle grazing properties. The Honeysuckle Creek arm runs adjacent to Apollo Road which heads up to the old Honeysuckle Creek Tracking Station site next to Namadji National Park.



Honeysuckle Creek is mostly surrounded by healthy wooded vegetation. The Orroral River section largely comprises upland bogs.

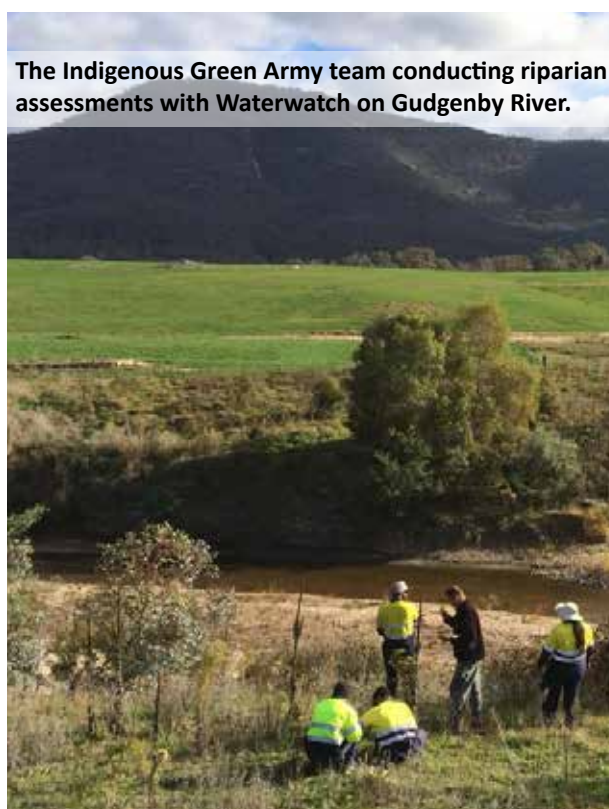
Reach Condition

The hot, dry Summer had negative impacts in Namadji National Park, where much of this reach is situated, with some small creeks in the network becoming quite stagnant and/or high in nutrients. Towards the end of summer many creeks began to completely dry up. The good flushes of rain over early Spring and in March this year kept water quality readings out of the bad books.

In addition, the timing of these events will have made a significant difference to the success of sensitive water bugs such as the numerous stonefly, caddisfly and mayfly nymphs found in both the Spring and Autumn surveys.

The vegetation along many of the creeks in this network is bereft of significant native tree cover and understory, possibly due to clearing, hence the 'poor' riparian condition assessment.

A native Mountain galaxias was found during the Spring water bug survey. These are now only found in upland waterways that are free of both species of introduced trout.



The Indigenous Green Army team conducting riparian assessments with Waterwatch on Gudgenby River.

Hospital Creek Catchment CGH1

Headwaters of Hospital, Breakfast and Little Dry Creeks to the confluence with the Gudgenby River

2016/17 CHIP Result A- (Excellent)

2015/16 CHIP Result B+ (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	30
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Good	4

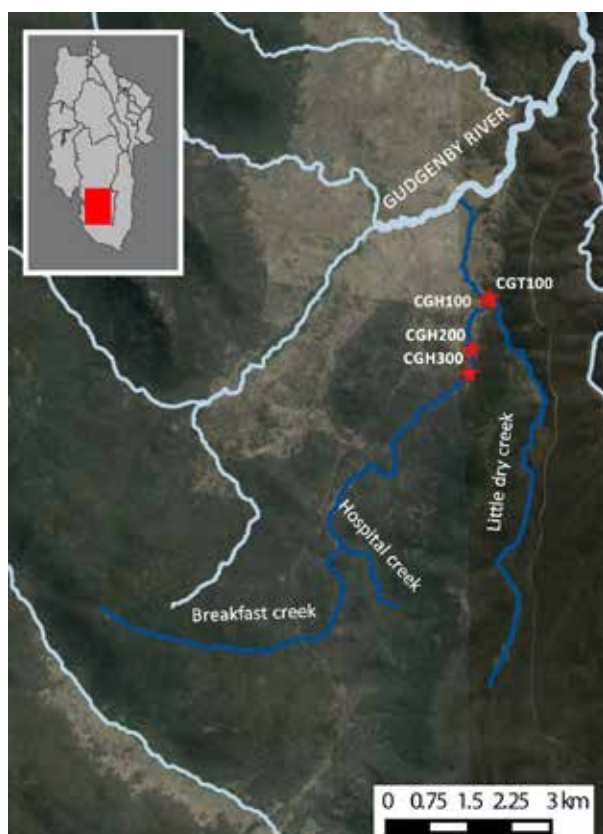
Reach Facts

Reach network length: Hospital Creek arm (on the left) 12km, Little Dry Creek arm (on right) 7km

Dominant land uses: Conservation

Hospital Creek is mostly a forested gully situated south south east of Bogong Creek. It runs north forming an upland bog before joining the Gudgenby River near its headwaters.

Little Dry Creek is an ephemeral arm to the east of Hospital Creek.



Reach Condition

This year saw an improvement in pH and nitrate readings and the Hospital Creek catchment return to the 'excellent' health it had in 2014-2015. It is also enjoying the increased monitoring by the Brindabella Venturers, who are also monitoring three sites on Hospital Creek and the site on Little Dry creek.

The small native fish Mountain galaxias, were found in the Spring water bug surveys. It is always nice to find these as they are rarely found in the same waterway as the introduced trout species. Spotted grass frogs *Limnodynastes tasmaniensis* and Common Eastern froglets *Crinia signifera* frogs were heard calling well into late spring with *C.signifera* continuing to call in January from the pools in the lower site. The hot drying summer had the same effect as it had on the other upland reaches with many creeks ceasing to flow, and then drying up. Spotted grass frogs were heard again in May after the solid rainfalls in Autumn.

Good rainfall in Spring and early Autumn saw a good diversity of sensitive water bugs such as 200+ caddisflies in the Autumn survey



The upland bogs of Hospital Creek. (Photo: M.Chalk)

Isabella Pond TIP1

Large pond south of Monash

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	Good	27
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Poor	2

Reach Facts

Reach network area: approx. 5.8Ha

Dominant land uses: Suburban

This reach is the main settlement pond for stormwater entering Lake Tuggeranong from the south western Tuggeranong suburbs. Water flows over a high weir at its western end into Lake Tuggeranong (TLT1).



Reach Condition

This reach has had the most dramatic twelve months of any in our region.

Over Summer the water levels dropped and the gross pollution traps became 'clogged with rubbish' according to the notes from the Waterwatch volunteer. By March the water at the dam wall was high in phosphorus (0.15mg/L) and green.

Last April there was a 'foul smell' just before the lake was drained in May for extension work on the zig zag dam wall. Several tons of mostly Carp were removed from this and neighbouring Upper Stranger Pond, which links to Isabella Pond. This was done by the ACT Government's Conservation and Research team with the help of the Aboriginal Green Army team and SACTCG volunteers. An unofficial record breaking Carp was pulled from the pond at 16kg!

Taking advantage of the dam works, Isabella Pond is also getting the first of the major wetland infrastructure refits under the Australian and ACT government's Healthy Waterways program



Lake Tuggeranong Wetlands TLT1

Drakeford Drive weir to South Quay foot-bridge weir

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Good	24
pH	Good	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 4.3Ha

Dominant land uses: Urban

This is the southern section of Lake Tuggeranong upstream of the weir that runs under a pedestrian walkway near the new South Quay Development. It forms a narrow neck at the southern end which is fed by a large zigzag dam wall which overflows from Isabella Ponds.



Reach Condition

The 'wetland' end of Lake Tuggeranong was partially drained again this year for works along the South Quay foreshore. Additional flows were also delivered from upstream to the wetlands from Isabella and Upper Stranger Ponds when they were completely drained for remedial works.

In Spring lots of tiny mayfly nymphs were found from the family Caenidae, which are the hardiest of mayflies and can survive in these slow moving silty waters. Fly larvae and water boatman made up the bulk of other bugs leading to a poor overall score despite eight different types being caught overall. In Autumn in the low water levels remaining, only pollution-tolerant bugs such as water boatmen and fly larvae were found in greater than single figures.



The Green Army conducting the Autumn bug survey at Lake Tuggeranong.

Lake Tuggeranong TLT2

Main lake body

2016/17 CHIP Result C- (Fair)

2015/16 CHIP Result C- (Fair)

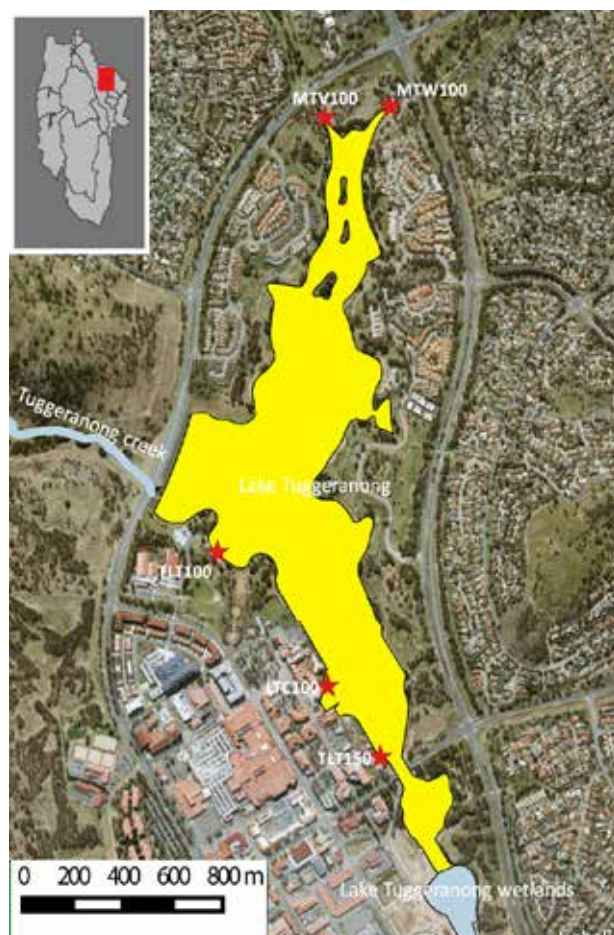
Parameter	Rating	No. Survey
Water quality	Good	38
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Water bug	Degraded	2
Riparian condition	Poor	5

Reach Facts

Reach network area: approx. 56Ha

Dominant land uses: Urban and recreation

This is the main body of Lake Tuggeranong, which is fed by the stormwater systems of 13 southern suburbs. Two major gross pollutant traps are at the northern end of this reach. Lake Tuggeranong wetlands (TLT1) are immediately upstream of this reach.



Reach Condition

Volunteer Ben picked up extreme nitrate readings at his sites at the northern end of the Lake in November. In January he had extremely high nitrate again combined with very low oxygen levels.

A prognosis from ACT Government experts suggested that gross pollution traps (GPTs) above the monitored sites capture hydrocarbon runoff from service stations, shopping centers and storage facilities which all deliver storm water to this end of the Lake. This would have the added effects of increasing electrical conductivity and altering dissolved oxygen levels, as well as producing the sheen that is seen on the water's surface all too often. These effects were also noted after rainfall events.

In June there were two oxygen supersaturation events recorded independently in the north end and at the middle of the Lake near the Arts Centre. A strange orange flocculent was also observed coming out of the GPT next to the pipes at MTV100 out of Kambah..



TTLT2 Wanniasa Creek Spring 2016. (Photo: Ben Bryant)

Murrumbidgee River CMM7

Michelago Creek confluence to Tharwa Sandwash

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B+ (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	24
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Water bug	Good	2
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 24km

Dominant land uses: Rural grazing and conservation

This stretch of the Murrumbidgee River begins at Willows Road in NSW, includes Angle Crossing on the ACT/NSW border and runs through the Gigerline Gorge Reserve in the ACT. It ends at Tharwa 'Sandwash'.

Recreational fishing is banned in the ACT section and the riparian vegetation is significantly healthier than downstream around the Tharwa township.



Reach Condition

The Murrumbidgee River as it enters the ACT at Angle Crossing brings the legacy of events upstream. An aggressive storm cell passed over the Bredbo area on the 23 December. The storm delivered up to 100mm in less than an hour in some parts. The farming and ploughing activities observed over the border combined with the weather delivering large amounts of muddy water to this reach with turbidity recorded at 200NTU on 30 December. Waterwatcher Bernie also noted a rise in water level overnight as she regularly patrols this part of the river as an ACT Ranger.

At Angle Crossing water quality was good enough to support a health diversity of aquatic invertebrates after a wet Spring. Large numbers of pollution-sensitive stoneflies, as well as four different families of mayflies and six different types of caddiesflies were recorded. This is despite the limited amounts of emergent and edge vegetation present that would have increased the bug diversity even more.



Volunteer Jan Koehler cleans the water bug tray at Angle Crossing during the Autumn surveys.

Murrumbidgee River CMM8

Tharwa sandwash to Point Hut Crossing

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	22
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Poor	3

Reach Facts

Reach network length: approx. 10km

Dominant land uses: Rural grazing

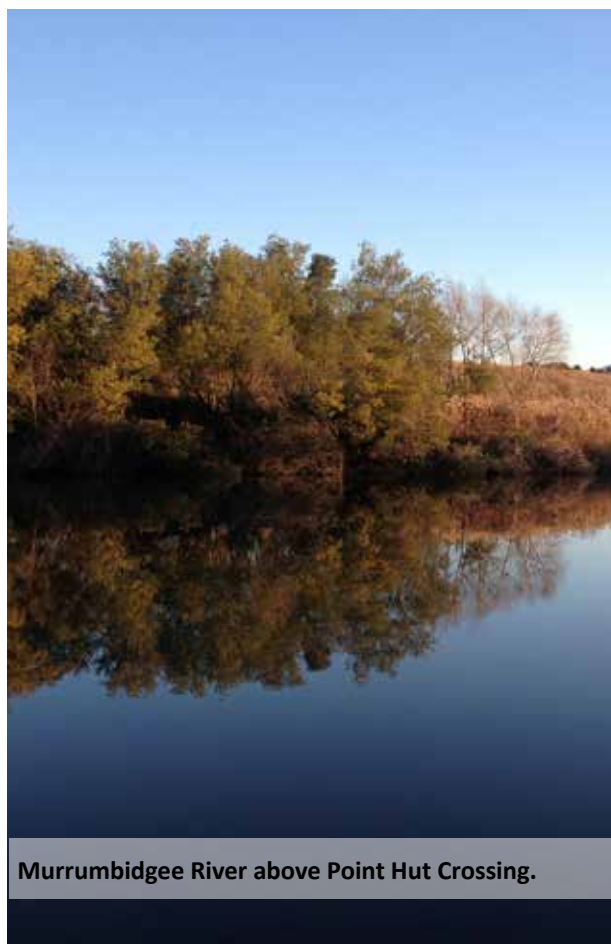
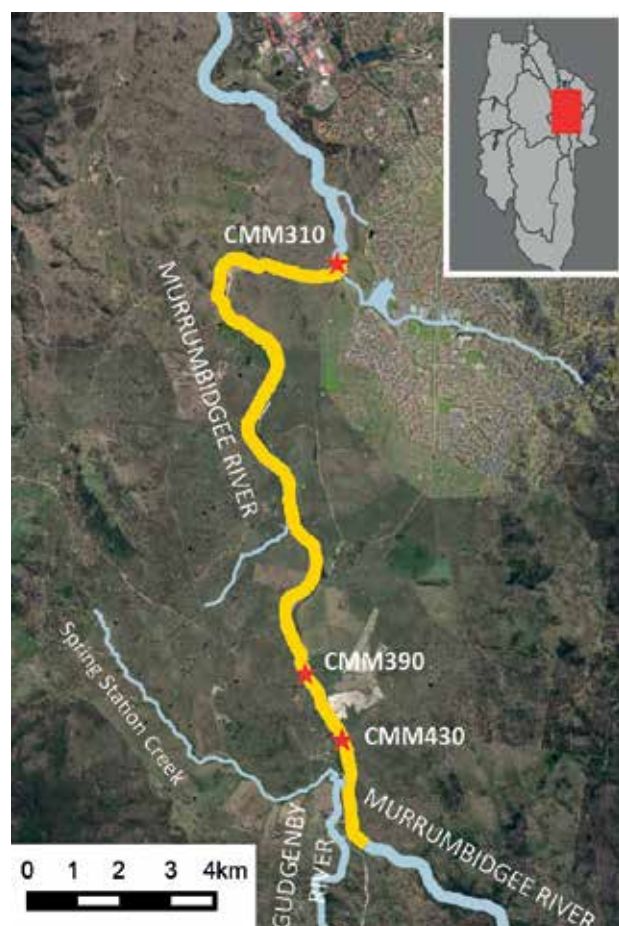
This reach covers the stretch of Murrumbidgee River from Tharwa Sandwash to Point Hut Crossing. Most of the eastern bank of this reach borders Lanyon Homestead. The western bank flows past a number of properties including Castle Hill and Lambrigg Homesteads among others in the Tharwa district.

Reach Condition

This section of the Murrumbidgee, is testament to what happens to a river when it becomes high in turbidity and devoid of trees. The water here was shallow and slow moving for most of the year. During the extremely hot Summer, the lack of plant cover and shallow depth allowed the water to heat up and loose precious oxygen. Along with a build-up of minerals this made the survival of aquatic animals a struggle.

Platypus surveys conducted along the River up and downstream of the Tharwa 'Engineered Log Jam' (ELJ) failed to record any sightings for the last two years. As Platypus need a diverse range of water bugs, it reasonable to expect that a lack of food here, as supported by the 'poor' water bug score, would be a major contributor.

That said, the ELJ has deepened the channel of the River adjacent to it from 40cm to 2 metres and surveys there continue to detect juvenile Murray Cod. Another ELJ is currently being planned further downstream on this reach.



Murrumbidgee River above Point Hut Crossing.

Murrumbidgee River CMM9

Point Hut Crossing to Kambah Pool

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Good	28
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Poor	1

Reach Facts

Reach network length: approx. 6.7km

Dominant land uses: Urban, conservation and recreation

This reach covers the section of Murrumbidgee River from Point Hut Crossing to Kambah Pool. Both spots are popular recreational sites. Red Rock Gorge and the confluence with Tuggeranong Creek are also within this reach.

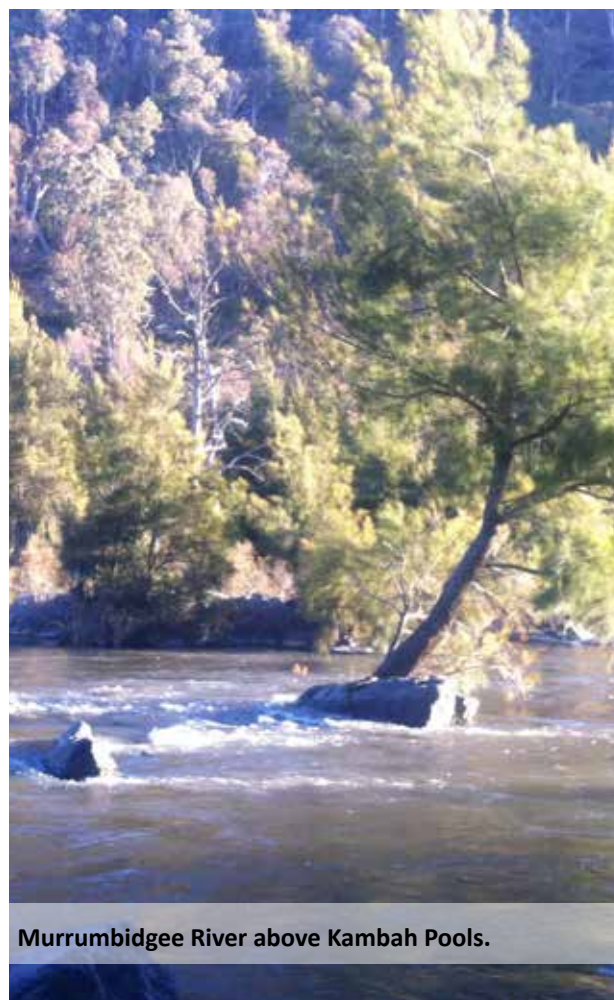


Reach Condition

While the turbidity score for this reach is 'excellent', the data tells a different story on the occasions that the volunteers do their sampling post a significant rainfall event. Pine Island saw four month where turbidity was over 20NTU and it reached 95NTU post a flood event in early September.

The faster flows, deeper water and slightly more abundant bank vegetation through this part of the river, give refuge to aquatic creatures and sees the health of the Murrumbidgee River improve as it flows down from the sandy, shallow sections at Tharwa. A few stonefly nymphs were caught at Kambah Pool last Spring in the water bug survey. This is significant as stoneflies have only been found in a couple of surveys of this reach before now and only after good flows.

The feral fish Carp and Eastern gambusia are regularly sighted in this reach.



Murrumbidgee River above Kambah Pools.

Murrumbidgee River CMM10

Kambah Pool to Uriarra Crossing

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Excellent	
Water bug	Good	2
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 11km

Dominant land uses: Rural grazing, forestry, recreation and conservation

This reach covers the section of Murrumbidgee River from Kambah Pool to Uriarra Crossing. Much of this reach flows past old pine forest plantations and areas still used for grazing and farming.

Reach Condition

The Murrumbidgee is joined by the Cotter and Paddy's Rivers in this reach, significantly increasing the flows. Interestingly, last September, Barbara recorded a turbidity reading of 80NTUs and the 'Sands' Waterwatch team had a score of 60NTUs brought by the heavy early spring rain. Looking at the Cotter and Paddy's at the same time, their turbidity levels remained stable. So sediment inputs are most likely coming from somewhere upstream on the Murrumbidgee.

The positive aspect of these high flows is the replenishing of oxygen and cooling of the river's water. The presence of stonefly nymphs at Uriarra Crossing last Spring and mayfly and caddisfly larvae at Casuarina Sands are testament to this affect.

A Platypus was sighted by the volunteers at Casuarina Sands in late July. Late Winter is a great time to see Platypus as their main food source, water bugs, are present in low numbers so Platypus are active for longer periods while they forage for food.



Murrumbidgee River at Casuarina Sands.

Naas River NNN1

Headwaters to Gudgenby River confluence

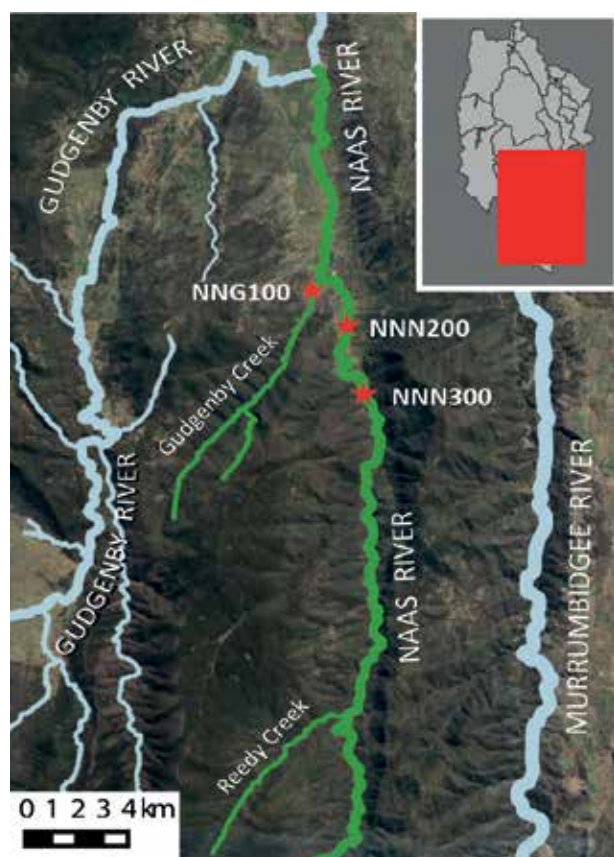
2016/17 CHIP Result B- (Good)		
2015/16 CHIP Result B+ (Good)		
Parameter	Rating	No. Survey
Water quality	Good	21
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Fair	3
Riparian condition	Fair	3

Reach Facts

Reach network length: approx. 40km

Dominant land uses: Rural residential, grazing, conservation

The Naas River runs south then hooks east then flows north running through the southern tip of the ACT in Namadji National Park. The lower part of the river runs past grazing properties before joining the Gudgenby River 10 km south of Tharwa. This reach also includes a site on the bottom of the Gudgenby Creek.



Reach Condition

Last Spring a Green Army team conducted monitoring at the lower sites including a water bug survey at Caloola Farm that found high diversity including high numbers of stonefly nymphs and 200+ of both mayfly and caddisfly larvae. Richard, who had lead that Green Army team, adopted the sites in the new year.

In November the Marsham family found very high phosphorous levels (0.15mg/L) up at the National Park gate and the sheep fence washed away. Summer's hot weather increased water temperatures and lowered oxygen levels as it did elsewhere.

On the Easter weekend this year, Caloola Farm 'hosted' an unauthorised 'rave' party of around 4000 revellers. The land owners in the valley were not impressed and Waterwatchers were asked by the head Namadji ranger to keep an eye out for unusual water pollution levels. Fortunately Richard found nothing untoward in the Naas River when he went out in early May.



Naas River at Caloola Farm during Spring 2015.

Paddy's River Catchment CTP1

Tidbinbilla Road bridge to Murray's Corner

2016/17 CHIP Result B+ (Good)

2015/16 CHIP Result B+ (Good)

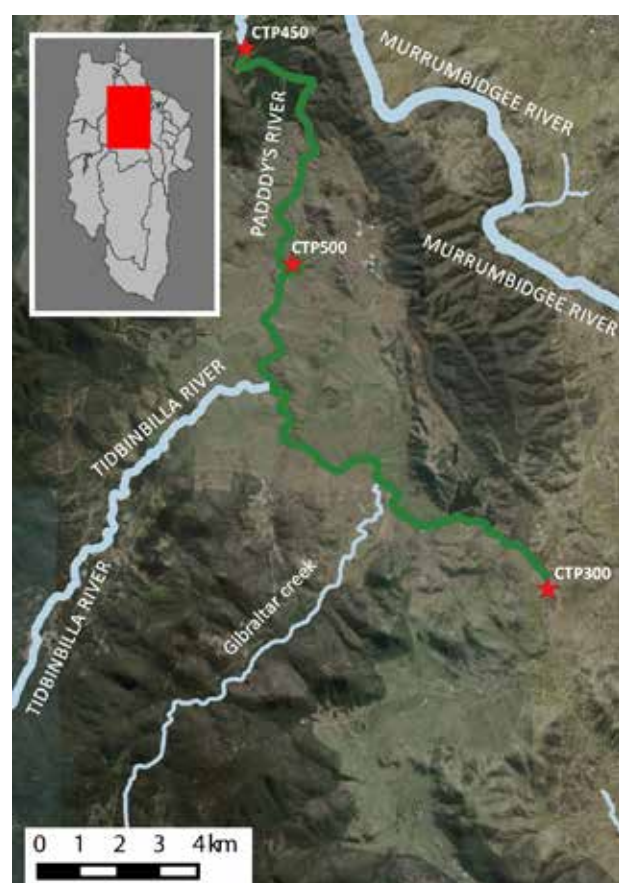
Parameter	Rating	No. Survey
Water quality	Excellent	36
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Water bug	Good	2
Riparian condition	Fair	3

Reach Facts

Reach network length: approx. 24km

Dominant land uses: Rural grazing

Paddy's River runs mostly through active grazing properties and softwood plantations. This reach covers the section below the headwaters high up on Mt Tennant in the Namadji National Park. The river has been subject to massive erosion through large flooding events in recent years. The consequences of this soil disturbance is still significant.



Reach Condition

Paddy's River was fast flowing during mid-winter 2016 and increased to flood conditions by August. By September all Waterwatch sites were recording 'high' to 'flood' water levels. Fleur and Maree noted that 'water has been at least 10 metres up the now gouged and rutted gravel access to the causeway'. By November all this flow left more heavy sand deposits along the river.

While the sandy deposits were not great for water bugs, the Spring survey, conducted as a training day for the Waterwatch staff, found 100s of sensitive stonefly, mayfly and caddisfly nymphs. These were located by sampling the cleaner riffle areas nearby as well as some vegetated edges.

As Summer progressed the water level dropped. In January 2017 a sign was erected at Murray's Corner warning the public of the presence of blue-green algae. In February this was replaced by another sign saying the water was unsafe for 'humans and dogs'. This was the first time that a water safety warning has been seen at Murray's Corner.



Water bug training at Murray's Corner with John Gooderham (pictured sitting in Paddy's River).

Point Hut Ponds MPG1

Headwaters of Conder Creek to Murrumbidgee River confluence

2016/17 CHIP Result C (Fair)

2015/16 CHIP Result C- (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	46
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Water bug	Degraded	2
Riparian condition	Poor	4

Reach Facts

Reach network length: approx. 2.5km

Dominant land uses: Urban

Conder Creek arises in the Rob Roy Nature Reserve and flows into Point Hut Pond. Point Hut Pond is a sediment control pond in the suburb of Gordon. Together they make up a stormwater system that has been engineered with flow reduction and verge vegetation to reduce negative impacts from suburban runoff.



The water from this system then flows into the Murrumbidgee River just downstream of Point Hut Crossing.

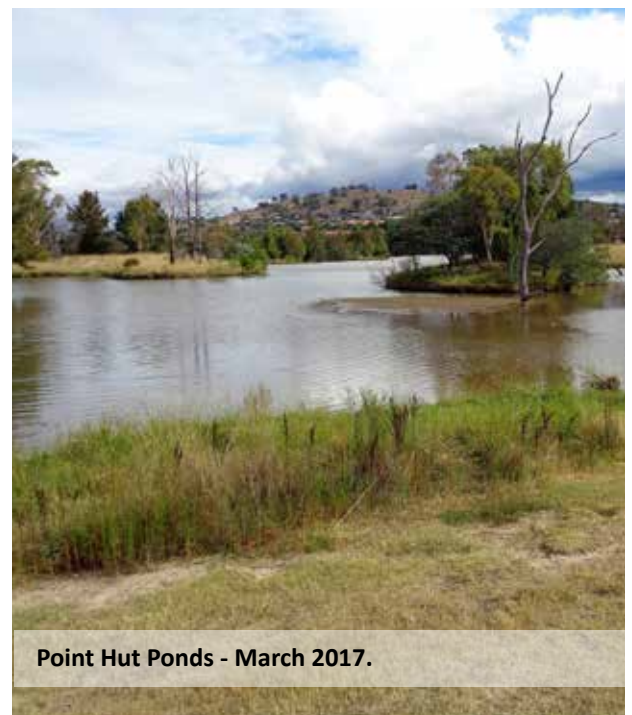
Reach Condition

The 'Carers of Point Hut Pond' Landcare group lamented the departure of much of their water bird population from Point Hut Ponds over the past 12 months. It was suspected that many birds have taken advantage of wetter conditions in other, possibly more natural, wetlands in NSW.

The water level in the Pond went from overflowing in September to well below the dam wall from January through to March. This began to expose mud around the northern bank by the end of February. A buildup of rubbish in the ponds inlets was a major concern in February and March after heavy rain, but no other water quality issues were reported. This is quite unusual for this reach.

The water bug surveys show very little diversity and a dominance of tolerant bugs such as 200+ 'true bugs' (Hemiptera) in the Autumn survey. These have the distinct advantage of being able to fly away when conditions get rough. The shallowness and the substrate of the bottom of the pond offer poor habitat for species and may be a contributing factor.

A large population of Carp were spotted by Vera up in the top wetlands in Conder. Plus the "biggest turtle ever" was seen by volunteer Stephen at Point Hut Pond south (MPG200) in March this year.



Point Hut Ponds - March 2017.

Spring Station Creek CMS1

Headwaters to Murrumbidgee River confluence

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	Good	7
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Degraded	1

Reach Facts

Reach network length: approx. 4km

Dominant land uses: Rural grazing

This reach covers most of this small rural creek separating a grazing property to its south and a property with high conservation value woodland to its north. This creek is immediately adjacent to the township of Tharwa. During high rain fall events it is subject to severe flooding at its lowest end where it crosses the Naas Road.



Reach Condition

The poor riparian vegetation score reflects a creek almost completely exposed to the sun along its length and the monitoring site at its mouth is extremely shallow and sandy. This gives rise to extreme temperature fluctuations (5-26°C) that cause significant stress to aquatic animals. While nutrients (nitrate and phosphorus) were not an issue this year, warmer water and low flows causing lack of oxygen, and heightened electrical conductivity levels were areas of concern.

When surveyed for water bugs, the results were more positive. As with many of the southern ACT waterways, good rains in early Spring and again just before the Autumn bug surveys, produced a good diversity of water bugs with some pollution-sensitive bug types found including a few stonefly larvae. It was however, the more tolerant bugs such as fly and beetle larvae that were found in the biggest numbers.



Spring Station Creek - taken from DeSalis Cemetary.

Stranger Pond MSP1

Stranger Pond in North Bonython

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Excellent	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Water bug	Poor	2
Riparian condition	Poor	2

Reach Facts

Reach network area: approx. 4Ha

Dominant land uses: Urban.

Stranger Pond is the small lake to the south of Lake Tuggeranong providing similar stormwater treatment for the suburb of Bonython. Overflow enters the Murrumbidgee River at Pine Island Reserve.

Reach Condition

The Green Army noted a lot of rubbish and 'strange smells' coming from Stranger Pond in November, but overall the Pond had no readings of concern over the last twelve months. Water quality was mildly affected by high mineral levels coming from the suburban catchment, as shown by the 'poor' electrical conductivity score.

Water bug surveys conducted at the dam wall noted the prevalence of pest fish in the pond. Eastern gambusia, leaping Carp and Redfin perch were all seen.

While mayfly and caddisfly larvae were present, they were smaller compared to those of other surveys. Spring saw large numbers of glass shrimp, which are common in our ponds, lake and dams. Fly larvae do particularly well in both seasons with at least three types of maggots seen. Students from Erindale College again helped with the Autumn bug survey and the Green Army gave a hand last Spring.



Stranger Pond.

Swamp Creek LMS1

Uriarra Creek confluence to Murrumbidgee River Confluence

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result B (Good)

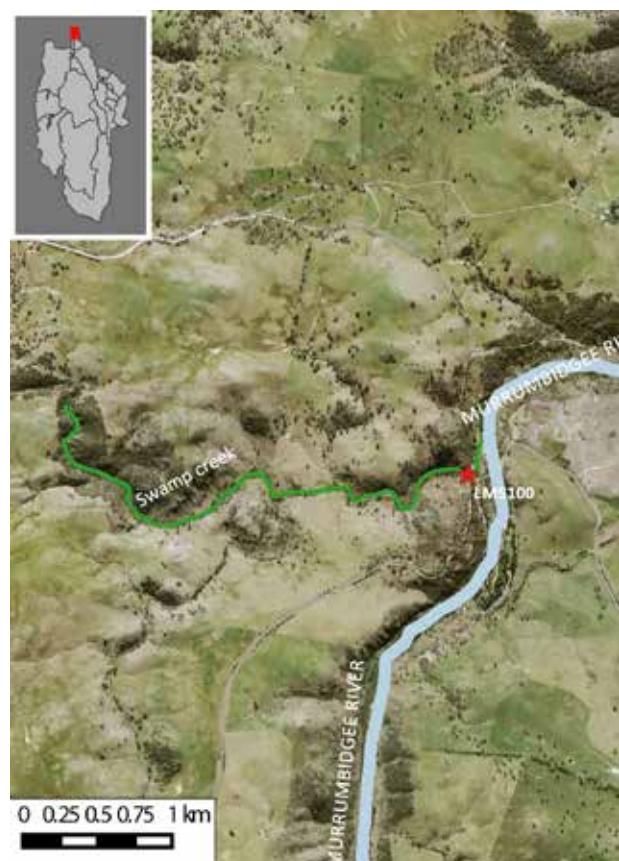
Parameter	Rating	No. Survey
Water quality	Excellent	12
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Water bug	Poor	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 1.5km

Dominant land uses: Rural grazing.

Swamp Creek is an ephemeral creek running through Uriarra Homestead. It intersects with Uriarra Creek 1km upstream to the west and flows under the Fairlight Road into the Murrumbidgee River next to Uriarra Crossing. Old maps name the stretch of creek to Murrumbidgee 'Uriarra Creek'. Signage at the reserve refer to it as Swamp Creek. We have opted for the latter.



Reach Condition

Swamp Creek scored the same water quality as upland streams and rivers in the southern ACT. Riparian vegetation at the monitoring site is in 'fair' condition but lacks the in-stream and edge vegetation required to host a variety of water bugs. This became apparent in the Spring bug survey where there were high numbers of the pollution sensitive bugs including stoneflies, 100+ caddisfly and 100+ mayfly – all bugs found in the clean riffle zone. Overall, however, only six types of bugs were found, highlighting the need for a variety of habitats to maintain diversity.

In addition, two species of introduced fish were found during the same survey in the sandy substrate just above the confluence with the Murrumbidgee River. These were juvenile Carp and two Oriental weatherloach. The latter are particularly resilient given their ability to tolerate very warm water and draw oxygen from the air when dissolved oxygen levels are low.



Swamp Creek looking upstream from LMS100.

Tidbinbilla River CTT1

Headwaters of Tidbinbilla River and Ashbrook Creek to Gilmores Road crossing

2016/17 CHIP Result B (Good)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Excellent	56
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Water bug	Fair	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 8.5km

Dominant land uses: Conservation, tourism and rural grazing

This reach covers most of the Tidbinbilla River and the adjacent artificial wetlands (the Sanctuary). Most of the river is in the Tidbinbilla Nature Reserve and has significantly recovered from a catastrophic bush fire in 2003. Ashbrook Creek is a small upland creek running from the top of the reserve past the Hanging Rock Aboriginal shelter site.



Reach Condition

The wetlands in Tidbinbilla Sanctuary were high in turbidity and levels were low in March but a storm on the 20th dumped 135mm in three hours giving them a much needed clean out.

When the water bug survey was conducted in April the majority of the river bed was covered in gelatinous tubes of diatoms 'filaments'. The most common species found were fly larvae. There were some mayfly and caddisfly larvae but in much fewer numbers and only a single specimen of four other bug types. The hot dry Summer affected the top of the River as well, with only six water bug types being found in the Autumn survey. This is also a legacy of how the river substrate was dramatically and permanently changed after the 2003 fires. A once complex and rocky river bed became full of sandy sediment and the fire still appears to be having an adverse impact on this River.



Tidbinbilla River. Photo: Fiona Spier

Tuggeranong Creek, Upper TUG1

Headwaters of Tuggeranong Creek catchment to Theodore

2016/17 CHIP Result C- (Fair)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Good	20
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Poor	2
Riparian condition	Degraded	1

Reach Facts

Reach network length: Monks Creek (upper arm 3.2km), Tuggeranong Creek (lower arm) 4km

Dominant land uses: Rural grazing

The monitoring site is near the Monaro Highway at the eastern border with NSW and is fed from Monks Creek to the east and Tuggeranong Creek to the south. The Tuggeranong Creek arm runs adjacent to the Monaro Highway in NSW.



Reach Condition

Waterwatch volunteer Eileen reported the usual abuse that happens to this creek under the Monaro Highway and adjacent to the Tuggeranong suburb of Theodore. It is a regular dumping ground for rubbish, car parts, spray cans from graffitists and other detritus. The flow ceased for the first time in 20 months last February and the creek had a foul smell over summer. The headwater site, four kilometres upstream was dry from January to April.

In spite of these hardships this little creek has always produced pleasant surprises. When the water bug survey was conducted at the end of Spring 2016, the first task was to carefully remove all the massive Pobblebonk tadpoles from the trays. Pollution-sensitive mayfly nymphs were found in good number (75+) in both the Spring and Autumn surveys and a couple of good sized yabbies were caught in Autumn too. It was, however, the lack of bug diversity overall that ultimately kept the scores down.



Tuggeranong Creek directly upstream of Monaro Hwy.

Tuggeranong Creek, Middle TUG2

Concrete drain system upstream of Isabella Pond

2016/17 CHIP Result C- (Fair)

2015/16 CHIP Result D+ (Poor)

Parameter	Rating	No. Survey
Water quality	Excellent	48
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Water bug	Degraded	4
Riparian condition	Degraded	4

Reach Facts

Reach network length: approx. 8km

Dominant land uses: Urban.

This reach consists of a Y shaped network of two concrete stormwater channels. The main arm runs north west from under Leinhop Street in Theodore. This joins another channel following south west from Fadden near Isabella Drive where the channel then flows into Isabella Pond.

Reach Condition

Middle Tuggeranong Creek is a concrete drain fed by suburbia and yet received a perfect score for water quality this year. This improvement can most likely be attributed to the wet Winter and Spring that produced continuous flow throughout Summer and beyond.

Over the hottest months when many Waterwatch sites across the catchment are experiencing low dissolved oxygen, all four sites in this reach experienced 'super-saturation' of around 120%. Why? The continuous flows maintained an array of algae in the channel over the Summer months which go crazy photo-synthesising when the water is clear and warm. A by-product of this process is oxygen which can be detrimental when it occurs at such extreme levels as this. Interestingly, another effect of photo-synthesis is that it can drive up pH levels and, again, all four sites experienced pH readings of 8 or higher during those hot months.

Of course, no matter how interesting the water quality result, it doesn't change that this is a concrete channel and does not measure up as habitat. No riparian vegetation and almost no aquatic organisms were found in this reach.



Fadden stormwater channel.

Tuggeranong Creek, Lower TUG3

Tuggeranong Creek to Murrumbidgee River confluence

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	10
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 1.8km

Dominant land uses: Suburban reserve

This reach includes the natural stretch of Tuggeranong Creek fed by the overflow from Lake Tuggeranong. This creek enters the Murrumbidgee River 2kms downstream of Pine Island Reserve.

Reach Condition

The increase in health score for this reach is not easily explained. Improvements in water bug sampling methodology have definitely given greater consistency over the two survey seasons, with eight bug types found on both occasions and mayfly and caddisfly larvae being noted both times (albeit in very small numbers). In the last CHIP report, the Spring survey recorded only four bug types.

Water quality was affected by the same seasonal issues that occurred in our other small creeks. In particular; low oxygen and higher than optimal nutrients and electrical conductivity. In February an oxygen super saturation event was captured. The expert prognosis was that:

"This occurs in flowing waters with the right combination of temperature, light and is driven by benthic algae. In Tuggeranong Creek the lower flow and (probably higher biomass of in-stream attached algae) enables the oxygen peak to get quite high."



Lower Tuggeranong Creek - July 2017.

Westwood Farm TMM1

McQuoid's Hill to Murrumbidgee River

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Good	22
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Water bug	Fair	2
Riparian condition	Fair	2

Reach Facts

Reach network length: approx. 2.5km

Dominant land uses: Rural grazing and recreation

This reach covers McQuoid's Creek and the associated dam on Westwood Farm, Kambah. A tributary of the creek runs past the Murrumbidgee Golf Club. McQuoid's Creek flows into the Murrumbidgee River near Kambah Pool. The upstream sections are predominantly cleared land, while the downstream section is still well vegetated.



Reach Condition

The sites monitored for this reach reveal similar stressors effecting water quality as seen in our other small rural water ways. Dissolved oxygen levels were lowered by elevated water temperatures and electrical conductivity got higher as the water got lower and the salts and minerals became more concentrated. The rain around New Year saw the farm dam become very muddy with a reading of 60NTU. Phosphate levels in the water were also slightly elevated for a range of reasons common on working farms. In the dam this rose to 0.2mg/L.

In spite of this, the students at Lions Youth Haven found 13 bug types living in McQuoid's Creek last Spring. This included a stonefly as well as a good spread of damselfly larvae, water beetles, maggots, water boatmen and snails. Three types of worms were also found.



Cow posing at McQuoid's Creek Dam.



Yass Catchment Facts

Yass catchment is approximately 2,800km², and is situated to the north of the ACT. The Yass catchment is made up of two major rivers. The first is the Yass River that has its headwaters approximately 100kms to the south east around Wamboin. The River flows north west past Sutton and downstream to the township of Yass and then through steep gorge country until it flows into Burrinjuck Dam from the east. The major tributaries of the Yass River include Brooks Creek, Gundaroo Creek, Murrumbateman Creek, Dicks Creek and Manton Creek. The second major river is the Murrumbidgee River that becomes part of the Yass catchment (in terms of the CHIP report) at the confluence with Ginninderra Creek just after both waterways exit the ACT. The Murrumbidgee runs north through Wallaroo and Cavan, to the west of Murrumbateman, before entering Burrinjuck Dam from the south. This lower section of the Murrumbidgee has large sand slugs resulting from reduced flows, and the impounded waters of Lake Burrinjuck. The natural river bed is swamped by the sand deposits creating wide shallow sections with little or no in-stream structure.

A large proportion of this catchment is cleared grazing land and as a result, major issues in this catchment include dryland salinity and erosion. Many of these issues could be ameliorated through stock exclusion and the regeneration of the riparian zone. This is occurring on a number of fronts throughout the catchment with the Yass Area Network of Landcare Groups (YAN) playing a major part.



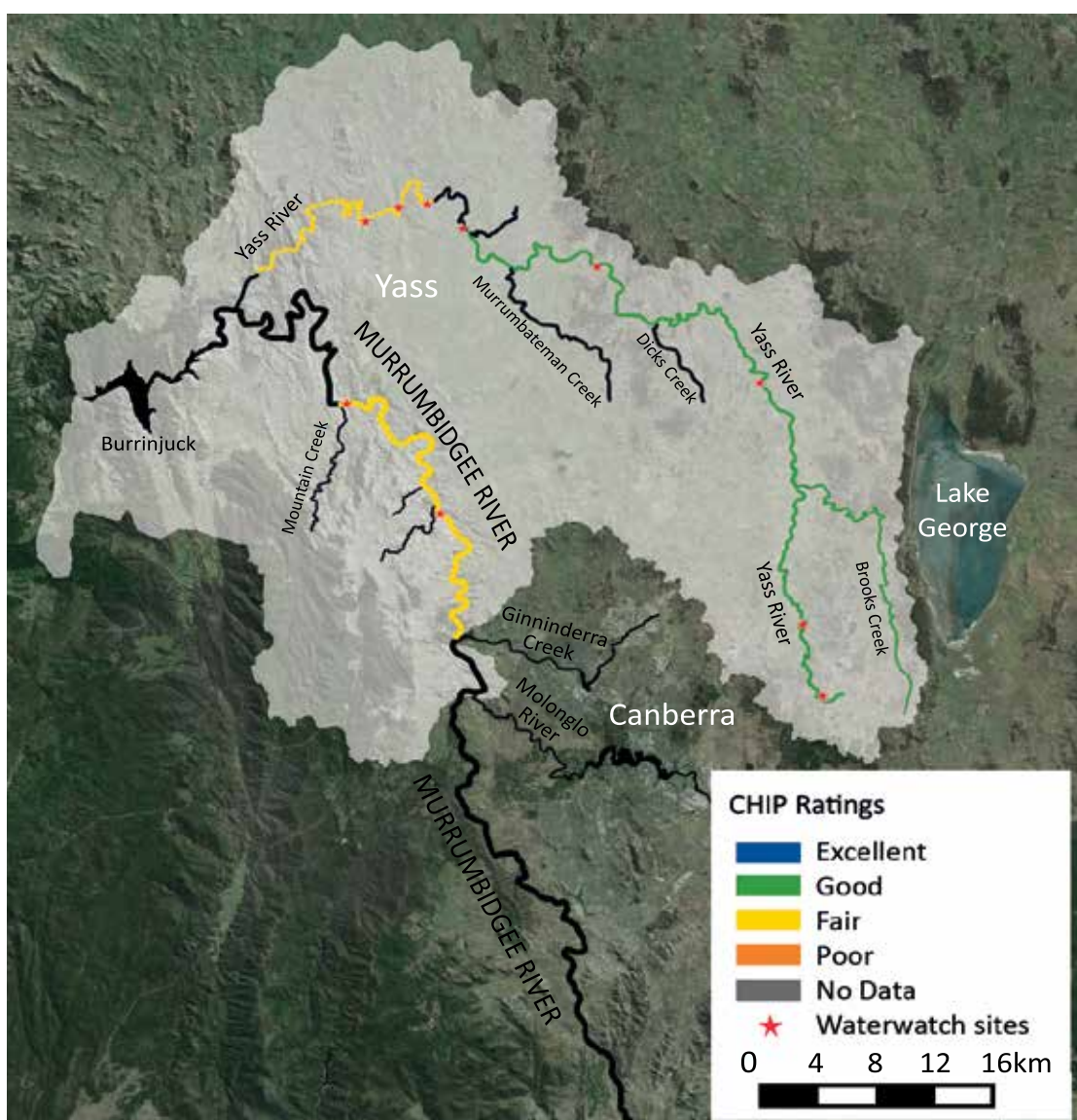
Yass Catchment Health Summary

This is the third year that data have been collected for the CHIP on Yass Region and it is great to see the effort of the volunteers and the community involvement in Waterwatch. There are currently five reaches being monitored, with a total of nine active sites. A new reach has been created for the Yass River within the township of Yass and will be featured in next year's CHIP report. Our aim is to increase to 20 monitored sites overall for the next CHIP, and continue to collaborate with the Yass Valley Council, landholders and members of the community who interested in improving knowledge and awareness of their waterways.

This year, two reaches scored 'good' and three scored 'fair' in the Yass Catchment. Of those, three reaches scores remained the same, one has decreased from 'good' to 'fair' (CMM12), and one has increased from 'poor' to 'fair' (CMM13). All parameters (water quality, water bugs and riparian condition) have been collected at CMM13 reach this year, which have contributed to an overall improved score, as last year it was data deficient for water quality. CMM12 was data deficient for riparian condition this year, which may have lead to a slightly lower score if it had been undertaken. Riparian assessments and water bugs tend to drag overall scores down as they are less transient than water quality.

Elevated nitrate readings have been observed on CMM12 and CMM13 along the Murrumbidgee River. These were recorded during low flows and it's possible that the Lower Molonglo Water Quality Control Centre (LMWQCC) could be influencing these results. That said, the site directly below the LMWQCC did not have water quality data collected for this CHIP (this has now been rectified) and so further monitoring is warranted.

A good diversity of fauna have been spotted by the volunteers during their monitoring, including turtles, frogs, skimmers, grebes, and a pair of Wedge-tailed eagles.



Murrumbidgee River CMM12

Ginninderra Creek confluence to above Mullion Creek confluence

2016/17 CHIP Result C- (Fair)

2015/16 CHIP Result B (Good)

Parameter	Rating	No. Survey
Water quality	Good	6
pH	Good	
Turbidity	Good	
Total Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Water bug	Degraded	2
Riparian condition	Fair	1

Reach Facts

Reach network length: approx. 18Km

Dominant land uses: Grazing, conservation

This Murrumbidgee River reach starts at the confluence with Ginninderra Creek, and ends above confluence with Mullion Creek in Wallaroo. Much of this reach is surrounded by cleared grazing lands, and a very narrow riparian zone. In a few notable places, private landowners are undertaking riparian vegetation replantings to improve river condition.

Reach Condition

This year the CHIP result used the riparian condition value from 2015 as a new assessment has not been done in the past two years.

Electrical conductivity showed some high readings during low flows (350 and 420 $\mu\text{S}/\text{cm}$). Nitrate had consistently high readings with the highest being in late February of 25 mg/L, the highest reading recorded in the Yass and Ginninderra region. This February reading coincided with some particularly low flows and while CMM100 is 18 km downstream of the Lower Molonglo Water Quality Control Centre (LMWQCC), it would appear that the effects are felt a substantial way downstream when conditions dictate. The high nitrate continued to be felt all the way downstream to our lowest Murrumbidgee site at Taemas Bridge (CMM010 – see report card CMM13) just above Burrinjuck Dam. The volunteer contacted the Environmental Protection Agency (EPA).



Murrumbidgee River near the Ginninderra Creek confluence.

Murrumbidgee River CMM13

Mullion Creek confluence to Taemas Bridge above Burrinjuck Dam

2016/17 CHIP Result C- (Fair)

2015/16 CHIP Result D (Poor)

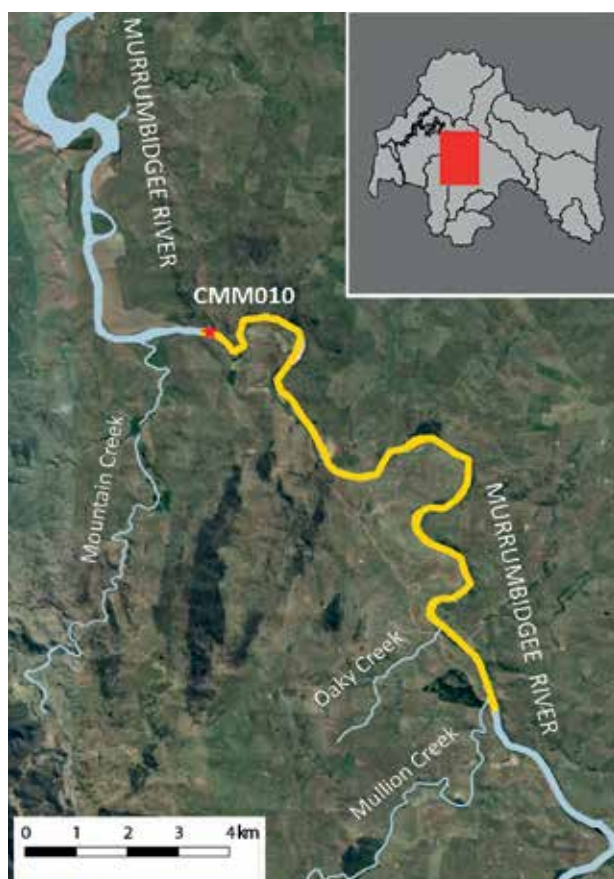
Parameter	Rating	No. Survey
Water quality	Good	5
pH	Excellent	
Turbidity	Fair	
Total Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Water bug	Degraded	1
Riparian condition	Poor	2

Reach Facts

Reach network length: approx. 20Km

Dominant land uses: Rural

This reach of the Murrumbidgee River is the most downstream of 13 reaches on the Murrumbidgee River. The downstream end at Taemas bridge is immediately upstream of the impounded water of Lake Burrinjuck. Much of this catchment is cleared grazing land, with poor in-stream habitat and a narrow and at times, heavily degraded riparian zone.



Reach condition:

This reach showed moderate readings of turbidity (10-22 NTU) and the volunteer has noted that the water colour was yellowish in several occasions. There were elevated readings of nitrate on four occasions with the highest in early March 2017 (10 mg/L). This may be from the Lower Molonglo Water Quality Control Centre (LMWQCC) as was suspected in CMM12.

The site at Taemas Bridge was transformed after good Winter and Spring rains. Usually lacking in edge and in-stream vegetation, the back fill from Burrinjuck Dam flooded the young adjacent eucalypts and provided some habitat for water bugs. While the majority of bugs recorded were tolerant species, with high numbers of backswimmers, water striders and water boatmen, there were some caddisflies and mayflies caught which is a nice change for this rather depauperate site.

Alas, the addition habitat also faired well for the introduced Carp with seven juveniles caught in the Spring survey and many others recorded jumping at the site.



Murrumbidgee River at Taemas Bridge - Spring 2016.

Yass River YAS1

Headwaters to Brooks Creek confluence, including Brooks Creek

2016/17 CHIP Result B- (Good)		
2015/16 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Good	13
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Fair	3
Riparian condition	Fair	2

Reach Facts

Reach length: approx. 60km

Dominant land uses: Rural, rural residential

The upper Yass River and Brooks Creek represent the top of the Yass River catchment. This reach is likely to represent the reference condition for this catchment. Improving condition in this reach will have benefits for the Yass River downstream.

Reach condition.

Water level regularly fluctuates on this section of Yass River. In some occasions, there was no visible flow and the River formed isolated pools. Electrical conductivity continues to be a problem in this reach and understandably, is worse when those pools have formed and the salts and minerals are more concentrated. The electrical conductivity has deteriorated compared to last year and got as high as 1110 μ S/cm in March after a dry, hot Summer.

Volunteers have commented on the “very lush surroundings” at YAS010, and it has been noted the presence of bulrushes, reeds, and water milfoil. Although a good ground cover is present throughout this reach, the amount that is native is still limited.

Spring and Autumn water bug surveys showed similar variety of species, and water striders were a common finding at both YAS005 and YAS010.

Tadpoles, frogs and fairy wrens were commonly spotted or heard by the volunteers, in addition to the sighting of a pair of wedge-tailed eagles on March 2017 at YAS010.



Yass River looking upstream from YAS010.

Yass River YAS2

Dicks Creek confluence to Manton Creek confluence

2016/17 CHIP Result B- (Good)

2015/16 CHIP Result B- (Good)

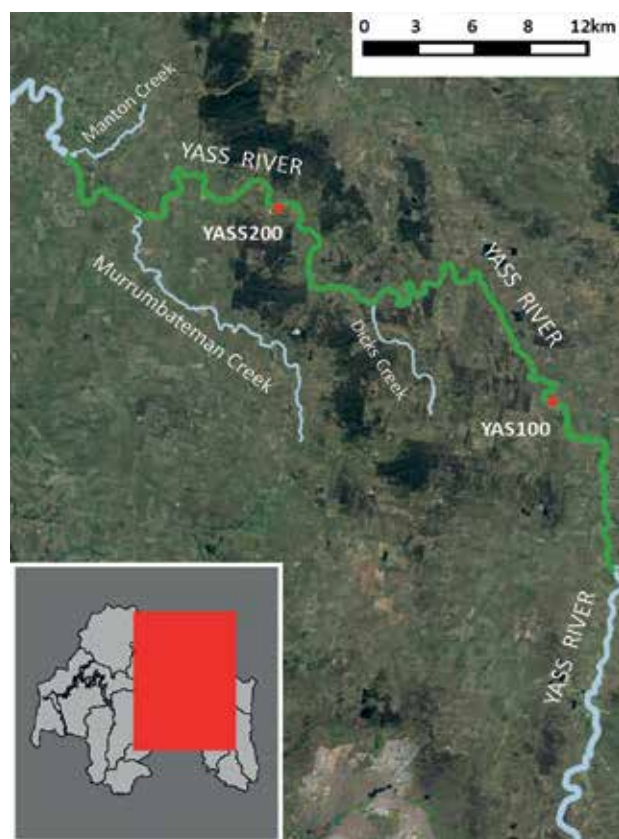
Parameter	Rating	No. Survey
Water quality	Good	19
pH	Excellent	
Turbidity	Fair	
Total Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Water bug	Good	2
Riparian condition	Fair	4

Reach Facts

Reach length: approx. 30km

Dominant land uses: rural

This mid-section of the Yass River contains the major tributaries of Murrumbateman and Manton Creek. The catchment is largely cleared and used for grazing. Riparian condition is generally poor, with pasture improvement right up to the river bank and stock access to the river, evident. Likely issues in this reach include high sedimentation leading to reduced in-stream habitat and high electrical conductivity due to historical land use.



Reach condition:

Dissolved oxygen saturation has showed some variation on this reach (19-127%), but lower values were evident during late Summer when the water warmed up and the flows were reduced. Surprisingly, the lowest reading was recorded at Booth's Crossing on May 2017. Electrical conductivity was elevated throughout the reach, with two readings reaching 930 and 1190 μ S/cm.

It can only be assumed that these dissolved oxygen and electrical conductivity results are still affecting the water bug scores in spite of some excellent and diverse habitat present. While the bug score was an improvement on last year, bug types continue to be present in limited numbers. That said, stonefly nymphs were caught for the first time here in Spring so things are looking up.

Riparian condition was variable between the two sites in this reach. The regeneration of native understory and canopy species at Goldenholm (YAS200) is also great to see, thanks to the hard work of volunteers Kate and Jeremy Wilson.

Tadpoles, Water rats, Swamp wallabies, baby grebes and Carp have been seen by the volunteers in this reach. A native fish, an Australian smelt, was caught in the Spring bug survey.



Kate Wilson sampling at 'Goldenholm'.

Yass River YAS3

Yass township to Lake Burrinjuck

2016/17 CHIP Result C+ (Fair)

2015/16 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	Good	21
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Water bug	Poor	2
Riparian condition	Fair	2

Reach Facts

Reach length: approx. 33km

Dominant land uses: urban, rural

This downstream section of the Yass River includes the township of Yass and runs through extensive gorge country before running into Lake Burrinjuck. Flow is heavily influenced by Yass Dam and urban inputs from the town are also likely to influence water quality in this reach. There is ongoing habitat rehabilitation occurring both in the Yass Gorge at the top of the reach and in downstream rural properties.



Reach condition:

Elevated electrical conductivity readings, ranging from 420-950 μ S/cm, were recorded during medium to low flow. Values fell to 90-210 μ S/cm after floods which diluted the River. Nitrate were also considered high, especially in Hattons Corner and Chinaman's Creek (5 mg/L).

It was positive to see abundant native understory regeneration and total ground cover in this reach, but native ground cover is still considered moderate. Habitat restoration projects are underway, led by landowners below the township, which should have a positive impact on catchment's health over the long-term.

Water bugs were represented mainly by tolerant species including 100+ shrimp in both Spring and Autumn surveys, which tend to do well in waters with high electrical conductivity. The township proximity is potentially affecting the water quality and consequently the diversity of water bugs.

Volunteers have spotted Swamp wallabies, wallaroos, turtles, frogs and skimmers. Carp have also been sighted in this reach.



Yass River near 'Hatton's Corner' downstream of Yass. (Photo: Rebecca Widows)

Additional Waterwatch Data

While the CHIP exclusively uses data on water quality, water bug surveys and riparian condition, a range of other data sources collected by Upper Murrumbidgee Waterwatch provide additional information and important context to the CHIP.

Platypus Month

Upper Murrumbidgee Waterwatch runs surveys for Platypus and Water rats (Rakali) during Platypus Month (August) throughout the catchment. Surveys are conducted by enthusiastic volunteers early in the cold Winter mornings stationed along a predefined reach of river, at seven survey sites across our catchment. Surveys run for one hour and are conducted at least twice at each site. Surveys are conducted on the Molonglo River upstream of Lake Burley Griffin (MOL5), Jerrabomberra Wetlands (JER2), Murrumbidgee River at Tharwa (CMM8), Murrumbidgee River at Bush Heritage Australia's Scottsdale Reserve (CMM6), Murrumbidgee River near Cooma (CMM4), Cooma Creek (COO2) and Numeralla River (NUM3).

In August 2016 a total of 18 surveys were conducted across the survey sites thanks to 80 hardy volunteers. In total 16 individual Platypus and five Water rats were confirmed to be present, with Platypus present at every site with the exception of the Murrumbidgee at Tharwa. The most Platypus were recorded at CMM6, where five individuals were recorded during one survey. Three Platypus were recorded at MOL5, two each at CMM4, COO2 and NUM3, and one individual at CMM8 and JER2. One Water rat was recorded at MOL5, CMM4, CMM6, CMM8 and JER2.

Waterwatch's Platypus survey program is now in its fourth year and is the longest standing formal survey program tracking Platypus and Water rat numbers in the upper Murrumbidgee River catchment. The data is important because just the presence of Platypus in a waterway does not necessarily indicate good waterway health, rather it is the number of Platypus found along a given stretch of waterway which is more indicative.

Monitoring long-term trends will also provide much needed information on the status of Platypus and Water rats in our waterways, which is currently lacking for our catchment. The need for this data is highlighted by the IUCN listing of the Platypus as 'near threatened', predicting that Platypus are in decline, with local extinctions possible in the future. Unfortunately, our friend the Water rat is also thought to be in decline.

We are pleased to report that our data is also supporting action by the community to protect these charismatic and loved inhabitants in our local waterways. For example, the Cooma Creek surveys confirmed presence of Platypus in the Cooma Creek and the habitat is now being enhanced and protected as part of the NSW Environmental Trust funded 'Improving the Cooma Creeks project'.

Further information regarding Platypus Month can be found at: www.act.waterwatch.org.au/Platypus.html



Carp Love 20°C

European carp (Carp) were introduced into Australia (Victoria) almost 100 years ago. After a slow start, it wasn't until the 1970s when their numbers grew rapidly and they spread throughout the Murray-Darling basin. In the mid-1970s, Carp were introduced into Lake Burley Griffin (accidentally) and now make up ~75% of the fish biomass in the upper Murrumbidgee River catchment. They have many detrimental impacts on water quality and in-stream native flora and fauna.

Efforts to control Carp will include targeted removal, improving natural ecosystem resilience, and potential releases of control agents such as a genetic modification termed 'daughterless Carp technology' and the Koi Herpes Virus. However, any intervention requires information on the biology and ecology of the species in order to be effective. At the present time, we know very little about the breeding biology and movement patterns of Carp in the upper Murrumbidgee River catchment.

Carp Love 20°C is a citizen science campaign initiated by Waterwatch in Spring 2015. With the assistance of the Invasive Animals CRC FeralScan portal (www.feralscan.org.au), the public can report sightings of Carp in the local waterways. In Spring when water temperatures reach around 20°C, Carp start to spawn, often in a spectacular fashion, with large numbers of individuals aggregating in shallow water where vigorous chasing and splashing takes place.

Over Spring and the first two weeks of summer of 2016, 65 records of Carp were made to the FeralScan portal, while 21 were specifically of Carp spawning behaviour. Sightings were made in and around Lake Burley Griffin, Sullivans Creek and Jerrabomberra Wetlands, along with riverine spawning events in the Yass River upstream of Yass township, Numeralla River and Cooma Creek.

A comparison of spawning dates between 2015 and 2016 revealed that Carp tended to spawn a couple of weeks earlier in 2015 than in 2016. This highlights the importance of tracking the environmental conditions that occur when Carp are breeding to further our understanding of breeding and recruitment in this species in our region.

This information will assist in managing future interventions to control Carp, as well as in building a model of Carp breeding, recruitment and movement within our catchment. More information can be found at: <http://www.act.waterwatch.org.au/Feral%20Fish.html>.



Volunteer list

Cooma

Jim Wharton

Rita Brademann

Ann Henkel

Mark Shubert

Edel & Erich Stephans

Tim Scrace

Pam Vipond

Alison Howell

Gill & Tony Robinson

John Chapman

Matthew Kent

Melinda Kent

Laurene Lewis

Bob & Jenny Cooper

Alan & Marj Jones

Kerryn Milligan & Phil Irons

Ed & Sue Dawson

Jackson Volker

Morgan Blaschke Broad

Alexander Freeman

Remi Brademanne

Raen Brademanne

Belinda Wilson

Gwenda Stockton

Sandra Henderson

Samantha Donohoe

Phil Palmer

Chris Taylor

Stephanie Martin

Casey Gough

Annie Didcott

Dean Sugden

Frank Ingwersen

Alistair Bestow

Gordon Roberts

Alex Thompson

Peter Strang

Corin Pennock

Rebeca Duarte

Thalez Brito

Emily Jones

Ruth

Claire Fitzgerald

Mia Jessurun

Isabella Somerville

Alex Tomlinson

Rebekah Vettasseri

Abbie Wane

Shelley Zhao

Kai Johnson

Angus Funnall

Alexandra Nichols

Joe Salmona

John Cannon



Ginninderra

Valentina Columbo

Alex Dudley

Portia Condell

Lesley Harland

Gregg Berry

Johanna Wallner

Luke Wensing

Kate Rhook

Joe Zhou

Sari Ruuska

Samantha Donohoe

Woo O'Reilly

Luke Hulbert

Lyndsay Britt

David Fitzsimmons

Ash Morris

Lisa Jobling

CIT students

Molonglo

Peter Abbott & Fraser Argue

ANUgreen Sustainability Office

Kate Badek

John Bissett

Tanya Boston

Michael Burton

Ange Calliess

Des & Jenan Cannon

Captains Flat Landcare Group

Tim Carroll

Eva Culek

Bruce Davies

Anna van Dugteren

Ema Falez & Chris Tracy

Chloe & Stewart Foster

Miranda Gardner

Sue Gibson

Hilary Gunn & Christine Bond

Yan Jiang & Troy Delbridge

Andrew Kaye

Bernard Kertesz

Sylvia Larsson

Sandy Lloyd

John Moore

Gail Neumann & Darryl Beaumont

Tony Patis

Stuart Pearson

Peter Robertson & Deb Shaw

Tanya Rough & Callum Bodenschatz

Royalla Landcare Group

Phil Sahlqvist

Mike Sim

Amar & Vidya Singh

Watson Woodlands Working Group

Terry Williams

Melissa Witham

Water buggers: Liz's Green Army team, John, Colin, Sharon, Ginny, Friends of Jerrabomberra Wetlands, Tim, Mel, Sonia, Jacob and Richard.

Southern

'Aboriginal Green Army

ACT Parks and Conservation Service

'Bidgee Blue' Waterwatch group (Anne & Bill Kerrigan)

'Carers of Point Hut Pond' Landcare

Caroline Chisholm School

Owen Maycock

Eli Charnock

Bill Heng

Jaykeb Brooks-Johnson

Jack Toal

Corey Foley

Vincent Narayan

Connor McNaught

Bill Meade

Deelai Chounlamountry Kim

Ben Hur Bustillo

Brooke Harder

Riley Roberts

Connor Mann

Rose Monkivitch

Ashlee Kirkland

Alex Spoor

Zander Blount

Eve Gaunt

Ashley Cooper

Conder Wetlands Waterwatch group

Coolleman Ridge Parkcare group

'Cuppacumbalong' Waterwatch Group

CVA Tidbinbilla Sanctuary Volunteer Interpreter Program

'Friends of Tidbinbilla' Parkcare group

Green Army

'Gudgenby Bush Regenerators' Parkcare Group (Martin Chalk, Michaela Popham, Samantha Donohoe)

Lake Tuggeranong College: Sustainability Unit

Lions Youth Haven Schools Program

Namadji School

Outward Bound Australia

'Paddy's River' Waterwatch Group

'Park Carers of Southern Murrumbidgee' Parkcare group(P.O.S.M)

'Sands' Waterwatch Group

Southwell Scout Group Venturers

Uriarra Parkcare Group

Eileen Becker & Stuart Young

Richard Bland

Ben Bryant

John Corcoran and Jan Koehler

Anthony Cory and Sue Bond

Walt Daly

Nic & Kerry Marsham

Alan Parker

Ella Shaw

Erindale College

Melrose High School ACE Science.

Weston Joey Scouts & Arrawang Girl Guides

Yass

Richard Bland

Ginny Edwards

Kate Wilson

Jane Major

Fiona Hamer

Rebecca Widdows

Carol Boughton

Paul Churcher

Janette Ryan

Krish Sanghvi

Glossary

Baseline monitoring:

The collection of data prior to a planned intervention/project

Biennial:

Occurring once every 2 years

Confluence:

The intersection of two waterways

Cyanobacteria:

Photosynthesizing bacteria often responsible for blue-green algae blooms

Data deficient:

Being either unsampled or having insufficient information to provide a confident assessment

Dissolved oxygen:

The amount of oxygen present within water, either presented as an absolute amount (mg/L) or as a percentage of the total oxygen saturation at a given temperature

Eastern gambusia: A small invasive pest fish introduced from central America

Electrical conductivity:

A measurement of the total combined salts/minerals within water and used as a proxy for salinity

Ephemeral:

Contains water intermittently, as opposed to permanent

Erosion:

The loss of soil from the land into waterways

Eutrophication:

The rapid blooming of algae and cyanobacteria in nutrient-rich water, which can lead to depletion of dissolved oxygen

Fish kill:

A natural or artificially induced mass die-off of fish occurring in a small space of time, often related to rapid depletion of dissolved oxygen

Flashy:

A term used to describe the temporal response of river discharge following rain

Fragmented:

Areas of habitat that have become disconnected due to habitat change

Frost hollow:

An area of land that is subject to severe frosts. Often occurs near waterways

Galaxias:

A small species of native freshwater fish

Gorge: A narrow, steep-sided, often rocky area immediately adjacent to a waterway

Groundwater: Water that is sourced from deep within the soil

Hydrograph: The relationship between river discharge and time

Leachate: Liquid effluent containing harmful substances

Metamorphic: A type of rock, related to its process of formation

Macrophytes: Aquatic plants

Nitrate: A naturally occurring form of Nitrogen. High levels can indicate excessive nutrient inputs into waterways

pH: A measure of the acidity or basicity (alkalinity) of a solution

Phosphorus: A naturally occurring element essential to life. High levels are often implicated in algal blooms in waterways. Measured as Orthophosphate on CHIP

Reach: A length of waterway defined by hydrological, environmental, landuse and social attributes for the purpose of reporting on ecosystem health

Riparian: The zone immediately adjacent to a waterway, which both directly receives and contributes to the aquatic ecosystem

Runoff: Water that flows into a waterway after rain

Sand slug: A large intrusion of sand within a river channel

Sediment: Soil that has become washed into a waterway

Stormwater: Same as runoff

Stressors:

Natural and man-made processes that can negatively affect natural ecosystem function

Turbidity:

The degree of suspended solids in water that gives it a muddy colour

Willows: an introduced riparian tree species

Abbreviations

ACWA: Actions for Clean Water Plan (an initiative to reduce turbidity in the upper Murrumbidgee)

DO: Dissolved Oxygen

EC: Electrical Conductivity

mg/L: Milligrams per Litre

μS: MicroSiemens

NTU: Nephelometric Turbidity Units

N: Nitrogen

QAQC: Quality Assurance, Quality Control

P: Phosphorus

RARC: Rapid Appraisal of Riparian Condition

TSR: Travelling Stock Reserve

UMDR: Upper Murrumbidgee Demonstration Reach



Appendix I

Cooma region CHIP scores by parameter

Reach	pH	EC	Turbidity	DO%	TP	NO3	WQ Score	WB Score	RARC Score	CHIP Score	Letter
BAD1	1	1	1	5	1	1	1.67	2.00	2.50	2.06	B+
BAD2	1	1	1	5	1	1	1.67	3.00	2.00	2.22	B+
BRD1	1	2	1	3	1	1	1.50	1.50	2.50	1.83	A-
BRD2	1	4	1	5	1	1	2.17	2.00	4.00	2.72	B-
CMM1	1	1	1	4	1	1	1.50	2.00	3.00	2.17	B+
CMM2	1	1	1	4	1	1	1.50	2.00	4.00	2.50	B
CMM3	1	1	1	4	1	1	1.50	1.00	3.00	1.83	A-
CMM4	1	1	1	1	1	1	1.00	2.00	4.50	2.50	B
CMM5	1	3	1	1	2	1	1.50	2.50	4.50	2.83	B-
CMM6	1	4	1	1	1	1	1.50	1.00	4.00	2.17	B+
COB1	1	5	1	4	4	1	2.67	2.50	4.00	3.06	C+
COO1	1	5	1	5	4	1	2.83	2.50	4.00	3.11	C+
COO2	2	5	3	4	5	2	3.50	2.00	5.00	3.50	C
COO3	2	5	1	5	5	2	3.33	2.00	4.00	3.11	C+
GUD1	2	5	1	1	1	1	1.83	1.50	4.00	2.44	B
KYB1	1	2	1	4	2	2	2.00	4.00	4.00	3.33	C+
MIC1	1	5	1	5	2	1	2.50	3.00	4.00	3.17	C
NUM1	1	4	1	2	1	1	1.67	1.50	4.00	2.39	B
NUM2	1	3	1	1	1	1	1.33	3.00	3.50	2.61	B
NUM3	1	2	1	5	1	2	2.00	2.50	3.00	2.50	B
NUM4	1	4	1	3	2	1	2.00	2.00	4.00	2.67	B-
ROC1	2	5	1	1	1	1	1.83	2.50	4.00	2.78	B-
STR1	1	2	1	1	1	2	1.33	2.00	4.00	2.44	B

1 = excellent, 2 = good, 3 = fair, 4 = poor, 5 = degraded

Molonglo region CHIP scores by parameter

Reach	pH	EC	Turbidity	DO%	TP	NO3	WQ Score	WB Score	RARC Score	CHIP Score	Letter
BUR1	1	4	1	5	1	1	2.17	2.50	4.00	2.89	B-
DIC1	1	4	1	5	1	5	2.83	3.00	3.00	2.94	B-
GGG1	1	4	1	3	1	2	2.00	DD	2.50	2.25	B+
JER1	1	4	1	5	1	1	2.17	2.00	4.00	2.72	B-
JER2	1	5	3	5	5	2	3.50	3.00	4.00	3.50	C
LYN1	1	2	3	5	2	2	2.50	4.00	4.00	3.50	C
MOL1	DD	DD	DD	DD	DD	DD	DD	1.00	4.00	2.50	B
MOL2	1	4	1	5	2	2	2.50	2.50	2.00	2.33	B+
MOL3	1	4	1	5	1	2	2.33	2.00	4.00	2.78	B-
MOL4	1	4	1	5	2	2	2.50	2.50	4.00	3.00	C+
MOL5	1	4	1	5	1	1	2.17	4.00	4.00	3.39	C
MOL6	1	4	2	1	1	1	1.67	3.00	4.00	2.89	B-
PRI1	1	5	1	1	1	1	1.67	3.00	4.50	3.06	C+
QUE1	2	2	1	2	1	1	1.50	2.00	2.00	1.83	A-
QUE2	1	2	1	1	1	2	1.33	2.50	3.00	2.28	B+
QUE3	1	3	1	1	1	2	1.50	2.50	4.00	2.67	B-
SCA1	3	3	1	5	1	DD	2.60	DD	3.00	2.80	B-
SUL1	DD	DD	DD	DD	DD	DD	DD	3.00	4.00	3.50	C
SUL3	1	4	1	5	5	1	2.83	3.00	4.00	3.28	C+
SUW1	1	1	2	DD	2	2	1.60	5.00	3.00	3.20	C+
SUW2	DD	DD	DD	DD	DD	DD	DD	5.00	3.00	4.00	D+
WAT1	1	2	3	5	1	1	2.17	3.00	4.00	3.06	C+
WES1	1	4	1	5	5	2	3.00	3.00	4.50	3.50	C
WOO1	1	5	1	5	1	1	2.33	3.00	5.00	3.44	C
YAN1	1	1	1	5	1	1	1.67	3.00	2.50	2.39	B
YAR1	1	4	3	5	1	1	2.50	4.00	3.00	3.17	C+

1 = excellent, 2 = good, 3 = fair, 4 = poor, 5 = degraded

Ginninderra region CHIP scores by parameter

Reach	pH	EC	Turbidity	DO%	TP	NO3	WQ Score	WB Score	RARC Score	CHIP Score	Letter
GDC1	1	4	3	5	1	1	2.50	3.00	3.00	2.83	B-
GIN1	1	4	1	5	1	2	2.33	3.00	3.00	2.78	B-
GIN2	1	4	1	5	1	1	2.17	3.00	4.00	3.06	C+
GIN3	1	4	1	5	1	2	2.33	3.00	4.00	3.11	C+
GIN4	1	4	1	5	2	2	2.50	3.00	4.00	3.17	C+
GIN5	1	4	3	1	1	2	2.00	5.00	5.00	4.00	D+
GOO1	1	5	1	5	1	2	2.50	4.00	5.00	3.83	C-
GUN1	DD	DD	DD	DD	DD	DD	DD	3.00	3.50	3.25	C+
GUN2	1	5	2	5	1	2	2.67	3.00	3.50	3.06	C+
KIP1	1	5	2	5	4	5	3.67	4.00	3.00	3.56	C
MCW1	2	1	3	1	1	2	1.67	4.00	3.50	3.06	C+
MFL1	1	2	3	1	2	1	1.67	3.00	3.00	2.56	B
YER1	2	4	1	4	1	2	2.33	3.00	4.00	3.11	C+

1 = excellent, 2 = good, 3 = fair, 4 = poor, 5 = degraded

Southern region CHIP scores by parameter

Reach	pH	EC	Turbidity	DO%	TP	NO3	WQ Score	WB Score	RARC Score	CHIP Score	Letter
CGB1	1	1	1	5	1	1	1.67	1.50	3.00	2.06	B+
CGG1	1	1	1	1	1	1	1.00	1.50	4.00	2.17	B+
CGH1	1	1	1	5	1	2	1.83	2.00	2.00	1.94	A-
CMM7	1	2	1	1	1	1	1.17	2.00	3.50	2.22	B+
CMM8	1	3	1	5	1	1	2.00	4.00	4.00	3.33	C+
CMM9	1	3	1	5	1	2	2.17	2.50	4.00	2.89	B-
CMM10	1	3	1	1	1	2	1.50	2.00	3.50	2.33	B+
CMS1	2	3	1	5	1	1	2.17	2.50	5.00	3.22	C+
CTP1	2	1	1	1	1	1	1.17	2.00	3.00	2.06	B+
CTT1	2	1	1	1	1	1	1.17	3.50	3.00	2.56	B
GIB1	1	1	1	2	1	1	1.17	1.00	2.00	1.39	A
LMS1	2	1	1	1	1	1	1.17	4.00	3.00	2.72	B-
MCC1	2	1	1	2	1	1	1.33	2.00	3.00	2.11	B+
MCC2	2	1	1	1	1	1	1.17	2.00	3.00	2.06	B+
MMB1	1	3	1	5	1	1	2.00	3.00	3.00	2.67	B-
MPG1	1	4	2	1	1	1	1.67	5.00	4.00	3.56	C
MSP1	1	4	1	1	1	2	1.67	4.00	4.00	3.22	C+
NNN1	1	4	1	5	1	1	2.17	3.00	3.00	2.72	B-
RAN1	3	2	3	2	2	1	2.17	4.00	4.00	3.39	C
RAN2	1	1	1	5	1	1	1.67	5.00	5.00	3.89	C-
TIP1	1	1	3	5	1	1	2.00	4.00	4.00	3.33	C+
TLT1	2	3	3	5	1	2	2.67	4.00	4.00	3.56	C
TLT2	1	2	2	1	1	5	2.00	5.00	4.00	3.67	C-
TMM1	1	3	1	5	2	1	2.17	3.50	3.50	3.06	C+
TUG1	1	3	1	5	1	1	2.00	4.00	5.00	3.67	C-
TUG2	1	1	1	1	1	1	1.00	5.00	5.00	3.67	C-
TUG3	1	3	2	5	2	2	2.50	3.00	3.00	2.83	B-

1 = excellent, 2 = good, 3 = fair, 4 = poor, 5 = degraded

Yass region CHIP scores by parameter

Reach	pH	EC	Turbidity	DO%	TP	NO3	WQ Score	WB Score	RARC Score	CHIP Score	Letter
CMM12	2	4	2	1	1	5	2.50	5.00	3.00	3.50	C
CMM13	1	4	3	1	1	5	2.50	5.00	4.00	3.83	C-
YAS1	1	5	1	5	1	1	2.33	3.00	3.50	2.94	B-
YAS2	1	5	3	5	1	1	2.67	2.50	3.00	2.72	B-
YAS3	1	5	1	1	1	5	2.33	4.00	3.00	3.11	C+

1 = excellent, 2 = good, 3 = fair, 4 = poor, 5 = degraded

Appendix II

CHIP Methodology

Upper Murrumbidgee Waterwatch (Waterwatch) produces an annual catchment health report called the Catchment Health Indicator Program (CHIP), based upon the data collected by volunteers throughout the preceding year. This report is a key output of this program, and is used as both a communication tool and to inform management and policy regarding water resource use and protection. However, multiple complex calculations are involved in producing the CHIP, and numerous catchment groups around Australia produce similar (albeit slightly different) CHIPs. Conversely, specific details regarding these CHIPs are not generally forthcoming. This document aims to clearly outline the underlying philosophy and methodology regarding the Waterwatch 2015–2016 CHIP.

Multiple Types of Data

Waterwatch volunteers and co-ordinators collect data relating to water quality, macro-invertebrate abundance and diversity, and riparian condition. Each of these data sources are 'indices' or 'parameters', which, when combined, form an 'indicator'. Currently, the goal for volunteers is to collect water quality data every month, at every site. Volunteers and co-ordinators also collect aquatic macro-invertebrate data twice a year, in Spring and Autumn at key sites within each reach, generally near the bottom of each reach (to provide an indication of the entire reach). Finally, Rapid Appraisal of Riparian Condition (RARC; Jansen et al. 2005) assessments are conducted by volunteers and co-ordinators at each site once every 2 years (biennially). RARCs are conducted at lower frequency, as riparian condition changes at a slower rate than macro-invertebrate assemblages, and water quality. All these data are combined into the CHIP. Finally, additional data regarding algae abundance and diversity, frog abundance and diversity, and Platypus abundance are used to provide context regarding catchment health, but are not formally included in the CHIP calculations (Table 1). More details regarding these additional data sources can be found in the section "Additional Data"

Water Quality Parameters

Currently, volunteers strive to collect water quality data for multiple parameters every month (Table 1). These parameters have been widely established as the best indicators of water quality while being relatively easy to measure and have been discussed in detail previously (eg. Waterwatch Victoria 1999). While there are known (and unknown) site-specific variations in these parameters, it is generally accepted for a majority of these that a specific range of values indicate good catchment health (eg. ANZECC 2000). Deviations away from these ideal values indicate declining health of the waterway. It is this philosophy that underpins the computations of the CHIP, and the grading of catchment health (see Appendix III).

Table 1. Summary of waterway health parameters collected by volunteers and co-ordinators, that are included in the CHIP. The values here reflect current goals, but are not always achieved in all instances.

	Parameter	Frequency	Number of sites
Water Quality	pH	Monthly	All sites
	Electrical Conductivity	Monthly	All sites
	Turbidity	Monthly	All sites
	Phosphorus	Monthly	All sites
	Nitrate	Monthly	All sites
	Dissolved oxygen	Monthly	All sites
	Temperature	Monthly	All sites
Macro-invertebrates	SIGNAL 2.0	Biannual (Spring & Autumn)	Key sites (min 1/reach)
Riparian Condition	RARC	Biennial	All sites

Macro-invertebrates

Aquatic fauna (and flora) are ideal indicators of catchment health, as they are entirely dependent on the waterway for their existence. Aquatic macro-invertebrates differ greatly in their requirements, and their tolerances to changes in their aquatic environment. Numerous programs exist to assess waterway health based upon abundance and diversity of macro-invertebrate assemblages (eg. AUSRIVAS, SIGNAL, ALT) and are similar in many respects. Waterwatch use SIGNAL 2.0, with macro-invertebrate identification to the order level (not family as with AUSRIVAS). Specific details of the sampling methodology are outlined in the SIGNAL 2.0 user manual (Chessman 2001; Chessman 2003).

The SIGNAL 2.0 score obtained at each site receives an additional calculation to produce a modified stream pollution index. This helps to control for the diversity of macro-invertebrates found at a site. We have included an additional criteria this year, that examines whether the three key sensitive orders of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies) are present, to aid with standardising scoring across the three data sources (WQ, Water bugs and RARC). This number is transformed (similar to the water quality parameters, above), and the median value of all the sampling periods within the reach (including Spring and Autumn surveys), before being included in the CHIP (Table 2). Further details are present in Appendix III.

Table 2. Summary of SIGNAL 2.0 scores, and thresholds between the CHIP score categories.

Number of Taxa	SIGNAL Score	EPT Present	EPT Absent
>7	>5.5	Excellent	Good
>7	>5.5	Good	Fair
≤ 7	≤ 5.5	Fair	Poor
≤ 7	≤ 5.5	Poor	Degraded

Riparian Condition

The riparian zone along a waterway is integral to waterway health. The riparian zone performs several important functions, including acting as a buffer and filter to incoming runoff, and extracting nutrients from the waterway itself. Currently, RARC assessments are conducted biennially at all sites. A substantial number of surveys were conducted in Summer and Autumn 2015. This data has been incorporated for the first time into the CHIP in 2014–2015.

RARC was developed for use along the Murrumbidgee River in open floodplains dominated by a River Red Gum overstorey. As such, its applicability to the upper Murrumbidgee River catchment, urban environments and non-riverine habitats is questionable. However, it is still likely to be an effective tool for recording changes in riparian composition over time, irrespective of the score. The thresholds applied in the 2015–2016 CHIP are as follows (Table 3). These thresholds may be revised in the future, to better reflect the actual distribution of RARC scores present in the Upper Murrumbidgee River catchment.

Table 3. Summary of RARC scores, and thresholds between CHIP score categories.

RARC Score	CHIP Parameter
41–50	Excellent = 1
31–40	Good = 2
21–30	Fair = 3
11–20	Poor = 4
0–10	Degraded = 5

Combining Water Quality, Macro-invertebrate and RARC Data

Using the scores calculated for water quality, macro-invertebrates and RARC assessments, these values are averaged for each site. Currently, water quality, macro-invertebrates and RARCs are equally weighted in the CHIP. However, in the event that one of these is missing, a CHIP score is still produced. If two of the three assessments are missing for a reach, no CHIP score is produced.

Data Density

A potential source of bias can arise from insufficient data collection at sites within reaches. In order to overcome some of these issues, a rule has been applied to the water quality data to ensure a minimum amount of data is present, before a CHIP score is produced. Currently, a minimum of 25% of total potential water quality data must be present for a CHIP score to be produced. This is calculated by dividing the total number of sampling events available for analysis in the preceding year, by the number of sites within a reach, multiplied the number of total sampling events that should have occurred (12). This provides a proportional measure of the amount of sampling that has taken place within a reach in the preceding 12 months. In the event that <25% of data was collected, the water quality data is not included in the computation of a CHIP score.

The CHIP Score

The resulting CHIP score for each reach provides an indication of the overall health of that particular reach. While specific site-level variations (eg. some sites have naturally high electrical conductivity, low pH etc) may receive lower scores, it therefore requires that careful interpretation of these CHIP values be undertaken prior to making inferences of catchment health. In addition, the application of SIGNAL 2.0 in non-flowing aquatic habitats and RARC assessments in heavily urbanised environments may produce unusually low scores. In these instances, comparing within reaches, between years will be more appropriate than comparing between reaches, within years. These considerations must be taken into account when using and interpreting the CHIP. Finally, vitally important context is provided by the Waterwatch coordinators, who know the underlying geology, hydrology, landuse and history of the catchments. Their expert knowledge is critical to valid interpretations of the CHIP scores.

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Appendix III

Refining macroinvertebrate scores for the 2015–2016 CHIP

Background:

As part of the continual process of improving the rigour and transparency behind the calculation of CHIP scores, this year we have re-evaluated the process regarding how macro-invertebrate survey data contributes to producing final reach scores.

Throughout the 2013-2014 and 2014-2015 CHIP reports, macro-invertebrate scores have been based upon the divisions defined in the SIGNAL 2.0 manual (Chessman 2003; Table 1).

Table 1. Previous approach to computing CHIP scores based on macro-invertebrate sensitivities and abundance, as defined by SIGNAL 2.0 (Chessman 2003).

SIGNAL SCORE	Number of macroinvertebrate orders	
	0 - 7	>7
>5.5	Fair	Excellent
≤ 5.5	Poor	Good

Macro-invertebrate surveys are categorised into 1 of 4 categories based on the number of taxonomic groups (Orders) and the weighted sensitivity of those orders collected (Chessman 2003). For example, where the weighted sensitivity is >5.5 and the number of taxa >7, will result in a CHIP score of “Excellent”. Conversely, a weighted sensitivity of ≤ 5.5 and ≤ 7 taxa would result in a CHIP score of “Poor”.

Unfortunately, this does not fit well with our 5 category ranking of catchment health. Indeed, under the previous scheme, it would be impossible to score a reach as “Degraded”, as there is no “Degraded” category for macro-invertebrates.

Adjusting the score to 5 levels

To make the adjustment to a 5-level scoring system for macro-invertebrates, we have incorporated an additional criteria to the computation of the CHIP score for each macro-invertebrate survey (Table 2). This additional criteria examines whether all three EPTs (Ephemeroptera, Plecoptera and Trichoptera) are present. If 2 or less are present (eg. any one or more of these taxonomic groups are missing), then scores are penalised (Table 2).

Table 2. New macroinvertebrate scoring system for the 2015-16 CHIP.

Number of Taxa	SIGNAL Score	EPT Present	EPT Absent
>7	>5.5	Excellent	Good
>7	>5.5	Good	Fair
≤ 7	≤ 5.5	Fair	Poor
≤ 7	≤ 5.5	Poor	Degraded

Why EPTs?

The “EPTs” (Ephemeroptera, Plecoptera and Trichoptera) are the three orders of highly sensitive water bugs – The Mayflies, Stoneflies and Caddisflies. These three orders are generally present where both water quality and aquatic habitat are in excellent condition. Indeed, in all surveys undertaken in the Upper Murrumbidgee catchment by waterwatch in the last two years, all surveys listed as “Excellent” contained these three orders. Both nationally and internationally, there is a strong focus on the EPTs as they are universally considered to be good indicators of good catchment health (eg. Marchant et al. 1995).

What do these changes mean for the CHIP?’

The main effect this change will have on the CHIP report is providing greater differentiation between Good, Fair and Poor reaches. Furthermore, it will now be mathematically plausible to score a reach as “Degraded”. All previous sites scored as Excellent are unlikely to change, however reaches scored as Good, Fair and Poor have greater scope to shift downwards, if these three important taxa are missing from their macro-invertebrate surveys.

How does this change the previous CHIP?

By way of examination of these changes on the CHIP result, here we present a comparison of CHIP scores from the 2014–2015 CHIP report, with the old CHIP scores, and the new (Table 3).

Table 3. Summary of changes to the reach scores from the 2014-15 CHIP with the update in macroinvertebrate scoring.

SCORE	OLD	NEW
Excellent	4	4
Good	45	34
Fair	36	42
Poor	5	10
Degraded	0	0

In the 2015-2016 CHIP, we present the 2014-2015 CHIP results with the updated macro-invertebrate scoring system, to facilitate direct comparison between the two reports.

Chessman, B (2003) New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research* **54**: 95-103

Marchant, R., Barmuta, LA., and BC Chessman (1995) Influence of sample quantification and taxonomic resolution on the ordination of macroinvertebrate communities from running waters in Victoria, Australia. *Marine and Freshwater Research* **46**: 501-506

Appendix IV

Refining water quality thresholds for the CHIP

Background:

In developing the 2013–2014 CHIP, a set of thresholds had to be applied to the water quality parameters in order to produce water quality scores. These are summarised in Table A2 of Appendix III of the 2013–2014 CHIP report (Table 1).

Table 1. Summary of 2013–2014 water quality thresholds for the CHIP report.

Indicator Rating	Excellent - 1	Good - 2	Fair - 3	Poor - 4	Degraded - 5
pH	6.0 – 6.9	5.5 – 5.9 or 7.0 – 7.9	8.0 – 8.5	5 – 5.5 or 8.5 – 8.9	<5 or >9
EC (µS)	<= 65	<= 200	<= 350	<= 400	> 400
Turbidity (NTU)	<= 10	<= 12.5	<= 15	<= 20	> 20
Dissolved oxygen (mg/L)	<i>(Not included in CHIP)</i>				
Dissolved oxygen saturation (%)	95 – 105	85 – 95 or 105 – 110	75 – 85	65 – 75 or 115 – 120	< 65 or > 120
Phosphorus	< 0.01	0.01 – 0.02	0.02 – 0.05	0.05 – 0.09	> 0.09
Nitrate (mg/L)	< 1.0	1 – 4.9	5 – 9.9	10 – 15	> 15

These thresholds are based largely on those developed by the Molonglo CHIP report (M-CHIP). The M-CHIP values were developed in 2 parts – an urban and rural scale. The rural-scale values were used for the 2013–2014 CHIP report, with a few minor tweaks (mostly to dissolved oxygen) before being implemented. Unfortunately, there is no clear evidence trail of how these thresholds were developed, and so we treated them as based upon expert knowledge.

For the 2014–2015 CHIP report, we aimed to develop a new set of thresholds based upon water quality data collected in the ACT region. The key issues in developing these new thresholds will be outlined here.

Identifying a data set: independence, data quality and reference sites

Numerous sources (ANZECC, ACT Water Regulations, other catchment report cards) promote the development of meaningful thresholds based upon a ‘training dataset’. A training dataset is a relevant water quality dataset used to determine thresholds which can be applied to data collected throughout the catchment for the purposes of reporting. The strengths of this approach are that thresholds are locally relevant, are developed in a transparent manner and are updateable and repeatable.

Ideally, an independent dataset would be used to redefine thresholds. This has two major benefits.

Firstly, an independent dataset would not be burdened with any real or perceived data quality issues that volunteer collected data may have. Key issues regarding sampling bias, accuracy and precision of equipment and reporting of data can be eliminated. Secondly, thresholds developed from an independent dataset may be retrospectively applied to all Waterwatch data. The use of Waterwatch data would prevent the application of thresholds to data used to define the thresholds (a problem of circularity).

There are limited sources of data available in the ACT region which may be used to develop thresholds. The most obvious data sources are those collected and maintained by the ACT Government, Icon Water and University of Canberra.

In examining the external water quality to develop thresholds, a key consideration is the choice of sites with which to use to create new thresholds. Obviously, the choice of sites will have a major impact on the threshold values produced. Sites that are considered to represent 'reference condition' are preferred over all others. Reference condition is defined, for the purposes of the CHIP, as sites that represent minimally impacted areas in the ACT region. Ideally, these sites will exist in minimally impacted agricultural or conservation managed lands, without significant impacts from urban centres or major developments.

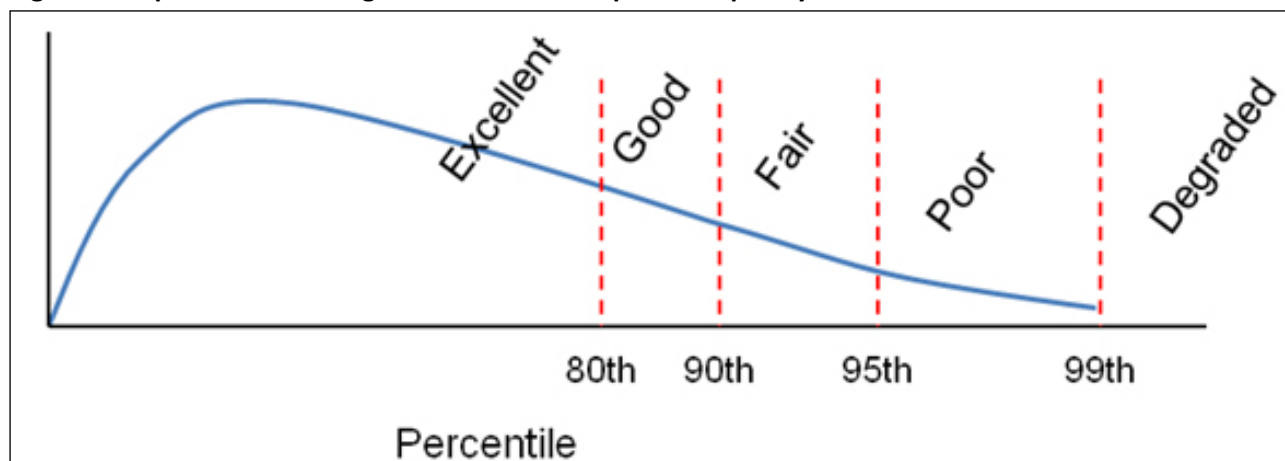
A second key issue is the amount of data available. This is further complicated by the impact that the millennium drought had on reference site condition. For example, data from reference sites of the AUSRIVAS macro-invertebrate monitoring program showed major declines in the relative health of some reference sites during the millennium drought. This is not surprising, but including data that shows negative impacts of drought would influence the discriminatory power that the reference condition approach could provide. These impacts are likely to be present in water quality data that exists from the same time period.

Defining the thresholds

There are numerous ways water quality data could be categorised to produce a score, but we have chosen to use percentiles derived from a frequency histogram of water quality data taken from reference sites to define the thresholds for the CHIP.

Our approach is outlined in figure 2. After creating a frequency histogram from reference condition data, the threshold values for each parameter are defined using the 80th (Excellent), 90th (Good), 95th (Fair), 99th (Poor) and >99th (Degraded) percentiles. The implicit assumption is that parameter values that occur in excess of 80% of the time in the reference sites reflect excellent quality, with rarer occurring events being of lower quality. Finally, it is assumed that 'degraded' water quality would only be observed <1% of the time in a reference condition site.

Figure 2. Depiction of defining thresholds based upon a frequency distribution of data.



Identification of 'reference sites'

The selection of sites from which to produce thresholds will have a major impact on final scores produced in the CHIP report. Site selection is critical to how scores are interpreted. While arguably the score is irrelevant, and rather the change in any site/reach through time is more important, the reality is that scores will be interpreted directly without appropriate thought to how they were derived.

Preference will be to select sites that exhibit minimal levels of agricultural and urban impacts. Avoiding urban influences should be relatively straightforward, however agriculture is widespread throughout the upper Murrumbidgee catchment, hence obtaining sites without agricultural impacts will be difficult. Furthermore, historical impacts from agriculture, mining and land clearing may still be having pervasive impacts on water quality, which may be hard to identify in the first instance, and may not be readily avoidable, in any case. As such, 'reference condition' must not be interpreted as 'pristine'. Rather, it reflects the condition of minimally impacts sites within the catchment. As such, long-term goals aspiring towards water quality in sites equivalent to that of reference condition is a worthy goal, yet by no means suggests a return to pristine or non-impacted conditions.

There are limited sites in the Upper Murrumbidgee River catchment that have long-term data records from which to derive frequency distributions. Data available from Icon water for the Upper Cotter River catchment (above, and including Corin reservoir) and water quality collected from the Goodradigbee River catchment represent the most practical 'reference condition' datasets for the CHIP.

The catchments to the east of the Murrumbidgee River have a different underlying geology compared to the catchments west of the Murrumbidgee River (eg. The Cotter River, and Goodradigbee River.) Likewise, the Ginninderra and Yass catchments may tend to exhibit high electrical conductivity compared to other catchments. With additional data, electrical conductivity thresholds would be developed for the Molonglo, Ginninderra and Yass catchments, provided suitable data from 'reference condition' sites could be found. This is highly unlikely to occur.

Data availability

Icon Water generously provided water quality data for 2 riverine sites upstream of Corin reservoir, three sites within the upstream-most section of Corin reservoir, and data from 3 sites on the Goodradigbee River, and 3 sites on tributaries of the Goodradigbee River, collected by University of Canberra (Table 1).

Table 1. Summary of sites used to define reference condition for CHIP thresholds

Site Name	Years of data	Parameters
Cotter Hut	2007-2014	pH, turbidity, EC, DO
Gingera	2003-2015	pH, turbidity, EC, DO
Corin Reservoir site 7	1994-2015	TN, TP
Corin Reservoir site 8	1993-2015	TN, TP
Kangaroo Ck	2003-2015	TN, TP
Goodradigbee River site 1	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee River site 2	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee River site 3	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 1	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 2	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 3	2006-2015	pH, Turbidity, EC, TN, TP

Data analysis

Data analysis involved producing frequency histograms of each of the water quality parameters at each site. Firstly, the impact of the millennium drought was explored by comparing histograms for data collected 2010-current, against pre-2010 data. If no observable difference in distributions was present, data was combined. If significant differences were present, only data post-2010 was considered for threshold production.

After identifying non-drought impacted data, sites were combined and examined. If substantial differences in distributions were evident across sites, they were not combined. Conversely, if no major discrepancies were present, data across sites was combined. The exception to this rule was made for electrical conductivity –the upper Cotter River is very low in electrical conductivity, compared to the Goodradigbee catchment. We chose to combine data from the Cotter River and Goodradigbee River to produce EC thresholds for the CHIP as this will better reflect the apparent naturally higher EC readings from other areas in the catchment such as the Molonglo and Ginninderra.

Current thresholds

Table 2 presents the threshold values applied in the current CHIP. Thresholds were developed based upon the 80th (excellent), 90th (Good), 95th (Fair), 99th (Poor) and > 99th (Degraded) percentiles, for each parameter. For pH and dissolved oxygen, the 10th and 90th (Excellent), 5th and 95th (Good), 2.5th and 97.5th (Fair), 0.5th and 99.5th (Poor) and <0.5th and >99.5th (Degraded) percentiles were used to define thresholds. These thresholds were redefined for the 2014-15 CHIP report onwards.

Table 2: Water quality CHIP thresholds.

Parameter	Excellent	Good	Fair	Poor	Degraded
pH	6.6 – 7.8	6.1 – 6.5, 7.9 – 8.0	5.7 – 6.0, 8.1 – 8.2	5.4 – 5.6, 8.3 – 8.6	< 5.4, > 8.6
EC (uS)	≤ 98	99 – 156	157 – 212	213 – 404	> 404
Turbidity (NTU)	≤ 10	11 – 16	17 – 36	37 – 90	> 90
DO (mg/L)	<i>(Not included in CHIP)</i>				
DO Sat. (%)	88 – 99	84 – 87, 100	81 – 83, 101 – 106	78 – 80, 107 – 115	< 78, > 115
Phosphorus (mg/L)	< 0.02	0.02 – 0.03	0.04 – 0.05	0.06 – 0.08	> 0.08
Nitrate (mg/L)	< 1.0	1.0 – 1.3	1.4 – 1.7	1.8 – 2.6	> 2.6

Going forward: interpreting the CHIP

Interpreting CHIP scores must explicitly consider how the scores were derived. The data used to derive the water quality thresholds come from water quality monitoring sites in the upper Cotter River catchment and the Goodradigbee River catchment.

As such, all WQ CHIP scores are to be considered in relation to the ‘reference condition’.

