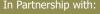


# Catchment Health Indicator Program 2021



Supported by:











Waterwatch acknowledges the Traditional Custodians of the region, the Ngunnawal and Ngarigo peoples. We recognise and respect the enduring relationship they have with their lands and water, and pay our respects to Elders, past, present and emerging.

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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: <a href="http://www.act.waterwatch.org.au">http://www.act.waterwatch.org.au</a>

The Atlas of Living Australia provides database support to the Waterwatch program. Find all the local Waterwatch data at: https://biocollect.ala.org.au/actwaterwatch

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- Front cover image of Waterwatcher Jill sampling on the Paddy's River by M. Blume.
- Page 7, image of Waterwatcher Vera at Conder Wetlands on a chilly July day taken by 4 year old Ari.
- Page 8, image of flood pouring over Cooma pumping station weir and fish ladder by M. Mannile.

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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 11,400km<sup>2</sup>.

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 [waterbug] 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 (sections of waterway) report cards, using data collected by Waterwatch volunteers.

The 2021 CHIP report is based upon 1,779 water quality surveys, 181 waterbug surveys and 219 riparian condition surveys conducted by over 200 volunteers. The total number of sites surveyed was 229 with a total of 96 reach report cards produced. Waterwatch now includes the important addition of the number of 'dry' surveys conducted in the overall survey tally (ie. when a volunteer has visited their site but it is completely dry). While these do not contribute to the CHIP score, they are an important factor in the condition of the catchment and highlight survey effort. A total of 17 water quality surveys were dry in 2021 which is in stark contrast to the height of the drought in 2019 when 193 dry surveys were recorded.

Of the 96 reaches presented in this report (Table 1), seven were scored as in *excellent* condition. This is the highest number of excellent ratings recorded in the eight years the CHIP has been produced in its current format. A further 42 reaches were scored as being in *good* condition, four more than last year, and 45 reaches were in *fair* condition, eight less than 2020. Two reaches received a *poor* score, the same as last year, and no reaches received a *degraded* score. Every catchment saw a trend upwards in condition this year with Cooma showing the most improvement and Molonglo producing an almost identical result to 2020.

Some keen CHIPspotters out there will note that the comparative scores from 2020 differ slightly from those in last year's printed report. This is due to a review in 2021 of the CHIP data analysis method for water quality which resulted in the primary method of calculating the average score switching from modal to median. While the difference in the overall CHIP scores resulting from this change is modest, it is an important shift in accurately representing the data for the individual water quality parameters. The result is a small but important step in improving the CHIP approach and better reflecting catchment health. A full write up of this analysis is provided on page 118 of this report.

Table 1: CHIP results from 2021.

CHIP Result	Cooma	Ginninderra	Molonglo	Southern ACT	Yass	Total
Excellent (A)	2	0	1	4	0	7
Good (B)	13	3	10	14	2	42
Fair (C)		12	14			45
Poor (D)	0	0	0	2	0	2
Degraded (E)	0	0	0	0	0	0

The 2020 CHIP report captured the dramatic impact of the bushfires at the beginning of that year, when ash and sediment was washed into our waterways following heavy rainfall. By late 2020, the water quality data started to look more positive as phosphorus concentrations declined and the rivers became clearer with the constant flows. The rains persisted throughout 2021 with 912mm falling in total, making it the fifth wettest year on record (Canberra average 614mm). The results have been overwhelmingly positive for the upper Murrumbidgee catchment with 44 of the 96 reaches showing improvement, 34 remaining steady and only 18 showing a decline. It is heartening to see catchments directly and indirectly impacted by the fires, such as Hospital and Bogong creeks in Namadgi National Park and the Badja and Numeralla rivers in the southeast, all bounce back this year. Three of the reaches in those catchments even received *excellent* report cards.

Of the many other reaches that showed improvement, the strongest representation was in reaches along the larger rivers - the Murrumbidgee River, Molonglo and Queanbeyan rivers. One of the most common water quality parameters to see improvement was electrical conductivity as the consistent high flows diluted salts and minerals washed off the landscape. The other clear winner was dissolved oxygen, benefiting from the cooler, faster flows. The results also translated to a positive waterbug response with many pollution-sensitve types, such as stonefly nymphs, being detected either for the first time in some reaches, or returning after many years.

With consistent rainfall having such a postive effect on our waterways, it may be tempting to ask if anything we do as land managers makes a difference. Meaning, is it all down to the weather? It may be hard to remember the Murrumbidgee River ceasing to flow in in December 2019 and the stress our waterways were under at that time. The dry conditions will return again and this is when groundcover and intact riparian zones filtering runoff and providing shade and habitat will be most valuable. This is when good in-stream habitat, connectivity and refuge pools along our waterways will make all the difference for our aquatic fauna. In fact, some of the riparian restoration works already carried out by many dedicated volunteers and community groups in the region, have seen a number of river reaches improve their riparian scores this year, as young plantings get a well needed boost from the rain. Such efforts will provide overall landscape resilience that has lasting benefits for our waterways, long after the La Niña has ended.

While the 2021 CHIP has been overwhelmingly positive, not all the reaches showed improvement. Of the 18 reaches showing declines, half were in urban wetlands and waterways. This included bigger waterbodies such as Lake Tuggeranong and Lake Ginninderra as well as some smaller wetlands. High nutrient levels in the form of nitrate and phosphorus were regularly detected washing off the surrounding suburbs and waterways adjacent to development sites continued to experience high turbidity. Electrical conductivity, while better than previous years, still often produced *degraded* levels as stormwater travelled over many an impermeable surface, such as concrete drains, before entering the waterways. Dissolved oxygen levels also fluctuated greatly. The increased nutrients can result in supersaturated dissolved oxygen events when there is too much algae and this was observed by the Waterwatch volunteers on a number of occasions in 2021.

This all highlights the importance of us all doing our bit in suburbia to improve stormwater by actions such as cleaning up the leaves in our gutters. It also shows the value of having more naturalised urban landscapes to treat the stormwater, a function many of our wetlands deliver. The recently constructed Holder Wetlands, which now has two Waterwatch sites at its inlet and outlet, are already demonstrating how effective they are at drawing nutrients out of the system.

It would be nice to get through this report without having to mention COVID, but alas our second lockdown in August 2021 resulted in Platypus Month coming to a dramatic stop just as eager volunteers were getting warmed up. Platypus Month will return in earnest in 2022.

On top of lockdowns, 2021 saw border closures and more access issues due to floods - and yet the data still rolled in. So **thank you, as always, to the volunteers.** This report would not be possible without your continued efforts to collect this important data on the health of our waterways. Please remember that your efforts make a significant contribution to the improvement of the upper Murrumbidgee waterways.

Waterwatch also acknowledges the Traditional Custodians of the region, the Ngunnawal and Ngarigo peoples. We recognise and respect the enduring relationship they have with their lands and water, and pay our respects to Elders, past and present and emerging.

The 2021 CHIP report would not be possible without the generous financial support from ACT Government and Icon Water.



## 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 11,400km<sup>2</sup>.

Four Waterwatch coordinators support volunteers in the major sub-catchments of Cooma, Molonglo, Southern ACT, Ginninderra and Yass (see Figure 1). Each of these sub-catchments make up sections I – V of this report.

As at 31 December 2021, Waterwatch had 229 active sites being monitored by over 200 volunteers. Waterwatch thanks the generous funding from the ACT Government as well as funding for the Cooma Region through Icon Water. Local Land Services also supports the program in the Cooma Region. The Atlas of Living Australia provides support through the maintenance of the database used by the Waterwatch program. At the time of writing this report, the database houses over 27,800 Waterwatch records.

### The purpose of the CHIP

The Waterwatch annual report card is called the Catchment Health Indicator Program (CHIP) and is 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 waterway 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 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' and it contributes to multiple monitoring programs and reports within the ACT Government and Icon Water.

### How does the CHIP work?

Waterwatch volunteers and coordinators collect data relating to water quality, waterbugs (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 waterbug 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 coordinator. 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, as well as from our colleagues at Frogwatch, 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	рН	Monthly	All sites
	<b>Electrical Conductivity</b>	Monthly	All sites
	Turbidity	Monthly	All sites
	Phosphorus	Monthly	All sites
	Nitrate	Monthly	All sites
	Dissolved Oxygen	Monthly	All sites
	Water Temperature	Monthly	All sites
Macroinvertebrates	SIGNAL 2.0	Biannual (spring & autumn)	Key sites (min 1/reach)
<b>Riparian Condition</b>	RARC	Biennial	All sites

Figure 1. Overview of the upper Murrumbidgee River catchment, outlining the five major sub-catchment areas represented in this report as well as the border of the ACT. The Goodradigbee catchment is not included in this report.



### **2021 CHIP**

The 2021 CHIP report is based upon 1,779 water quality surveys, 181 waterbug surveys and 219 riparian condition surveys conducted by over 200 volunteers. The total number of sites surveyed was 229 with a total of 96 reach report cards produced. Waterwatch now includes the important addition of the number of 'dry' surveys conducted in the overall survey tally (ie. when a volunteer has visited their site but it is completely dry). While these do not contribute to the CHIP score, they are an important factor in the condition of the catchment and highlight survey effort. A total of 17 water quality surveys were dry in 2021 which is in stark contrast to the height of the drought in 2019 when 193 dry surveys were recorded.

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The 2020 CHIP report captured the dramatic impact of the bushfires at the beginning of that year, when ash and sediment was washed into our waterways a following heavy rainfall. By late 2020, the water quality data started to look more positive as phosphorus concentrations declined and the rivers became clearer with the constant flows. The rains persisted throughout 2021 with 912mm falling in total, making it the fifth wettest year on record (Canberra average 614mm). The results have been overwhelmingly positive for the upper Murrumbidgee catchment with 43 of the 96 reaches showing improvement, 35 remaining steady and only 18 showing a decline.











# **Cooma Region Catchment Facts**

The Cooma Region catchment includes the upper Murrumbidgee River south of the ACT, plus the Bredbo, Numeralla, Kybeyan and Badja river sub-catchments. These sub-catchments provide the majority of inflows for the upper Murrumbidgee River upstream of the ACT as 95% of its headwaters are diverted at Tantangara Dam as part of the Snowy Hydro Scheme.

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. The headwaters of catchments are generally less modified and are in better condition. Protection of in-stream and riparian (riverbank) habitat needs to be prioritised in these areas.

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 river catchments as areas where erosion risk is very high. Addressing erosion goes hand in hand with maintaining and restoring native vegetation and high levels of groundcover while reducing the impact of invasive weeds. These issues are the focus of Landcare groups and regional catchment organisations in the Cooma Region.

The upper Murrumbidgee River has areas of high-quality aquatic habitat where species such as Murray cod, Trout cod, Macquarie perch, Murray river crayfish, Platypus, Rakali (Water rats) and Eastern long-necked turtles are found. Protecting and improving these habitats and species is the focus of the Upper Murrumbidgee Demonstration Reach (UMDR) initiative. The UMDR works with many partners, including Waterwatch, and focusses on the upper Murrumbidgee River between Tantangara and Burrinjuck Dams.

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







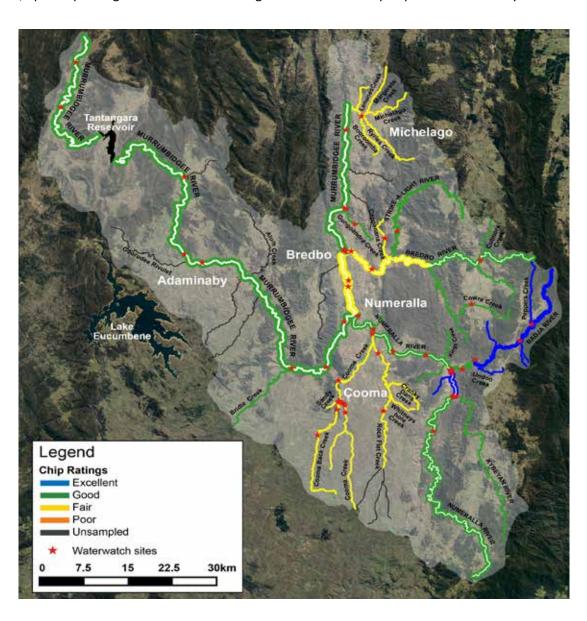
### **Cooma Catchment Health Summary**

2021 saw consistently better flows in the Cooma Region, especially towards the end of the year. Rainfall has replenished groundwater supplies and flows have in part been sustained from groundwater sources. Groundwater and clean surface water flows have had a positive effect on river ecological processes and consequently we saw an increase in catchment health for just over half of the reaches in the Cooma Region. Not only did water quality improve in many instances but also the waterbug survey results, highlighting a positive ecosystem response.

Saturated catchments made our river levels very responsive to rain, with levels increasing even after small rainfall events. Reaches where there is a lack of good in-stream and deep-rooted native riparian vegetation, saw an increase in erosion processes and for these reaches an overall decline in health was also recorded. One such reach is the lower Bredbo River where erosion and the ongoing effects from bushfires upstream (ash accumulation and sedimentation) continued. Reaches such as this one have also seen a decline in waterbug survey results as ash and sediment smother what limited available habitat exists.

Our fly-fishing volunteer Kerryn noted that increased flows and cooler conditions have corresponded with water temperatures being cooler for longer in the upper reaches of the Murrumbidgee River where she samples (and fishes). Such conditions are beneficial for maintaining higher dissolved oxygen levels. That said, this section of the Murrumbidgee declined in condition slightly and the lack of improvement in this reach could be linked to feral horses (streambank pugging/grazing of in-stream reeds).

There has been a range of actions to improve river health in the Cooma Region in 2021 carried out by Local Land Services, Rivers of Carbon, the UMDR, Landcare groups, the NSW Soil Conservation Service, Bush Heritage Australia, the Bredbo Fishing Club and landholders. Actions include woody weed control, erosion mitigation, carp removal, riparian plantings and better stock management which will help improve our waterways into the future.



# Badja River BAD1 Headwaters to Undoo Creek

2021 CHIP Result A (Excellent)		
2020 CHIP Result B+ (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	18
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	Excellent	2
Riparian condition	Good	2

### **Reach Facts**

Reach network length: approx. 51km

Dominant land uses: Rural and conservation

The Badja River rises in the Badja Swamps Nature Reserve which includes the nationally-listed Big Badja Swamp. From there the reach flows through open, historically cleared country and then on through steeper, uncleared country with good native vegetation cover. Up until December 2019, this reach was one of the healthiest streams in the Cooma Region, with consistently excellent water quality, abundant and diverse waterbugs and good riparian condition.

The 2019-2020 bushfires, however, greatly impacted this reach with fire burning out most of the catchment and the river has been going through the recovery process since then. Two years on, much of the riparian shrub and canopy layer vegetation has yet to recover. One of the things that has been very favourable is the great rain and replenished groundwater that the river has been receiving over the last two years. This has washed the large amounts of ash and sediment deposited in the channel downstream and supported groundcover vegetation growth across the catchment.

With thick groundcover returning in the catchment to help filter run-off and in-stream habitats now free of ash and sediment, this reach has seen great improvements in 2021. This extends to the spring and autumn waterbug results which were dominated by high numbers of the most sensitive waterbugs. This included two types of stoneflies, four types of mayflies, five types of caddisflies and megalopteras (toebiters). All very positive signs of recovery.





# Badja River BAD2 Undoo Creek to Numeralla River

2021 CHIP Result B+ (Good)			
2020 CHIP Result B (Good)			
Parameter	Rating	No. Survey	
Water quality	Excellent	26	
рН	Excellent		
Turbidity	Excellent		
Phosphorus	Excellent		
Nitrate	Excellent		
Electrical Conductivity	Excellent		
Dissolved Oxygen	Poor		
Waterbug	Good	2	
Riparian condition	Fair	3	

#### **Reach Facts**

Reach network length: approx. 8.6km

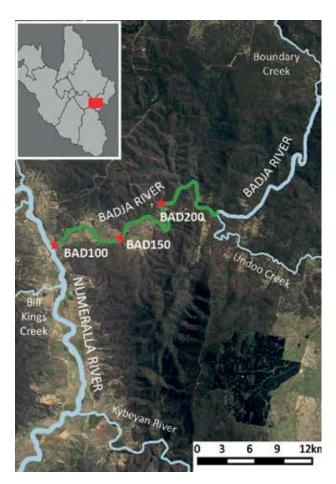
Dominant land uses: Rural and rural residential

The lower section of the Badja River runs through open, cleared country used predominantly for grazing and some dryland cropping. In contrast to the upstream section (BAD1), the cumulative impact of increased rural residential activities and historic landuse change are evident in this reach. This section of the Badja is known to become very turbid during high run-off events, Carp are present and there is an increase in woody weeds such as willows and blackberries. Recreational gold fossicking activities are also having an increasing impact on the riparian zone near BAD200.

Numeralla Landcare Group and local landholders have worked for many years to fence the river off from stock, control blackberries and willows, increase native plantings and control erosion on tributary gullies.

The 2019-2020 summer bushfires heavily impacted the catchment in the upper section of this reach, resulting in heavy ash and sediment flowing into the river. The consistently high flows (and frequent flooding) over the last two years have seen this ash and sediment get washed downstream, having a positive impact on riparian and in-stream habitat as well as water quality. Phosphorous levels have also improved, from highs of 0.25mg/L in 2020 to mostly excellent this year. Thick layers of ash can still be seen in the riparian zones and this together with the wet conditions throughout the year has supported dense growth along the river.

Our Waterwatch volunteer, Jim has observed that the river has not been so high for such an extended time in the thirty years that he has been living next to it.





# **Bredbo River BRD1**

### **Headwaters to Cowra Creek confluence**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	12
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug Excellent 2		
Riparian condition	Fair	2

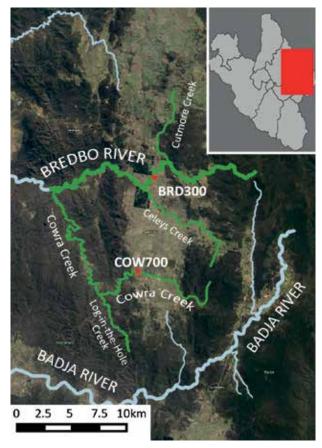
#### **Reach Facts**

Reach network length: approx. 33km Dominant land uses: Rural

This reach runs through a mix of unmodified and cleared grazing country. Generally good groundcover levels are retained throughout the catchment which in turn protects water quality, however some gully erosion is found in the middle of the Cowra Creek catchment. This is related to historical gold mining and landuse activities such as clearing and grazing. Our Waterwatch sites are upstream of this area.

In early 2020 a large part of the upper Bredbo and part of the Cowra Creek catchments were impacted by bushfires. The upper Bredbo River is still recovering two years later with ash and silt evident on banks and in-stream. The wet conditions throughout 2021 have seen consistent flows and abundant groundcover across the catchment, which likely contributed to the improvement in the overall reach score. Water quality readings have improved from last year's results but have yet to return to pre-bushfires standards where almost every parameter scored *excellent*.

In past years, sampling has shown healthy waterbug diversity and numbers in the Bredbo River including plenty of stoneflies nymphs - one of the most pollution-sensitive waterbug types. Waterbug surveys in 2021 pleasingly received an *excellent* score for first time since 2017 which is a sure sign it has bounced back from the bushfires. Once again, good numbers of the most sensitive waterbugs were detected although lots of black fly larvae (Family Simuliidae), a tolerant water bug type, were also present.





New Waterwatch volunteer, Phil Thurbon, sampling at BRD300 which was impacted by the fires.

# **Bredbo River BRD2**

### **Cowra Creek to Murrumbidgee River**

2021 CHIP Result C+ (Fair)			
2020 CHIP Result B- (Good)			
Parameter	Rating	No. Survey	
Water quality	Good	13	
рН	Excellent		
Turbidity	Excellent		
Phosphorus	Good		
Nitrate	Excellent		
Electrical Conductivity	Good		
Dissolved Oxygen	Degraded		
Waterbug Fair 2			
Riparian condition	Poor	3	

#### **Reach Facts**

Reach network length: approx. 25km

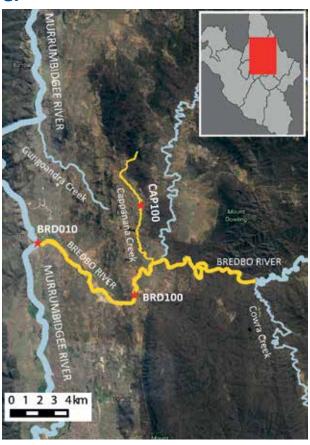
Dominant land uses: Rural including dryland cropping and grazing

The lower end of this reach has wide alluvial floodplains which are used for dryland cropping and grazing. In some areas, stock are allowed to graze the river corridor.

This reach is in a high priority ACWA catchment with five key erosion sites identified. Historic and current landuse activities have resulted in large amounts of sand and sediment washing down from the catchment and is now smothering available aquatic habitat. During high flow events, turbidity can become very high. Electrical conductivity (salt and mineral levels) is also often elevated but this is more attributed to natural groundwater sources.

Exotic species including African lovegrass, blackberry, willow and poplars dominate the riparian (riverside) vegetation. In the downstream section of this reach, native reed beds are stabilising sand bars. This is allowing the re-establishment of a defined river channel, increasing the diversity of in-stream habitat and in turn improving the diversity and abundance of waterbugs. The Bredbo Landcare Group is working along the river to control riparian weeds and improve native vegetation via the Two Rivers Wattle Park Drive project.

The high flows in 2021 saw streambank erosion reactivated along this reach, especially in areas where deep rooted native vegetation is limited. Large amounts of sand washed down from fire affected areas upstream have smothered in-stream habitat and this has contributed to the decline in reach condition in 2021, despite increased flows.





# Cooma Creek COO1 Headwaters to Banksia Lane

2021 CHIP Result C- (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Fair	14
рН	Good	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	Poor	2
Riparian condition	Poor	2

#### **Reach Facts**

Reach network length: approx. 22km Dominant land uses: Rural and urban

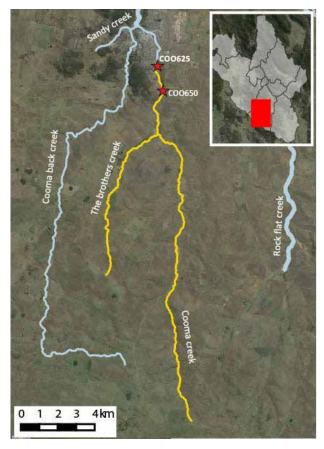
The headwaters of Cooma Creek rise south of Cooma and flow through open, basalt country. The fertile floodplains in this reach are used for dryland cropping and grazing agriculture. Native vegetation has been historically modified and in-stream vegetation such as reeds/sedges which are beneficial for stability and nutrient retention, are largely absent.

Much of the upper section of Cooma Creek is unfenced and stock access can reduce ground cover and increase erosion. Cropping activities can also mean that floodplain groundcover is laid bare and vulnerable to wash off during high intensity storm events.

Unlike in 2020, the creek had flows for most of the year. In contrast to many other reaches where increased flows improved the condition score, this reach has declined slightly. This may be due to the fact that during wetter periods, nutrients and organic matter can be mobilised. This is especially the case in agricultural catchments where there is an absence of in-stream vegetation and deep-rooted native vegetation in the riparian zones.

The geology of the catchment tends to influence electrical conductivity scores as concentrations can rise when surface water levels are lower and the groundwater contributes more to the flows.

At COO625 we saw large amounts of sediment and organic matter deposited towards the end of the year when higher flow events were experienced. The deposited sediment smothered in-stream waterbug habitat and this is reflected in the waterbug survey results, which declined compared to 2020.





The Cooma Creek at COO625 has little in-stream habitat which negatively affected the waterbug score.

## Cooma Creek COO2

### **Banksia Lane to Cooma Back Creek confluence**

2021 CHIP Result C (Fair)			
2020 CHIP Result C (Fair)			
Parameter	Rating	No. Survey	
Water quality	Fair	18 (1 dry)	
рН	Excellent		
Turbidity	Excellent		
Phosphorus	Degraded		
Nitrate	Good		
Electrical Conductivity	Degraded		
Dissolved Oxygen	Degraded		
Waterbug	Good	2	
Riparian condition	Poor	2	

### **Reach Facts**

Reach network length: approx. 3km Dominant land uses: Urban

This section of Cooma Creek flows through the township of Cooma. Flood mitigation levees have been constructed and there is a popular walking path along the length of this reach. Stormwater from the town is discharged directly into the creek and litter from stormwater drains is an ongoing problem.

The Cooma Creek environment is greatly modified and little native vegetation remains along its corridor. The small amount of in-stream habitat present, such as reeds and long grass, is highly important to support the creek's biodiversity including ducks, swamp hens, frogs, Galaxias (a small native fish), Rakali (native Water rat) and Platypus.

The Cooma Creek experienced medium to high flows towards the end of 2021 after very low flows in the previous years. The higher flows have, however, mobilised nutrients and dissolved salts, the latter being influenced by the basalt geology of the catchment. The better flows contributed to the improvement of the waterbug score this year (from fair in 2020).

Improving the habitat and health of Cooma's creeks is a focus of the Cooma Landcare Group in partnership with Snowy Monaro Regional Council and Cooma Waterwatch. This includes regular litter clean-ups along this reach. It's pleasing to report that the number of plastic bags, bottles and drink cans found are much reduced now that the single use plastic bag ban and the NSW container deposit scheme have been put in place.





The Cooma Creek flows through the heart of Cooma and levee banks assist with flood management.

## Cooma Creek COO3

### Cooma Back Creek confluence to Numeralla River

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Fair	28 (3 dry)
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
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. This reach is flanked by the North Ridge Nature Reserve at its upper end (which has better riparian vegetation), then flows through more open, rural residential holdings in the Mittagang Road area and finally through Bunyan/Chakola where river flats are used for irrigated cropping.

This lower section of this reach has been highly modified and riparian vegetation is very reduced, with a general lack of deep rooted native vegetation present. The riparian vegetation at all Waterwatch sites on this reach are dominated by exotic vegetation, lowering the riparian condition score for this reach.

The creek flowed throughout 2021, however levels were mostly low, with a better flows towards the end of the year. The fact that COO010 has been dry for so long previous to this year has meant there is little in-stream habitat present. The site is also dominated by a sand filled channel and this has a negative effect on the waterbug score for this reach due to the lack of in-stream habitat available.

Cooma's Sewage Treatment Plant is located on this reach and nitrate levels as high as 20mg/L have been recorded downstream at COO300. Our Platypus surveys on the Cooma Creek downstream of Cooma were cut short due to COVID in August 2021, and no individuals were recorded during the two surveys we were able to complete.





## Cooma Back Creek COB1

### **Headwaters to Cooma Creek**

2021 CHIP Result C+ (Fair)			
2020 CHIP Result C+ (Fair)			
Parameter	Rating	No. Survey	
Water quality	Good	21	
рН	Excellent		
Turbidity	Excellent		
Phosphorus	Poor		
Nitrate	Excellent		
Electrical Conductivity	Degraded		
Dissolved Oxygen	Degraded		
Waterbug Fair 2			
Riparian condition	Poor	3	

#### **Reach Facts**

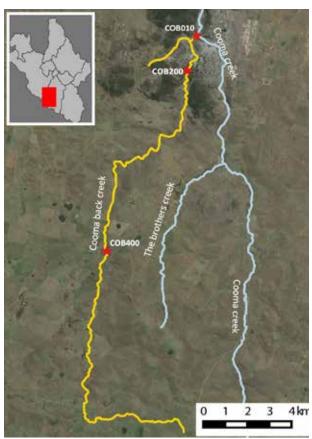
Reach network length: approx. 30km Dominant land uses: Conservation, urban, rural residential and rural

This reach includes the entire Cooma Back Creek and tributaries. The upper section of the reach flows through open, cleared country used for grazing and dryland cropping. The lower section of the reach includes Coolamatong (Lambie Gorge), a registered Aboriginal cultural site.

Frogwatch surveys conducted on the creek at the downstream end of Coolamatong show the highest frog diversity in the Cooma township area, with five species being recorded.

Riparian plantings are being carried out on the creek below the Coolamatong by Cooma Landcare to help enhance habitat for frogs and bank stability. Increasing willow and Box elder growth is an ongoing issue in the bottom half of the reach. The Landcare groups' ongoing focus on reducing exotic plants and replanting native vegetation in this reach will improve the riparian condition score.

Water quality in this reach is mainly influenced by catchment geology and urban in-flows. In contrast to 2020, when the creek was dry/reduced to pools for more than half of the year, 2021 saw consistent flows return in the reach, with medium to high flows towards the end of the year. Higher and fresher inflows in the reach saw water quality readings improve slightly this year compared with 2020-going from fair to good. Better flows, however, did not result in an improvement of the waterbug score, which found the creek to be dominated by mostly tolerant bug types that benefit from rich organic matter, higher nutrients and lower dissolved oxygen conditions.





# **Gungoandra Creek GUD1**

### **Headwaters to Murrumbidgee River**

2021 CHIP Result B (Good)			
2020 CHIP Result C+ (F	air)		
Parameter	Rating	No. Survey	
Water quality	Good	20 (2 dry)	
рН	Excellent		
Turbidity	Excellent		
Phosphorus	Excellent		
Nitrate	Excellent		
Electrical Conductivity	Degraded		
Dissolved Oxygen	Fair		
Waterbug	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. The upper section of the creek has been cleared and is used for grazing. The lower section, where the two Waterwatch sites are placed, is managed for conservation by Bush Heritage Australia (BHA) as part of their Scottsdale Reserve. This includes work to improve the health of the creek by planting native vegetation in the riparian corridor and throughout the catchment, in-stream erosion works as well as feral animal control.

Removal of stock grazing has seen stands of native reeds establishing along the length of creek at Scottsdale which provide positive benefits such as filtering the water, settling sediment, in-stream habitat and stabilising the stream channel. Galaxias (a small native fish), Rakali (native Water rats), Platypus and Lathams Snipe have all been sighted along the creek. Restoration works have been supported by funding from Local Land Services and the Upper Murrumbidgee Demonstration Reach partnership via the Rivers of Carbon program.

The entire catchment was impacted by bushfires in February 2020 with riparian vegetation and in-stream reed beds being entirely burnt along the creek. Recovery has been assisted by good flows throughout 2021 and saw condition improve from *fair* to *good*. Water quality improved overall except for electrical conductivity which is naturally high due to geological sources (as high as  $810\mu$ S/cm in May). Improved water quality and the full recovery of in-stream vegetation are reflected in the waterbug survey score. Weeds, however, such as mint, have become more prolific following the disturbance caused by the bushfires.





Looking upstream from GUD100 showing the recovery of in-stream vegetation since the 2020 bushfires.

# **Kybeyan River KYB1**Headwaters to Numeralla River

2021 CHIP Result B (Good)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Excellent	10
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	Excellent	2
Riparian condition	Poor	1

#### **Reach Facts**

Reach network length: approx. 49km Dominant land uses: Rural and conservation

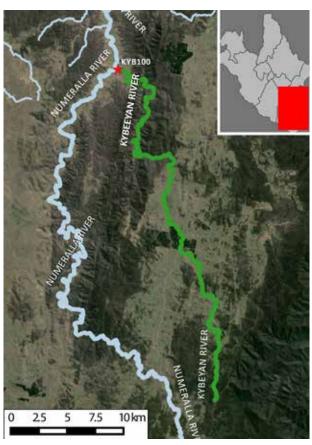
This reach includes the entire Kybeyan River catchment. The river has cleared grazing country around its headwaters, from where it flows through steep, unmodified country and then on to join the Numeralla River. There is an ACWA site on a tributary gully at the bottom end of this reach.

In the last two years the river has experienced steady medium-high flows which had very low turbidity and even during a flood event turbidity was not especially high (15 NTU) this year. This indicates that the rain may have also improved overall groundcover in the surrounding landscape. Flows have been the major factor which improved overall water quality from good in 2020 to excellent this year. The waterbug score also reflects the better conditions, with a range of pollution-sensitive bug types being recorded, even though the habitat at the site lacks the extra diversity seen at other sites, such as riffles and large woody debris.

A poplar tree on the edge of the streambank fell across the river at the Waterwatch site towards the end of the year, highlighting the added pressure higher flows are putting on streambanks.

The adjoining landholder notes that 20 years ago Trout were plentiful and Platypus sightings common. In contrast, Carp are now more often sighted, Eastern gambusia (a small pest fish) are present in large numbers and Platypus are sighted only very occasionally.

This reach has only one site and another volunteer to monitor an additional site further upstream would greatly enhance our knowledge of this catchment.





# Michelago Creek MIC1 Headwaters to Murrumbidgee River

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+(Fair)		
Parameter	Rating	No. Survey
Water quality	Good	10
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Poor	1

#### **Reach Facts**

Reach network length: approx. 55km

Dominant land uses: Rural, rural residential and conservation

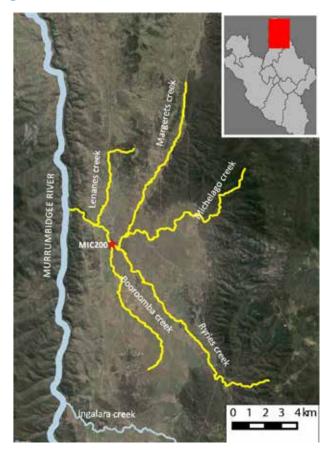
This reach includes the entire Michelago Creek catchment including the Margerets and Ryries Creeks. The upper sections of these creeks retain native, unmodified vegetation where they rise in the Tinderry Range. The lower sections flow through open, historically cleared country used for grazing and rural residential purposes (in and around the village of Michelago). Current and historical landuse has resulted in poor riparian condition with very limited native vegetation remaining, having been replaced by exotic species such as poplars and willows.

Within the village of Michelago, large stands of reeds are established in-stream which is having a stabilising effect as well as providing habitat. The creek however lacks a greater diversity of waterbug habitat (snags, riffles, overhanging titree) and this reduces the diversity of waterbugs detected in the surveys.

Michelago Landcare have previously conducted work along the creek, replanting native riparian vegetation and installing rock gabions to stabilise streambanks.

The top of the catchment was burnt in the Black Summer bushfires and a thick layer of ashen silt can still be observed on the bottom of the creek-bed and on banks. Electrical conductivity is naturally high in this reach due to the geology of the catchment, however the high level of freshwater from rainfall has meant levels have improved from previous years.

This reach is monitored at only one site and another volunteer to monitor an additional site upstream would greatly enhance our knowledge in this catchment.





### **Headwaters to Tantangara Dam**

2021 CHIP Result B (Good)		
2020 CHIP Result B+ (Good)		
Parameter Rating No. Survey		
Water quality	Excellent	14
рН	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	Good	2
Riparian condition	Poor	2

#### **Reach Facts**

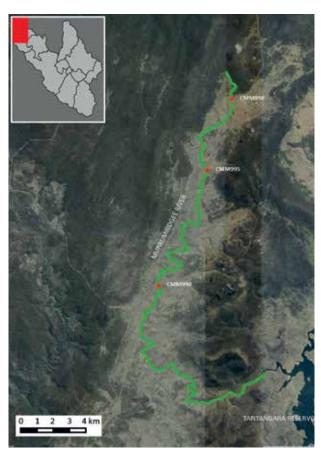
Reach network length: approx. 53km Dominant land uses: Conservation

This reach is the Murrumbidgee River from its headwaters to Tantangara Dam and is entirely within Kosciuszko National Park. The vegetation in the catchment includes heaths, grasslands, bogs and subalpine woodlands typical of the Australian Alps bioregion. The area is used for camping, fishing and touring. It is closed between the June and October long weekends and is not monitored during this time.

When we began monitoring in this reach, water quality and waterbug surveys showed consistently high scores. The river had crystal clear water, low nutrient concentrations, neutral pH and very low electrical conductivity. Waterbug surveys had very high species diversity including many of the most sensitive bug types.

Over the last years, however, we have been observing that the banks are increasingly pugged (destabilised by hard hooves of feral horses), the riversides heavily grazed and algal growth and sedimentation are increasing. While overall water quality scored excellent this year (as we would expect for this reach in a year of such good flows), some measurements are beginning to show a decline, such as increased nutrient readings. Waterbug surveys are detecting less pollution-sensitive species with some highly sensitive bugs, found in earlier sampling, now missing altogether.

Riparian vegetation only scores poor for this reach as the lack of canopy and shrub layers which is characteristic for natural tussock grasslands is not accounted for by the riparian survey method used by the CHIP.





headwaters of the Murrumbidgee River.

### **Tantangara Dam to Goorudee Rivulet confluence**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	20
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	Excellent	2
Riparian condition	Poor	2

#### **Reach Facts**

Reach network length: approx. 55km

Dominant land uses: Rural

This reach includes the Murrumbidgee River and its tributaries immediately downstream of Tantangara Dam. The catchment comprises of open valley floors with swampy meadows/tussock grasslands (now used for grazing and opportunistic dryland cropping) and a backdrop of steep unmodified country. Riparian vegetation scores are poor as the lack of the canopy layer in natural tussock grasslands is not accounted for by the riparian survey method used for the CHIP.

Tantangara Dam diverts 95% of river flows to Eucumbene Dam as part of the Snowy Mountains Hydro scheme and this affects flows in the reach. The river receives a small environmental flow allocation each year, dependent on inflows received the year before. The impact of flow regulation is very evident with in-stream habitat and aquatic species present exhibiting the characteristics of slower flowing ecosystems rather than a fast flowing upland stream. For example, water-lillies are growing at the edges and there is increasing fine sediment build-up instream when flows are low. Ash washed in from the black summer bushfires has exacerbated this issue.

Water quality scores reflect the high quality of water released from the dam, as well as inflows from catchments with good groundcover such as Yaouk Creek which benefitted from wetter conditions in 2021. Native Macquarie perch occur in this reach and are part of a nationally significant population which occurs in the upper Murrumbidgee River.

Carp and Redfin perch are not recorded in this reach and any sightings should be reported to NSW Fisheries.





This reach is seeing an increased build up in silt and algal fringes despite better flows in 2021.

### **Goorudee Rivulet to Bridle Creek confluence**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B+ (Good)		
Parameter Rating No. Survey		
Water quality	Excellent	12
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	Fair	2
Riparian condition	Good	2

### **Reach Facts**

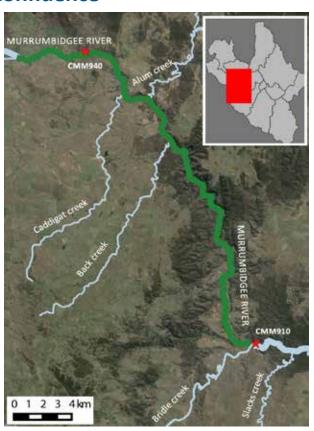
Reach network length: approx. 43km Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from Goorudee Rivulet down to the area known as 'Dry Plains'. The river in this reach firstly flows through more open, undulating country (used predominantly for grazing and dryland cropping purposes) and then through steeper gorge country dominated by woodland vegetation cover which remains largely unmodified. These factors contribute to the good riparian condition scores observed in this reach.

Of concern is the build up of fine and sandy sediments which are progressively accumulating on the bottom of the river, caused by tributory and catchment erosion more broadly. Such erosion has been exacerbated with medium to high flows seen throughout most of the year. High numbers of feral goats and increasing number of deer in the catchment are contributing to the problem.

Instream sediment has the ability to affect the habitat of the nationally significant Macquarie perch population present in the reach, which rely on clean, sediment free riffles to breed. Local Land Services' is making headway to protect in-stream habitat via working with landholders to revegetate riparian zones and manage stock access. They are also working with the NSW Soil Conservation Service to mitigate erosion.

The most upstream distribution of carp in the upper Murrumbidgee River occurs in this reach. Redfin are absent and sightings need to be reported to NSW Fisheries. A Platypus was spotted during water sampling in January, 'swimming along reeds on the opposite side'.





Looking downstream on the Murrumbidgee at CMM940 showing good in-stream and riparian habitat.

### **Bridle Creek to Numeralla River confluence**

2021 CHIP Result B (Good)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	23
рН	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	Good	2
Riparian condition	Poor	3

#### **Reach Facts**

Reach network length: approx. 31km

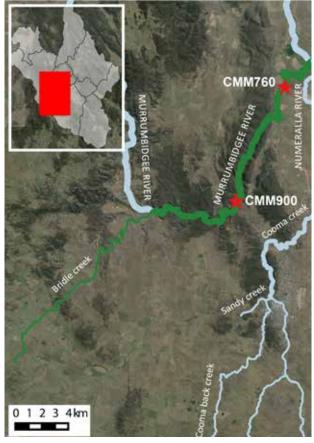
Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from Bridle Creek to the Numeralla River confluence. The upper section of this reach adjoins the Binjura Nature Reserve, including the Cooma Gorge which contains high quality riparian and aquatic habitat. This area is the known breeding habitat of a nationally significant Macquarie perch population (a threatened fish species). Downstream of the gorge the river adjoins wide alluvial floodplains which are used for grazing and cropping agriculture.

The 'Reaching for Recovery of the Macquarie perch' project is working to carry out willow control, revegetate riparian zones and manage stock access in this reach, which will help to increase riparian and in-stream habitat condition and connectivity, stabilise streambanks and improve water quality and waterbug scores.

In-stream sediment has notably increased after the 2020 fires upstream in the catchment, from which ash and sediment was washed from the fireground. This sediment continues to be remobilised and redeposited on the riverbed and along banks during each flood event, affecting water quality including turbidity. An example of this was during a high-flow event in June, where a turbidity of 60NTU was recorded during sampling.

There is a Platypus Month survey site at the top of this reach, where Platypus and Rakali (Water rats) have both been observed. Redfin (a feral fish species which are known to carry a virus deadly to Macquarie perch and trout) are absent and sightings need to be reported to NSW Fisheries.





### Numeralla River to Bredbo River confluence

2021 CHIP Result C+ (Fair)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	15
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	Poor	1
Riparian condition	Poor	2

### **Reach Facts**

Reach network length: approx. 12km Dominant land uses: Rural

This reach includes the Murrumbidgee River from the Numeralla River to the Bredbo River confluence. Wide alluvial floodplains flank the river in this reach and are used for dryland and irrigated cropping as well as grazing. Very limited native riparian vegetation remains due to historic clearing and this is reflected in the poor riparian condition score.

This reach is in a priority ACWA catchment and there are two ACWA erosion sites present. The Numeralla River is also a source of sand and sediment due to historic and bushfire erosion which is still moving downstream through this reach, two years on from the fires. These 'sand slugs' clog up the river channel, smother in-stream habitat and provide an ideal area for woody weeds such as Willows and Box elder to take hold and spread.

A thick layer of ashen silt (from run-off after the bushfires in the catchments upstream) was also observed on the banks and bed of the river throughout 2021 and continues to be mobilised and resettled with each flood event. This contributed to the slightly raised nutrient levels seen in the reach.

The high-water levels have reactivated streambank erosion in this reach especially in areas where native vegetation is limited. The consistently high-water levels made waterbug surveys difficult with only one survey being carried out. The limited edge vegetation (providing poor habitat) and a flood event before the surveys (which can wash away bugs) most likely contributed to the *poor* waterbug score.





areas where deep-rooted vegetation is lacking.

### **Bredbo River to Michelago Creek confluence**

2021 CHIP Result B (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	19
рН	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	Fair	2
Riparian condition	Good	2

#### **Reach Facts**

Reach network length: approx. 35km

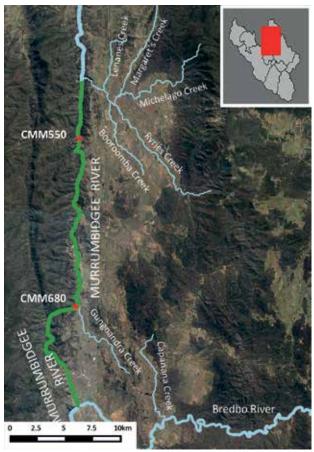
Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from the Bredbo River to the Michelago Creek confluence. It flows through the Bredbo and Colinton Gorges which form the upper and lower sections of the reach. These gorge areas contain good quality riparian and aquatic habitat. The middle section flows through the Bumbalong Valley which has more open, cleared country.

This reach demonstrates the importance of high quality riverine habitats on overall river health. For example, intact riparian and in-stream habitats in the gorge sections capture sediments entering the water and absorb nutrients out of the system, resulting in more stable oxygen levels and clearer water. Macquarie perch, Murray cod, Trout cod and Murray River crayfish, all of which are protected species, are present and further highlight the importance of this reach.

Bush Heritage Australia (BHA)'s Scottsdale Reserve flanks the lower Bredbo Gorge. BHA carries out Platypus Month surveys and are working to improve the river corridor through riparian restoration, erosion control and installing fish habitat. This is part of the Upper Murrumbidgee Demonstration Reach partnership, which is working with landholders to reconnect the Bredbo and Colinton gorges.

This reach was heavily impacted by bushfire in February, 2020. Subsequent rains resulted in the mass movement of ash and sediment into the river corridor, smothering in-stream habitat. Heavy deposits of ash and sediment remain on the banks and in-stream, and there is more sediment in tributary gullies which has been slowly eroding and contributing sediment downstream.





CMM575 by new Waterwatchers Alison and Brendan.

### **Headwaters to Kybeyan River confluence**

2021 CHIP Result B (Good)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	16
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Waterbug	Good	2
Riparian condition	Poor	2

#### **Reach Facts**

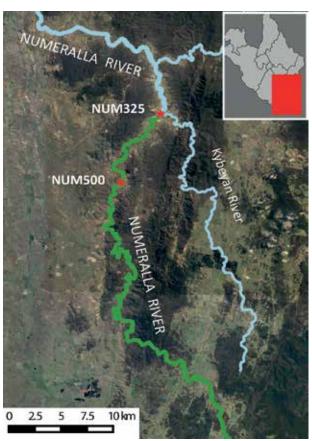
Reach network length: approx. 38km Dominant land uses: Rural and conservation

This reach includes the Numeralla River upstream of the Kybeyan River confluence. Land use includes dryland cropping and grazing, especially in the mid to lower sections. In these areas native vegetation has been cleared and historic erosion has contributed large amounts of sand and fine sediment to the river. Sections of the upper reaches retain native vegetation including in the Dangelong Nature Reserve.

Cultivation and grazing affects water quality through elevated electrical conductivity levels. Loss of native vegetation on banks reduces riparian condition scores as well as streambank stability. This reach is a high priority ACWA catchment where erosion risk was assessed as very high.

The Numeralla Landcare Group, Numeralla Fishing Club, landholders and catchment organisations have worked since the 1990s to stabilise streambank erosion, fence the river from stock, replant native vegetation and reintroduce woody habitat in the lower end of this reach. This has stabilised the river channel and improved riparian and in-stream habitat there.

This has been very beneficial during the medium to high flows and repeated flooding seen during 2021 which has put increased pressure on streambanks. Thanks to the many works along the river, treated erosion control sites have remained stable. Early in the year the cobble floodplain at NUM500 was completely covered in a thick white coating- which is a result of thick diatoms crusts (which can colonise still waters) drying up when the water receeded.





### Kybeyan River to Badja River confluence

2021 CHIP Result A- (Excellent)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Excellent	10
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	Excellent	2
Riparian condition	Fair	2

#### **Reach Facts**

Reach network length: approx. 40km

Dominant land uses: Rural and conservation

This reach includes the Numeralla River from the Kybeyan River to the Badja River confluence. It is flanked by wide alluvial floodplains used for dryland cropping and grazing. The Numeralla village is at the bottom end of the reach. Past landuse, which has resulted in loss of native vegetation and erosion, has contributed large amounts of sand to the river channel that continues to move downstream. This reach is a high priority ACWA catchment where erosion risk was assessed as very high.

Numeralla Landcare, the Numeralla Fishing Club, landholders and catchment organisations have been working since the 1990s to fence the river from stock, stabilise streambanks, replant native vegetation and reintroduce woody in-stream habitat (re-snagging). This has supported establishment of riparian and in-stream vegetation which acts to stabilise banks and filter catchment and agricultural run-off which has a positive effect on water quality. These factors all contribute to this reach usually having a better CHIP score than in the reach upstream (NUM1).

In 2021 reach condition has also improved compared to the previous year, supported by consistently high flows throughout the year. These flows are sustained from replenished groundwater sources which yield clear, high quality water. This, in turn, improves water quality and supports a variety of waterbug life, including more pollution-sensitive species. It is important to be mindful, however, that inadvertent nutrient or pesticide build up in soils can also be mobilised during such times. This highlights the importance of vegetated riparian zones and good instream habitat to provide beneficial filtration.





## **Badja River to Cooma Creek confluence**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	26
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	Good	2
Riparian condition	Fair	3

### **Reach Facts**

Reach network length: approx. 14km

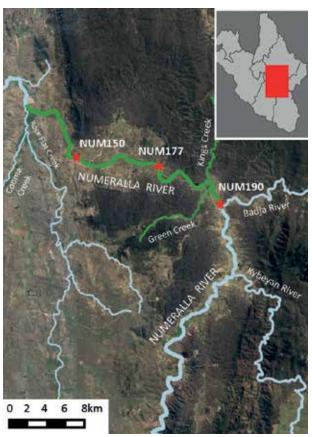
Dominant land uses: Rural and rural residential

This reach includes the Numeralla River from the Badja River to the Cooma Creek confluence. The top half of this reach is flanked with good native vegetation including tall stands of Ribbon gums, fringing ti-trees and bottlebrushes, beds of in-stream reeds and swathes of water milfoil submerged in the river.

The downstream section of the reach has wide floodplains used for dryland cropping and grazing. Here native vegetation has been cleared and historic erosion has contributed large amounts of sand and fine sediment into the river. This reach is in a high priority ACWA catchment where erosion risk was assessed to be very high.

Platypus were once common but are now only occasionally sighted. Carp are common and upstream of NUM150 there is a known carp spawning hot spot. Eastern gambusia are also found in high numbers.

Water quality and river levels are influenced by the inflows of the Badja River at the top of this reach which are typically of high quality. In 2019-2020 nearly the entire Badja River catchment was burnt and hence, this section of the Numeralla River was inundated with heavy ash and sand deposits from the fire grounds once flows were restored throughout the catchment. Consistent flows throughout 2021 and good in-stream and riparian vegetation which is defining a deep channel in this reach, are assisting to wash ash and sediment downstream as well as stabilising the channel.





## Cooma Creek confluence to Murrumbidgee River

2021 CHIP Result B (Good)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Excellent	18
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	Good	2
Riparian condition	Fair	2

#### **Reach Facts**

Reach network length: approx. 17km

Dominant land uses: Rural

This reach includes the Numeralla River from the Cooma Creek to its confluence with the Murrumbidgee River. It runs through wide floodplains which are used for grazing and dryland and irrigated cropping. There is very little native vegetation remaining along this section of the Numeralla River and exotic species such as willows, Box elder (an emerging, but rapidly spreading weed species) and poplars dominate the canopy vegetation. Stock are allowed to access the river in some areas.

This reach lies in a priority ACWA catchment where erosion risk was assessed to be very high. Increased turbidity has been observed after high run-off events. In-stream sand deposits are widespread in the river, however lower water levels over the last years have seen reeds and native ti-tree colonising in-stream sand bars which is having a stabilising effect.

Deposits of ash and sediment washed down from the fire affected Badja River catchment upstream can still be seen within the reach, with a thick layer of grey silt being noted on the base of the streambed. This will continue to affect the health of this reach as more is washed down from the catchment over time.

In 2021 reach condition improved from *fair* in 2020 to *good*, supported by consistently high flows throughout the year which improved water quality - particularly notably for dissolved oxygen. These flows are sustained from replenished groundwater sources which yield clear, high quality water. At the downstream end of the reach a large infestation of Box elder is taking hold.





# **Rock Flat Creek ROC1**

### **Headwaters to Cooma Creek**

2021 CHIP Result C (Fair)		
2020 CHIP Result C- (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	22 (4 dry)
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Fair	
Waterbug	Fair	1
Riparian condition	Degraded	2

### **Reach Facts**

Reach network length: approx. 42km Dominant land uses: Rural

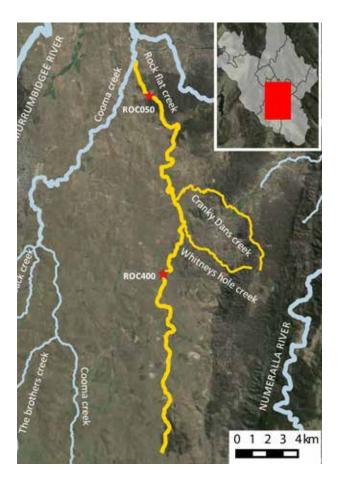
This reach flows through open basalt country, which is used for grazing and cropping agriculture. It includes a high priority ACWA site just downstream of the Cottage Hill Road crossing which is at risk of erosion.

Riparian vegetation along the creek is highly modified with the canopy and shrub layers largely absent, except for some scattered Willows. Similarly, there is a lack of in-stream vegetation along this reach, especially where the creek is accessed by stock. Stock impacts where observed include increased streambank pugging (trampling) and grazing of what in-stream vegetation is available.

Flows varied throughout the year in this reach. The first half of the year saw little or no flow recorded by Waterwatcher Michael, with an estimated 95% of the surface covered in the aquatic plant, Azolla, in May. By October the creek was flowing well. Sampling has shown that nutrient levels are very high during high flow events (up to 0.15mg/L by December) as the build up of organic matter in the catchment is washed into the waterways. The high flows in the reach have exacerbated streambank erosion, especially where deep rooted native vegetation is absent.

Electrical conductivity levels are influenced by the geology of the catchment. Salt and mineral concentrations can be high in the creek when flows are low and the groundwater contributes a greater proportion to flows. Higher flows have improved dissolved oxygen levels throughout the year.

This reach was at one time a renowned trout stream but now carp are more commonly seen.





Rock Flat Creek had high phosphorous levels during spring and summer flows (Photo: M. Mannile).

# Strike-A-Light River STR1

### **Headwaters to Bredbo River**

2021 CHIP Result B (Good)			
2020 CHIP Result C+ (Fair)			
Parameter	Rating	No. Survey	
Water quality	Excellent	11	
рН	Excellent		
Turbidity	Excellent		
Phosphorus	Good		
Nitrate	Excellent		
Electrical Conductivity	Good		
Dissolved Oxygen	Good		
Waterbug	Good	2	
Riparian condition	Poor	1	

#### **Reach Facts**

Reach network length: approx. 38km

Dominant land uses: Rural

This reach includes the entire Strike-A-Light River catchment. 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 cleared. The middle of the reach is largely native vegetation with intact riparian areas and good in-stream habitat.

The only Waterwatch site on this reach, STR200, runs clear and free of algae, even during periods of low flow. This reach is monitored at only this one site and another volunteer to monitor upstream would greatly enhance our knowledge of this catchment.

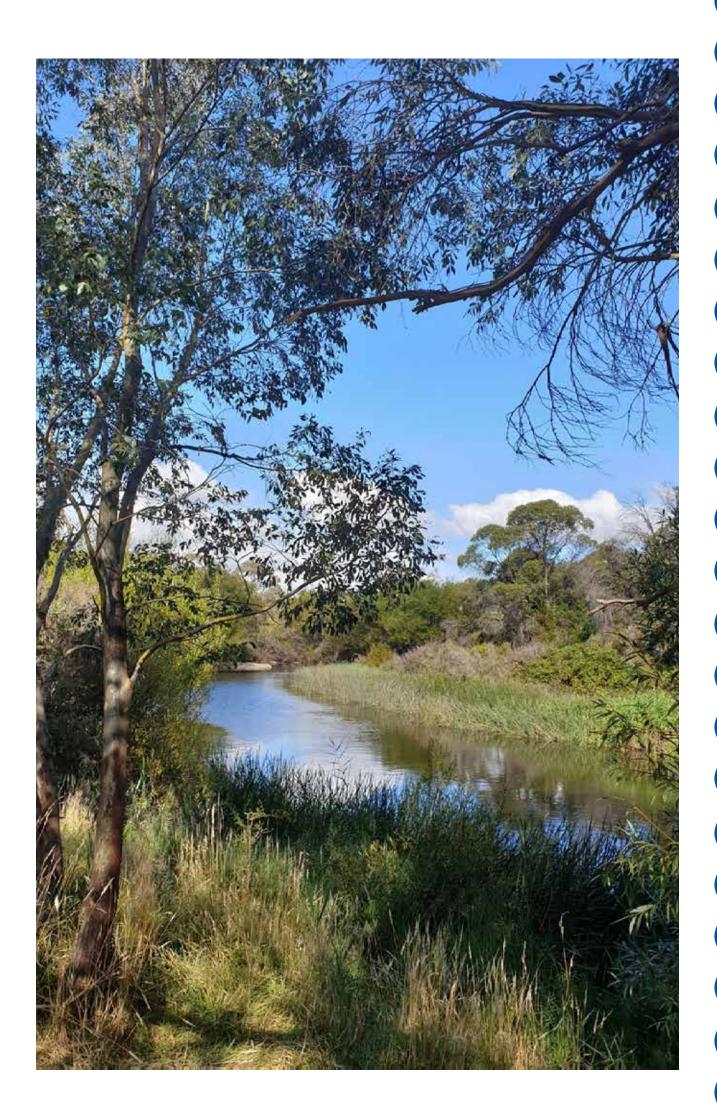
The top of the Strike-A-Light River catchment was impacted by the Calabash fire in February 2020 followed by heavy rains which flushed large amounts of ash off the fireground. Despite flushing flows over the last year, ashen deposits remain in-stream, affecting phosphorous levels, which had always been *excellent* before the fires.

Electrical conductivity is often high at this site, which in part can be attributed to the geology in the catchment. High flows in the reach throughout 2021 has seen a significant overall improvement in the reach condition including reduced electrical conductivity – down from a high of  $700\mu\text{S/cm}$  in 2020 to a relatively low  $320\mu\text{S/cm}$  in February 2021. Dissolved oxygen also improved and stabilised throughout the year as a result of the regular flushing flows. During flood events however, turbidity can be raised, indicating that streambank and gully erosion occurs in the catchment.





Cooma Waterwatch Officer, Antia, conducting the spring bug survey on the Strike-A-Light River (STR200).



## **Ginninderra Catchment Facts**

Ginninderra Creek begins in the north-western edge of Canberra, in the upper reaches of the Mulligans Flat Nature Reserve, and flows west though the suburbs within Gungahlin and Belconnen. Over 42% of ACT residents live in the Ginninderra Creek catchment making it the most urbanised in the ACT.

Ginninderra Creek enters the Murrumbidgee River 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 runoff from much of the NSW land around Wallaroo, including Halls Creek.

Steady development in Canberra's north has impacted the Ginninderra Creek 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. This includes Evatt, Umbagong District Park, Macgregor and Dunlop.

Ginninderra Waterwatch Volunteers have been monitoring this catchment since 1997.







### **Ginninderra Catchment Health Summary**

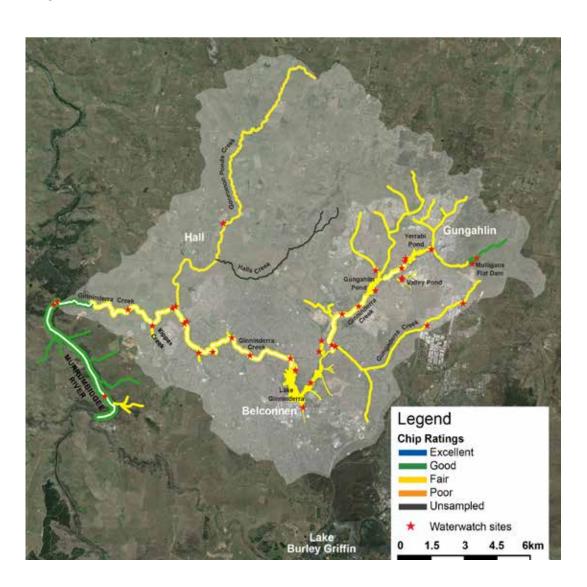
Like elsewhere in the upper Murrumbidgee, the Ginninderra Creek catchment had above average rainfall this year. This created high flows throughout most of the year which, in general, had a positive effect on catchment health.

Three reaches scored slightly worse than last year, all driven by poorer waterbug results. One of these sites, on lower Ginninderra Creek, can most likely be attributed to higher flows flushing bugs downstream. The other two sites, however, were in Gungahlin Pond and Lake Ginninderra which both experienced supersaturated dissolved oxygen levels in 2021. High nutrient inputs and algal growth were both recorded at these sites, which may have excluded some of the more pollution-sensitive waterbugs from the samples.

Of the remaining reaches, seven received the same results as last year and five reaches improved. Overall, three reaches had a *good* score and twelve had *fair* scores.

Of the three reaches with *good* scores, one was on the Murrumbidgee River and two in and above Ginninderra Creek. Interestingly, we observed the *good* scores in Ginninderra Creek at the top of the catchment, in Mulligans Flat Nature Reserve, and at the bottom, along the Ginninderra Falls area. This shows the influence of land use and the importance of maintaining and protecting native vegetation, including grasslands and woodlands, as they help to buffer the effects of urban stormwater flowing into the creek.

The higher flows also helped to clean away some of the ash and sediment that had accumulated along the banks of the Murrumbidgee River after the 2020 bushfires. There was also an improvement in nitrates readings in the Murrumbidgee River reach (CMM11) downstream from the Lower Molonglo Water Quality Control Centre, mostly likely diluted by the higher flows. Pollution-sensitive stonefly nymphs were also detected in this reach, within the Ginninderry Conservation Corridor. This was the first time that stoneflies had been recorded in this area, reinforcing the positive ecosystem response that consistent flows throughout the year can bring to a river.



### **Crace to Giralang Pond**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	20
рН	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	Fair	2
Riparian condition	Poor	3

#### **Reach Facts**

Reach network length: approx. 5km Dominant land uses: Urban

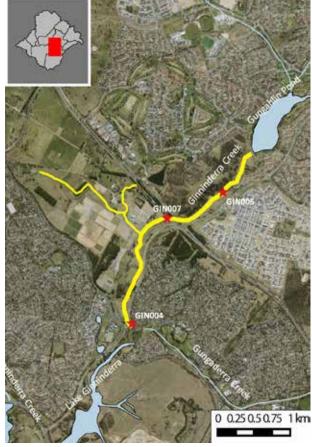
Starting at the outflow of Gungahlin Pond this reach includes the stormwater inflow from Nicholls and Crace. The middle of the reach receives runoff from the CSIRO field test facility while the downstream section flows through the Old Palmerville township historic site 12 and Landcare Forest. The end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

This section of the catchment is highly urbanised. Urbanised areas have a high proportion of impervious surfaces which increases runoff, warms the water and adds lots of urban pollutants to the waterways.

The areas adjacent to Ginninderra Creek in this reach have good ground cover and little signs of erosion, as well as plenty of in-stream reeds. The absence of large trees and shrubs, however, means the creek can be quite exposed, resulting in a *poor* score for riparian condition.

Due to the increased rainfall, Ginninderra Creek kept medium water levels through most of 2021 and this provided a boost in habitat quality for aquatic wildlife. In November, for example, a Pelican was observed in the creek close to Crace (GIN005). Pelicans are known to take advantage of new feeding habitat as it becomes available during wet periods.

Feral fish (Carp, Redfin perch and Eastern gambusia) are frequently sighted throughout this reach.





### **Lake Ginninderra**

2021 CHIP Result C (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	23
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	Poor	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 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.

The riparian zone in this area of Lake Ginninderra is mainly composed of grasses and shrubs, with many being introduced species. There is little available habitat for wildlife along the edges of the Lake. There is scope for improvement in areas that are not required for visitor access and do not need to be maintained in a "neat and tidy" manner.

An array of aquatic bird species are frequently noted by volunteers on Lake Ginninderra, with lots of baby swans spotted during May. Rubbish was also noted as it continues to be a problem throughout this reach.

This year Lake Ginninderra has received significant inputs of stormwater and water levels were higher than usual. At the lower site in this reach (GIN013), the grass was so tall that our volunteer had to move slightly down to access the lake. Additionally, high algae growth and potentially increased flow yielded elevated levels of dissolved oxygen close to the dam wall. The highest measured was in November with 172% saturation.





### **Dam wall to Ginninderra Drive**

2021 CHIP Result C (Fair)		
2020 CHIP Result C- (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	26
рН	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Poor	2
Riparian condition	Poor	3

#### **Reach Facts**

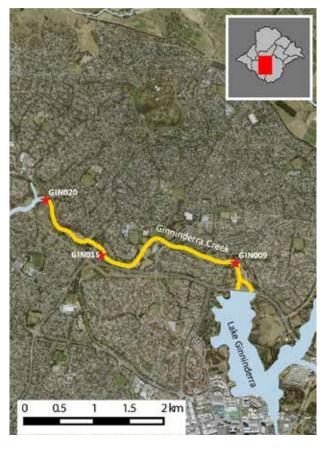
Reach network length: approx. 4km Dominant land uses: Urban

This reach begins below the Lake Ginninderra spillway and sits entirely within established suburbs with high urban stormwater inflow. The 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 observed when overflow from Lake Ginninderra occurs.

Even though there is a moderate presence of trees along the edge of Ginninderra Creek in this section, the majority are introduced species like Poplars and Willows. These trees drop large amounts of leaf litter into the waterways in autumn causing spikes in nutrients. Some areas of the creek (around GIN009) get choked up with these leaves.

The Ginninderra Catchment Group and ACT Government's tree unit have applied significant effort over several years to replace Poplars with native species in this reach. It will take a few years for the benefit of this management strategy to be reflected in the riparian condition scores. Two new wetlands that will help improve the water quality of the stormwater were recently built in this reach through the ACT Healthy Waterways program.

This year a wombat has been sighted just downstream of GIN020. Additionally, members of the public mentioned about seeing a Platypus in the creek downstream from the same site. An ad-hoc survey is scheduled to be conducted in 2022 with CIT students to investigate the potential presence of Rakali and Platypus.





### **Ginninderra Creek at Umbagong District Park**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	30
рН	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	Fair	4
Riparian condition	Poor	3

### **Reach Facts**

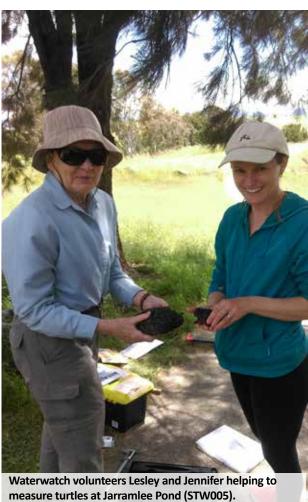
Reach network length: approx. 6km Dominant land uses: Urban

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

This year high flows have flushed more nutrients, such as phosphorus and nitrates, into Jarramlee Pond (STW005). One of the roles of stormwater ponds such as Jarramlee, is to trap sediment and absorb nutrients in order to clean up the stormwater before it enters Ginninderra Creek. Unfortunately, a potential spill was observed in the creek in May, with phosphorus levels detected at 0.45mg/L at Umbagong District Park (GIN024). The Waterwatch volunteer reported this to the Environmental Protection Authority.

The Waterwatch and Frogwatch team at Ginninderra Catchment Group have continued to work with volunteers on an Eastern long-necked turtle survey during 2021. This has taken place in West Belconnen as well as the Inner North urban wetlands. Results have shown that areas with more habitat connectivity within the urban landscape, such as the Jarramlee Pond, support a larger population of turtles and a much healthier size distribution within that population.





## **Gooromon Ponds Creek confluence to Ginninderra Falls Gorge**

2021 CHIP Result C (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	9
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	Poor	2
Riparian condition	Poor	2

#### **Reach Facts**

Reach network length: approx. 7km
Dominant land uses: Urban/Rural Fringe

This reach runs from the confluence with Gooromon Ponds Creek to the rural properties around Kilby Homestead. The upper section has significant bank erosion and the lower section runs through sheep and cattle farms.

This year there was a slightly improvement in the riparian vegetation scores, with the increase of native trees regeneration, fallen logs and increase in groundcover within the Kilby Homestead. It might take a few years, but that is a good start and it will eventually provide more habitat for small vertebrates such as frogs and lizards. On the other hand, feral deer are present in this area, and Yass Local Land Services is monitoring their impact, such as herbivory and habitat degradation.

Similar to last year, several flash floods have happened at this section of the creek. Erosion continues to be a problem in GIN030 due to the high flows coming from Ginninderra Creek and Gooromon Ponds. Heavy rainfall occurred in the lead up to spring waterbug surveys and debris was noted over the bridge at GIN040, highlighting how high the water levels were. We did, however, observe an improvement in waterbug scores in spring, with ten bug types recorded, compared to seven in autumn. While in-stream vegetation has not fully recovered from the flash floods, a general improvement in water quality in the catchment may have contributed the increased diversity and abundance in this year's bug surveys.





### Ginninderra Falls Gorge to Murrumbidgee River confluence

2021 CHIP Result B- (Good)		
2020 CHIP Result B (Good)		
Parameter Rating No. Survey		
Water quality	Excellent	4
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	Poor	2
Riparian condition	Fair	1

#### **Reach Facts**

Reach network length: approx. 3km Dominant land uses: Conservation

This reach comprises the high conservation value area of the Ginninderra Falls and Gorge. It is composed of large areas of native woodlands and shrubs. The rough terrain and inaccessible nature of the downstream section contributes to its complex structure. This section has the best riparian habitat in the catchment. Ginninderra Falls also represents an important Ngunnawal cultural and heritage site, known to host significant indigenous ceremonies and male initiations.

Although the riparian vegetation there is well represented by mature casuarinas and gum trees, not much regeneration is observed along the creek. Despite the good vegetation cover, the upstream stressors such as urbanisation and farming can still be seen downstream, with elevated electrical conductivity readings (range of 260-370  $\mu$ S/cm). The creek bed in this section is mainly rocky with very little aquatic vegetation.

Waterbug results were varied in 2021 with eight types detected in the autumn survey compared to only four in spring. That's possibly attributed to the large flood events in the catchment around spring time, which washed away most of the habitat available for waterbugs, such as casuarina foliage at the bottom of the creek. Another unusual observation was the greenish coloration of the water in April. Even though turbidity was normal, pH was slightly alkaline at 8.5, and that could have been the result of some disturbance upstream from the site.





## **Gooromon Ponds Creek GOO1**

### **Headwaters to confluence with Ginninderra Creek**

2021 CHIP Result C (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	14
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Poor	2

#### **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.

This reach represents a typically impacted farmland region with low riparian condition scores. Ground cover is relatively intact however exotic pasture grasses dominate, mid-storey and canopy species are scarce and mostly exotic and there is a complete lack of on ground habitat features such as fallen logs and tussock grasses. The lack of native canopy cover and consequently no leaf litter and native canopy regeneration all contribute to reduced soil stability and can result in erosion.

Historically, electrical conductivity has been elevated in this reach and is most likely influenced by both the geology of the region and historical land use. Readings as high as 1480 $\mu$ S/cm were recorded at GOO007 in January, however during floods such as in July, the increased flows dilute the salts and minerals resulting in values being as low as 270 $\mu$ S/cm.

Due to the duplication of Barton Highway upstream from this reach, the Waterwatch monitoring and the efforts of our volunteers have been more important than ever. The data being collected has been used to inform the Ginninderra Catchment Group and the government about the potential issues associated with soil disturbance and how this could affect water quality and aquatic fauna during construction.





The riparian zone on Gooroomon Creek (GOO007) has little or no mid-storey shrubs and trees.

# **Gungaderra Creek GDC1**

## **Gungahlin to Giralang Pond**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	Survey
Water quality	Good	19
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	Fair	2
Riparian condition	Poor	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. It also includes a stormwater channel from the University of Canberra and Canberra Stadium and has moderate urban stormwater inflow.

This reach displays a marked decrease in water quality parameters between the upstream (GDC010) and downstream site (STW001), showing the cumulative effects of water running through the urban landscape, travelling over lots of impermeable surfaces and through concrete drains.

In addition to these concrete stormwater drains, the lack of native canopy and understorey plus a dominance of exotic vegetation in this reach, account for its *poor* riparian vegetation assessment score. Volunteers have planted trees and shrubs to improve the width of riparian habitat along Giralang Pond in collaboration with the Ginninderra Catchment Group and ACT Government.

In 2021, water testing in September coincided with the cleaning of the gross pollutant trap (GPT) at STW001. Interestingly, a few parameters were outside normal values, such as high phosphorus levels (0.06mg/L), supersatured dissolved oxygen (114%) and pH with an alkaline value (8.75). Leaching nutrients from the organic material accumulated in the GPT could have been responsible for the phosphorus levels, which in turn could have facilitated algae growth leading to high dissolved oxygen levels and a change in pH.





## **Gungahlin Pond GUN2**

### Headwaters of Ginninderra Creek north arm to Gungahlin Pond

2021 CHIP Result C (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	30
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	Poor	2
Riparian condition	Poor	3

#### **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 drainage lines disconnected by stock dams before flowing into the sediment control pond of Gungahlin. This reach receives a high inflow of urban stormwater from surrounding suburbs and new developing suburbs.

Limited sections of the riparian zone score well for their habitat values, with some significant native canopy evident. Exotic species, however, with limited habitat values, dominate the edge of Gungahlin Pond. These highly urbanised areas are regularly mowed to the water's edge, making the regeneration of native plants difficult. On the other hand, in-stream vegetation in the form of reeds are present throughout the reach, and abundant in some areas, providing good habitat for frogs, turtles and waterbugs.

The resident Waterwatch volunteer noted some unusual results in the stormwater pond (STW006) during 2021. Dissolved oxygen values were supersatured (>115%) and in the *degraded* range at least five times during the year. There were spikes in nitrates and phosphorus, and electrical conductivity reached concentrations as high as 950 $\mu$ S/cm. It is possible that the increased amount of nutrients brought by the floods were in part responsible for the high growth of algae and aquatic plants. This, in turn, produced high amounts of oxygen as a byproduct of photosynthesis.





## **Kippax Creek KIP1**

### **Headwaters to Ginninderra Creek confluence**

2021 CHIP Result C (Fair)		
2020 CHIP Result D+ (Poor)		
Parameter	Rating	No. Survey
Water quality	Fair	10
рН	Excellent	
Turbidity	Good	
Phosphorus	Poor	
Nitrate	Fair	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	Fair	2
Riparian condition	Poor	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 Umbagong District Park.

Although the weed, African lovegrass, is still very common in the area, it is interesting to note the increasing presence of the native Kangaroo grass. Overall the reach lacks native ground cover, complexity in structure of layers and habitat features. There is some regeneration, however, with a few native trees and the presence of reeds along this reach.

Excess nutrients continue to be problem in this reach with very high levels recorded for phosphorus (1.8 mg/L) and nitrates (20 mg/L). To put this in context, an excellent range would be <0.02mg/L and <1 mg/L, respectively. With a largely impermeable catchment, nutrients are not filtered and absorbed into the landscape and instead are washed straight into the stormwater drains. Consequently these nutrients are then being leached from the gross pollutant trap upstream after heavy rains.

On a positive note, the waterbug scores improved in 2021 with nine and ten different Orders recorded in the respective autumn and spring surveys.





## **McKellar Wetlands MCW1**

## Designed habitat wetland system, McKellar

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	19
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Poor	2

#### **Reach Facts**

Reach network length: approx. 500m Dominant land uses: Urban

The two McKellar wetlands are designed primarily for frog habitat, and secondly for recreation. This is evident in the significant reed growth in both wetlands, and the connecting channel linking them, which is heavily vegetated to facilitate animals such as frogs and turtles to move through. It is situated in an established suburb, with nutrient inputs derived from sources such as gardening and cleaning as well as leaves from deciduous trees.

The *poor* riparian condition score is influenced by the low levels of canopy and understorey present. Ground cover, however, is considered relatively healthy with a high number of native tussock grasses. The area surrounding the wetlands in this reach are typical of many urbanised areas in Canberra, with manicured grasses and low numbers of trees. The riparian assessment does not account for all of the aforementioned good in-stream habitat.

In March this year, Waterwatchers Luke and Jim had never seen the water levels in the pond (MCW002) so high, it even covered the boardwalk where they usually access the pond for sampling. After 50ml of rain prior to their sampling day and higher than average rainfall in the preceding months, wetlands were overflowing and the connection channel between the two wetlands was in full swing.

Later in 2021, the volunteers noted an increase in algae growth and dissolved oxygen becoming super saturated (150%). Luke had never seen such elevated values during his time as a Waterwatcher or in his related career at the university.





## Mulligan's Flat Dam MFL1

## **Headwaters of Ginninderra Creek to Mulligan's Flat Dam**

2021 CHIP Result B- (Good)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	20
рН	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Fair	2

### **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. The Mulligan's Flat Woodland Sanctuary was established in 1995 to protect the Box-gum grassy woodlands and associated fauna in the Gungahlin area. The Dam is normally filled with rainwater that is grassfiltered, and is a popular spot for bird watchers. The site plays host to a number of conservation projects and the sanctuary is protected by a predator-proof

Mulligan's 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, such as frogs, lizards and the New Holland mouse. Most of the secondary grassland communities in Mulligans Flat were created by the early farmers who cleared woodland areas in the region.

2021 has been a good year for wildlife in Mulligan's Flat. The Waterwatch volunteer noted that the dam was full and overflowing throughout most of the year. Turtle patrollers have been busy helping longnecked turtles during their migration in spring and summer, assisting the animals on their journey when they get held up at the sanctuary fence.

Plenty of waterbugs have been recorded too, with nine and eight types in autumn and spring, respectively. Leptophlebiidae mayflies, a pollutionsensitive type of waterbug, were detected in the spring sample. They have long and prominent gills on their abdomens, to extract oxygen from the water.





spring 2021 at the very full Mulligan's Flat Dam.

# Murrumbidgee River CMM11 Molonglo River confluence to Ginninderra Creek confluence

2021 CHIP Result B- (Good)		
2020 CHIP Result C- (Fair)		
Parameter	Rating	No. Survey
Water quality	Excellent	8
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	Good	2
Riparian condition	Poor	2

#### **Reach Facts**

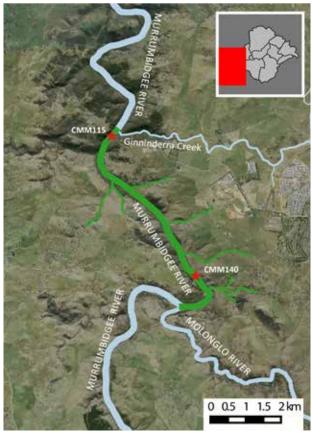
Reach network length: approx. 7.1km Dominant land uses: Conservation, rural

Starting below the confluence of the Molonglo River and finishing at the confluence with Ginninderra Creek, this reach includes mostly rural land and part of the Murrumbidgee River Reserve. Some sections of gorge country are also included and the upper section of the reach receives the outflow from the Lower Molonglo Water Quality Control Centre (LMWQCC).

A number of high nitrate readings have been recorded in this reach over the past couple of years, particularly during the low flows of 2018 and 2019. This can most likely be attributed to discharges from the LMWQCC as Waterwatch sites on the Murrumbidgee River above the Molonglo River confluence have indicated little to no nitrate present.

With the increased flows in 2021, there was an overall improvement in the water quality and waterbug scores in this reach. Nitrates presented lower values than usual (2-3mg/L), and sludge and ash from last year's fire were absent or detected in very low amounts along the river bank. Perhaps the most surprising finding was the presence of stonefly nymphs in the autumn waterbug sampling. Stoneflies are one of the bugs that are more sensitive to water pollution and this is the first time they have been recorded by Waterwatch in this section of the Murrumbidgee River.

A Wedge-tailed eagle was spotted within the river corridor (CMM140), which could reflect a good grassy groundcover in the surrounding habitat.





## **The Valley Ponds GUN1**

### **Wetland to Gungahlin Town Centre**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	8
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Poor	
Waterbug	Fair	2
Riparian condition	Poor	2

### **Reach Facts**

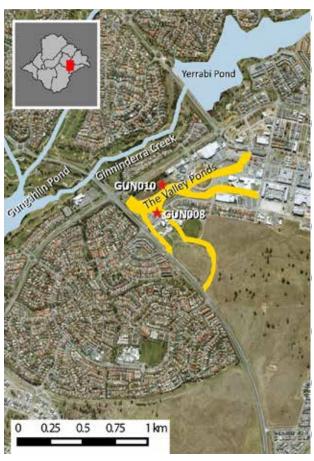
Reach network length: approx. 2km Dominant land uses: Urban

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 an urban wetland for the Gungahlin town centre and parts of Palmerston. It is now a high-quality education and recreation wetland.

There are low levels of native canopy cover and regeneration in this urban reach and reeds are a common feature in the ponds. The riparian assessment score should improve over time as the plantings in this wetland become more established.

Birralee Scout Group is heavily involved in the sampling in this reach, with Bunyip Cubs and Yowie Pack involved in the autumn and spring waterbug surveys. The local Waterwatch volunteers regularly observe Swamp hens, Black swans and cygnets in the wetland.

These two wetlands clearly demonstrate the importance of a chain of ponds approach in managing stormwater in urban landscapes. The upstream urban wetland (GUN010) first captures the stormwater and naturally treats it before it flows downstream to the lower section of the wetland system (GUN008). This process allows sediments to settle out of the water column as well as nutrients to be drawn out of the system by water plants. The effects can be demonstrated in the Waterwatch data. In October, for example, phosphorus (0.12mg/L) and nitrates (0.5mg/L) were recorded in the upstream wetland, following by a significant reduction in the lower one (0.02mg/L and 0.25mg/L, respectively). Electrical conductivity was also generally higher in the upper wetland compared to the lower one.





## Yerrabi Pond YER1

### **Headwaters of Ginninderra Creek to Yerrabi Dam Wall**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	17
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	Fair	2
Riparian condition	Poor	2

#### **Reach Facts**

Reach network length: approx. 10km Dominant land uses: Urban/Rural Fringe

The east arm of Ginninderra Creek originates in the rural landscape surrounding the northern suburbs of Gungahlin. It includes the former rural property, now significant woodland reserve, of Mulligans Flat Woodland Sanctuary. The upper section is mostly ephemeral creeks, interspersed by stock dams. The reach receives a moderate inflow of urban stormwater from surrounding suburbs.

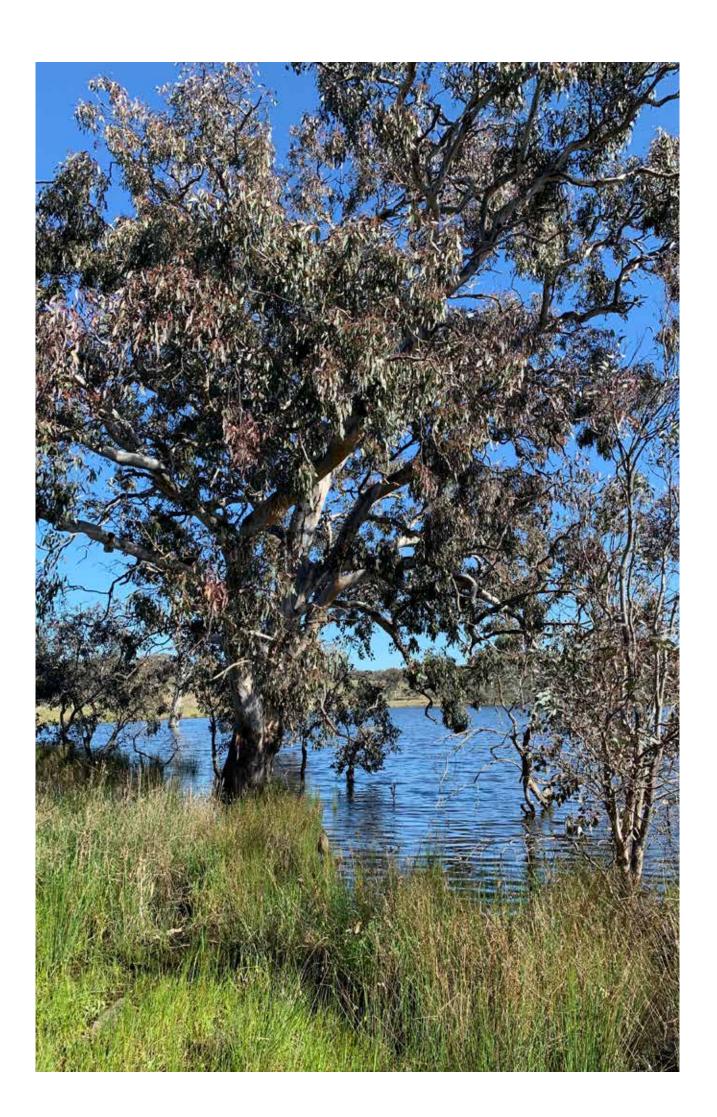
The riparian vegetation score is largely influenced by the outflow of Yerrabi Pond, which backs onto a concrete channel connected to a main road. The other areas that do contain riparian vegetation are mainly comprised of exotic species, especially in regards to the ground cover. A few scattered trees do occur, with Casuarinas being the most representative native tree.

Feral fish such as Eastern gambusia and Carp are regularly sighted throughout Yerrabi Pond although it is also stocked with Murray cod and Golden perch fingerlings by the ACT Government's Conservation and Research Unit.

Members of the public raised concern about a weed accumulating in certain parts of the pond in 2021. It turns out that it was actually Ribbon weed. Despite its name, this is a native in-stream plant which improves water quality and provides important habitat for aquatic life. It appears that Eurasian coots, as part of their natural behaviour, have been diving and ripping the straps of Ribbon weed out, eating part of it and discarding the rest. Combined with the strong winds often experienced in this part of the catchment, the remainder of the plant has ended up floating and accumulating in areas such as the pond inlet.







## **Molonglo Catchment Facts**

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

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. There is new residential development occurring at Googong, south-east of Queanbeyan, and around the lower Molonglo River in the Molonglo Valley. 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 drinking 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 information can be found at <a href="https://www.nca.gov.au/environment/lake-burley-griffin/water-quality">https://www.nca.gov.au/environment/lake-burley-griffin/water-quality</a>.

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

The Molonglo catchment formed a major part of the ACT Government's Healthy Waterways program with ten projects having been completed in recent years. Water quality improvements are anticipated from these raingardens, wetlands, ponds and waterway restoration projects.

Though water quality across the Molonglo catchment is generally good, when taking account of all our catchment health indicators (water quality, waterbugs and riparian condition). It is the highly urbanised reaches and rural creeks with largely cleared vegetation, that are in the poorest condition.



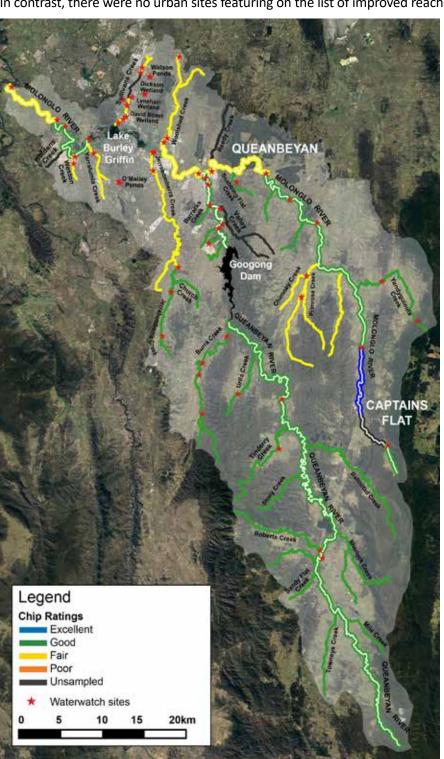
### **Molonglo Catchment Health Summary**

Flooding rivers, bubbling creeks and full wetlands were a common sight in the Molonglo catchment throughout 2021 with La Niña almost washing away any dusty memories of the drought and fires of previous years.

While two years of consistent rain has seen general improvements across the upper Murrumbidgee, the results were not as clear in the Molonglo catchment. With the exception of one reach moving up from a *fair* to a *good*, the overall scores for the Molonglo catchment remained the same as last year. If you look at incremental change within levels, you will see that seven reaches improved slightly, eleven remained the same and seven worsened.

Interestingly, the poorer reaches are largely made up of urban waterways, with water quality and waterbugs driving down the scores. Dissolved oxygen, which improved slightly across other reaches in the Molonglo, was the most common water quality parameter to decline across these urban waterways.

In contrast, there were no urban sites featuring on the list of improved reaches. All these were on the



Molonglo and Queanbeyan rivers plus one on Burra Creek. While water quality and waterbugs were the main drivers here, it was good to see a couple of the Molonglo River reaches see improvements in riparian condition. One of the most common water quality parameters to improve was electrical conductivity as the consistent high flows diluted salts and minerals washed off the landscape. The other clear improvement was in dissolved oxygen.

Although the overall CHIP ratings have remained consistent, waterbug diversity across the catchment was high, with stonefly nymphs being found on the Queanbeyan River, downstream of Queanbeyan city, for the first time. The wetlands of Canberra's inner north saw a decline in waterbug numbers, which may in part be related to the declining dissolved oxygen. Toad bugs were found on the Molonglo River and large numbers of Cow shrimp were noted at both Scabbing Flat and Yandyguinula Creeks - both rarities in the upper Murrumbidgee.

Despite COVID restrictions, flooding and some cross-border confusion, over 550 water quality surveys, 54 riparian condition surveys and 49 macroinvertebrate (waterbug) surveys were still completed. A huge effort! Thanks to all our volunteers for their hard work.

## **Banksia Street Wetland SUW2**

### **Sullivans Creek in O'Connor**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Good	9
рН	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	Poor	2
Riparian condition	Fair	1

#### **Reach Facts**

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

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

This wetland contains some of the best riparian vegetation of any of the urban wetlands. Revegetation work done by Banksia St Community Group have ensured a riparian condition score consistent with well the vegetated, highly diverse riparian corridors of the catchments upper-most rivers and creeks. Three functioning layers of vegetation are present, and the wetland has a great selection of riparian and waterplant species.

This wonderful example of urban revegetation is likely responsible for attracting large numbers of Superb parrots, listed as vulnerable in the ACT, which were spotted during water bug surveys in May. Reported by Waterwatch Coordinator, Deb Kellock, 'Superb parrots in trees around wetland - in pairs & 3's but eventually a flock of ~20'.

Turbidity was higher than usual this year with Waterwatchers Lyn and Louise regularly commenting on the water's brown appearance. The unusual absence of mayfly nymphs (Family Baetidaeis usually found here) in the spring bug survey may also have contributed to a drop in the waterbug score down from *fair* to *poor*.





## **Burra Creek BUR1**

### **Headwaters to Googong Foreshores NR**

2021 CHIP Result B- (Good)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	36
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Good	2
Riparian condition	Poor	4

### **Reach Facts**

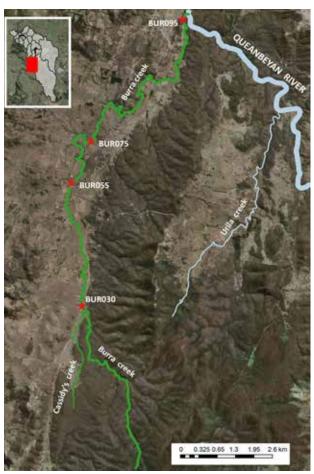
Reach network length: approx. 40km Dominant land uses: Native bush, grazing, rural, conservation

Burra Creek arises in the north-western edge of the Tinderry Mountains and flows into the Queanbeyan River just upstream of Googong Dam. It flows through rural subdivisions and includes the outlet of the pipeline from the Murrumbidgee to Googong water transfer scheme, before passing through the southern end of Googong Foreshores nature reserve.

With extensive historic grazing and land clearing, Burra Creek's riparian vegetation is largely dominated by exotic woody weeds such as willow and poplar, as well as exotic ground cover species including Phalaris and Bearded oat. Sodic soils (those high in sodium) in the reach increase the risk of erosion, and the potential for water logging and salt outbreaks. Ongoing access to the creek by stock exacerbate erosion issues which increases turbidity and reduces riparian revegetation. Three out of the four sites were given a *poor* riparian rating, due largely to the lack of native vegetation present.

Stoneflies were present at our macroinvertebrate surveys in spring for the first time since 2017. Highly sensitive, the stoneflies' presence could be attributed to this year's wet spring, with higher flows washing sand and sediment downstream, leaving riffles clean and creating suitable habitat.

Despite the wet year, flows at the start of the year were low, correlating with *poor* and *degraded* electrical conductivity. During these low flow periods, the concentration of salts and minerals in the water increases. This is then further exacerbated by the region's sodium-rich soils and drives up electrical conductivity readings.





Sensitive stonetly nympns were detected for the first time since 2017 during the spring waterbug survey.

## **David Street Wetland SUW1**

### **Sullivans Creek catchment in O'Connor**

2021 CHIP Result C (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	16
рН	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Fair	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	Degraded	2
Riparian condition	Fair	1

#### **Reach Facts**

Reach network length: approx. 0.21Ha Dominant land uses: Urban, recreation

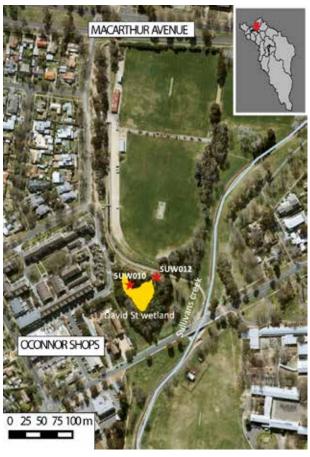
David Street Wetland is the second 'offline' wetland along the westerly branch of Sullivans Creek. It was constructed in 2001 and takes a portion of higher flows from the concrete stormwater channel. These pass through the wetland then overflow back into the westerly concrete channel, just before it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

David St Wetland is the oldest and smallest wetland in the inner north of Canberra, and the high variability in water quality scores, across all parameters, reflect the varied conditions and influences of an urban catchment. The increased rainfall has likely contributed to an increase in phosphorus and nitrate concentrations detected, as more nutrients are washed off the suburbs. Dissolved oxygen levels were particularly bad this year with every measurement falling into degraded levels (14-69% saturation).

Large native canopy species, particularly Acacias, dominate the edge of this wetland. A thick layer of pollen from these trees can often be seen coating the water surface.

Macroinvertebrate (waterbug) diversity was low in spring with only four Orders detected. Sampling efforts were somewhat hampered with a thick layer of sludge on the bottom and large amounts of filamentous algae making it difficult to properly detect the bugs. Eastern gambusia were also present in large numbers during the autumn waterbug survey.

Waterwatcher Fernando Villegas noted 24 ducks during a water quality sample in May, and a family of Wood ducks, including twelve fluffy ducklings, were observed in September.





## **Dickson Wetland DIC1**

### **Sullivans Creek catchment**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Good	13
рН	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	Poor	2
Riparian condition	Fair	1

### **Reach Facts**

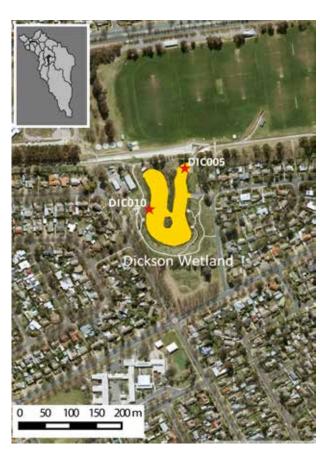
Reach area: approx. 1Ha
Dominant land uses: Urban

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.

A much-loved community resource, substantial revegetation efforts over the past few years have ensured a consistent riparian condition rating of *fair*, with scores expected to rise in the coming years as plantings mature. A high density of edge vegetation and a diverse array of habitat structures, such as reeds, sedges, logs and rocks, support a diverse population of aquatic bird life.

Poor dissolved oxygen and reduced numbers of waterbugs have all contributed to a lowering from last year's good rating. Large amounts of exotic Oak and Ash leaves were noted during spring waterbug surveys. Leaves dropped by exotic deciduous species during Autumn can cause a negative impact on water quality, increasing bacterial loads and thus depleting the dissolved oxygen content in the water. This impacts waterbug numbers, with more sensitive types unable to survive. Mayflies and caddisflies, both sensitive to lower dissolved oxygen levels, were present during autumn surveys but absent in spring.

Waterwatcher Lyn Grigg was helping out with the turtle nesting project and was delighted to discover a large Eastern long-necked turtle making a nest on the steep rocky banks next to the wetland in December. This was considered a very unusual site choice.





## Jerrabomberra Creek JER1

## **Headwaters to Fernleigh Drive**

2021 CHIP Result B (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Good	14
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Good	2
Riparian condition	Fair	3

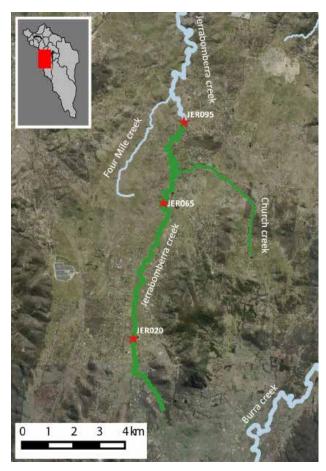
#### **Reach Facts**

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 southeast side of the ACT border. This reach, including a number of small tributaries, has varying degrees of riparian condition ranging from healthy sections through to rural subdivisions with very little riparian vegetation and sections with deep gully erosion.

The pollution-sensitive stoneflies were among an impressive eleven water bug Orders surveyed in total this year, benefiting from this year's higher flows. Due to the reach's relatively small catchment size, low flows are common during the summer. The local geology's mineral-rich metamorphic parent rock, historic land clearing and erosion issues, contribute to produce electrical conductivity readings of over 400  $\mu$ S/cm. These seasonal low flows can mean increased water temperature readings, which in turn can cause a reduction in dissolved oxygen. This year's turbidity score also dropped from *excellent* to *good*, an indication of increased erosion due to higher flows in winter affecting the region's already highly erodible sodic soils.

Although planting of riparian vegetation has increased over the last few years, two out of three of the reach's riparian surveys was given a rating of *poor*, largely due to these sites lacking some canopy and mid-story vegetational layers. Increased plantings of native tree and shrub species would be of great benefit, reducing erosion, and providing shade that helps to stabilise water temperatures.





## Jerrabomberra Creek JER2

## Fernleigh Park to Molonglo River confluence

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	29
рН	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	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, past residential, rural and industrial areas and a grassland reserve, before ending at the Jerrabomberra Wetlands Nature Reserve (JWNR). 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. The downstream reach of the creek also takes stormwater runoff from major roads and parts of Fyshwick light industrial area.

The poorer ratings for phosphorous, high electrical conductivity and turbidity can be attributed to Kelly's Swamp, an ephemeral wetland located in JWNR. Ephemeral wetlands are naturally higher in nutrients and minerals and provide important habitat for water birds and other aquatic fauna. Waterwatcher Peter Abbott noted increased growth rates of water plants around Kelly's Swamp.

The riparian condition scores are influenced by willows, poplar and other woody exotics downstream and exotic improved pasture grasses and Thistle upstream. Recent plantings at Narrabundah Wetlands, near site JER175, leave hope for an improved riparian rating in the future.

This reach has a new Waterwatch site; JER125, sampled by Waterwatcher Ross Taylor. Located at Lanyon Drive, this site captures data downstream of two major development sites: Queanbeyan sporting complex and The Poplars development. We will watch this area with interest over the next few years as the surrounding grassland is transformed into suburb.





## **Lyneham Wetland LYN1**

### **Sullivans Creek catchment off Wattle Street Lyneham**

2021 CHIP Result C (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	11
рН	Good	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	Poor	2
Riparian condition	Poor	1

#### **Reach Facts**

Reach area: approx. 1Ha
Dominant land uses: Urban

Lyneham Wetland is a large artificial wetland constructed in 2011–12 fed by stormwater from surrounding suburbs, including Dickson and the large concrete stormwater channel which flows from Dickson Wetland. Unlike Dickson Wetland, 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.

Although water levels remained high over the last year, macroinvertebrate (waterbug) surveys still produced a *poor* rating. Large amounts of deciduous leaf litter, observed in spring, possibly contributed to the low waterbug diversity as well as increased phosphorus levels (up to 0.07mg/l).

A freshly-baited opera house yabby trap was removed from the wetland during the autumn bug survey. These traps are illegal in all waterways in the ACT as they pose a drowning risk to airbreathing aquatic fauna such as Platypus and Rakali (native Water rats).

Habitat features such as hollow bearing trees, fallen logs and substantial leaf litter are absent from around Lyneham Wetland, reducing the riparian condition score. Despite this, it is home to variety of birds and aquatic fauna. A pair of Australasian grebes have bred chicks for two consecutive years now, delighting passers-by who viewed the nest from the footbridge. Turtle researcher, Bruno Ferronato, also found an Eastern long-necked turtle nest and captured and recorded data on seven individuals, including five juveniles.





### **Headwaters to Captains Flat**

2021 CHIP Result B (Good)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Excellent	4
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	Good	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 limited riparian vegetation. With the absence of a mid-story vegetational layer, as well as unrestricted access to sections of the river by stock, the reach's riparian condition was largely unimproved.

Thanks to Waterwatcher Beth Reczek, water quality data was finally collected at site MOL030, raising the reach's rating from last year's *fair* score. Whilst returning *excellent* readings for most water quality parameters, the reach's dissolved oxygen content was of concern. Low readings were recorded even in the cooler months when water temperature is low and able to hold more oxygen. These skewed results may be the result of early morning sampling times. As plants respire overnight, oxygen is taken from the water, leaving the oxygen content low by the morning. As the sun comes out and water plants start to photosynthesise, oxygen is released back into the water, causing the oxygen content to peak in the afternoon.

With high diversity of in-stream vegetation and habitat structure, macroinvertebrate (waterbug) numbers were among the best in the catchment, with eleven Orders detected during the spring survey. Two Families of stonefly nymphs were noted, a rarity in the Molonglo catchment, as well as other pollution-sensitive types such as mayfly and caddisfly larvae.





**Captains Flat to Travelling Stock Reserve** 

2021 CHIP Result A (Excellent)		
2020 CHIP Result A- (Excellent)		
Parameter	Rating	No. Survey
Water quality	Excellent	9
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	Good	2
Riparian condition	Excellent	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 mostly through modified rural land and finishes at the Travelling Stock Reserve (TSR) at 'Foxlow'.

This reach received the highest rating in the Molonglo catchment which was due to the improved water quality score. The higher flows most likely contributed to this, particularly pH and electrical conductivity, by decreasing mineral concentrations and diluting acidic mine leachate. Waterwatchers' Wendy and Steve noted flows so consistently high they had to move sample spots downstream as the normal spot was underwater for a lot of the year.

MOL2 also had the only *excellent* riparian condition score in the catchment but, with only one site, this score may not be representative of the entire reach. It does, however, indicate the importance of this TSR in providing essential habitat and refuge for birds and other animals, especially due to its vital connection to Yanununbeyan National Park.

Macroinvertebrate surveys produced pleasing results, which again could be attributed to this year's higher flows. Two species of stonefly nymph we found, as well as large numbers of caddisfly larvae. Toad bugs, a predatory species of true bug (Hemiptera) that do not often turn up in the Molonglo catchment, were also a welcome find.





The Molonglo River at MOL109 had the best riparian condition score in the Molonglo catchment.

### **Downstream of Travelling Stock Reserve near Foxlow**

2021 CHIP Result B- (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Good	15
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	Good	2
Riparian condition	Poor	3

#### **Reach Facts**

Reach network length: approx. 54km

Dominant land uses: Grazing, rural residential

This reach 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 Whiskers Creek and Stony Creek, with runoff from the Hoskinstown Plain, which as a frost hollow, is largely treeless.

Willows continue to re-establish along this reach, and riverside vegetation at many sites is either dominated by exotic species or absent for large stretches. Large rural properties with highly cleared landscapes dominate the main river channel, but some of the smaller creeks have better vegetation condition. Weeds at Burbong Bridge, in the rail corridor, are varied and extensive.

Waterbug surveys produced mixed results, with stonefly nymphs found in spring but not autumn, and only in small numbers. This reach is also home to large numbers of Eastern gambusia, a small but highly invasive species of fish that prey on macroinvertebrates in the water.

Electrical conductivity is historically high in this reach, due to the underlying geology of Stony and Whiskers creeks. These flow into the Molonglo River downstream the Molonglo River Nature Park. This year's improved *fair* score is probably in part due to the absence of sampling data from both these creeks. The three remaining monitoring sites are all on the mainstem of the Molonglo River and the mineral rich water from the smaller creeks becomes diluted, improving the overall electrical conductivity score.





### **Downstream of Burbong Bridge to Queanbeyan River confluence**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	14
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	Good	2
Riparian condition	Fair	2

#### **Reach Facts**

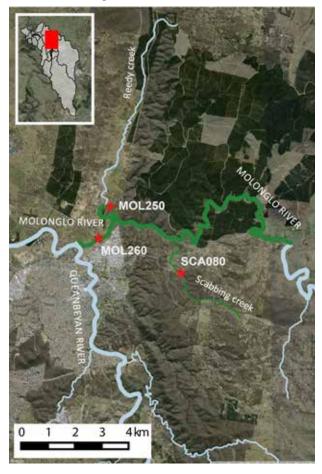
Reach network length: approx. 16km Dominant land uses: Grazing, rural residential, forestry, conservation, urban

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

A huge improvement on last year, this reach's elevation to a *good* rating is likely due to the inclusion of new site MOL250, just downstream of Molonglo Gorge. A real show piece of the catchment, the gorge's healthy native riparian vegetation helps to improve the reach's overall riparian condition score, and fast flows over rocky, steep sections of river could have aided in improving dissolved oxygen levels.

The increase in the riparian score may also be due to the maturing of native understory vegetation downstream of Molonglo Gorge before the Queanbeyan River confluence. This was planted as part of work undertaken by the ACT Healthy Waterways program in 2019. The high flows during 2021 may have proved a bit too much for some plantings closer to the river, with pink tree guards being washed kilometres downstream and recovered by local river clean-up volunteers.

This reach has high diversity of in-stream vegetation, both native and exotic, resulting in high waterbug diversity. Stonefly nymphs were present at both waterbug surveys, with large numbers found in spring, most likely benefiting from a healthy riffle zone, cleaned out by the high flows.





Scabbing Flat Creek upstream of SCA080.

## **Upstream of Lake Burley Griffin**

2021 CHIP Result C+	(Fair)
2020 CHIP Result C+	(Fair)

2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	13
рН	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Poor	2

#### **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 the Queanbeyan Sewage Treatment Plant near Beard, 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.

Waterway restoration from the top of this reach to Oaks Estate Road included revegetation and weed control in 2019 as part of an ACT Healthy Waterways program. Downstream, there is a good diversity of aquatic plants on the riverbanks at the bottom site, as well as Ribbon weed, but it is limited in extent.

Water quality varied slightly this year with a notable change the phosphorous score from *excellent* to *good*. While it's not clear what the cause is exactly, the combination of high rainfall in a reach with plenty of roads and earthworks, sewage seepage, grazing, fertilisers on turf farms as well as plant nurseries, can contribute to high phosphorous levels in waterways.

Large numbers of feral predatory fish species, such as European carp fingerlings and Eastern gambusia, were reported in this reach by Waterwatcher Tony Patis. Both these fish breed quickly and in plague-like numbers.





The confluence of the Molonglo and Queanbeyan Rivers, at the upstream end of MOL5.

### Scrivener Dam to below Deep Creek confluence

2021 CHIP Result B (Good)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Excellent	24
рН	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Excellent	
Waterbug	Fair	2
Riparian condition	Fair	3

#### **Reach Facts**

Reach network length: approx. 10km

Dominant land uses: Urban, grazing, conservation

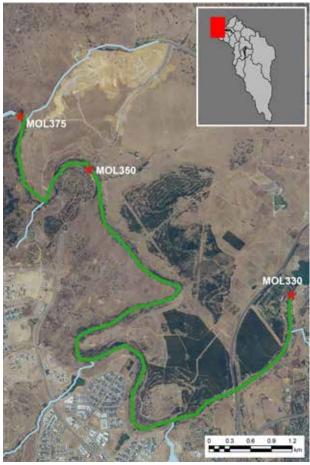
This section of the Molonglo River extends from downstream of Lake Burley Griffin to below the Deep Creek confluence, due south of Kama Nature Reserve. This reach encompasses extensive and ongoing Molonglo Valley urban developments and the Molonglo River Reserve runs its entire length.

Dissolved oxygen took a jump from *poor* in 2020 to an *excellent* rating, improving the overall CHIP score. This was likely driven by this year's higher flows and subsequent releases from Scrivener Dam, helping to aerate the water along many of the reach's riffle zones.

Turbidity in the reach was again a problem in 2021, with turbid water noted coming from Deep Creek due to continued development upstream in the suburb of Whitlam. Erosion issues were noted upstream of the Deep Creek confluence with large gullyerosion channels forming at the newly established Namarag-Molonglo River Reserve. Downstream of Butters Bridge, extreme bank erosion was noted on the unnamed ephemeral creek that takes run-off from the Denman Prospect sediment ponds, further contributing to high turbidity readings.

Pleasingly, riparian condition improved this year as well, largely due to increased understory and groundcover growth, spurred on by two years of decent rainfall. Recent plantings of native riparian vegetation may see this score continue to improve as plantings mature, and vegetation further covers exposed ground.

At least three individual Platypus were recorded over a one-kilometre stretch in this reach during the annual Platypus Month surveys.





Turbid water flowing into the Molonglo River from Denman Prospect just downstream of Coppins Crossing.

### Deep Creek confluence to Murrumbidgee River confluence

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	8
рН	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	Poor	2
Riparian condition	Fair	1

#### **Reach Facts**

Reach network length: approx. 16km Dominant land uses: Urban, infrastructure, grazing, conservation

This reach on the Molonglo River extends from below Deep Creek confluence to the Murrumbidgee River confluence. Prior to 2019 it was the downstream section of MOL6. This reach includes the Molonglo River Reserve and the Lower Molonglo Water Quality Control Centre (LMWQCC) just above the confluence.

This reach is highly impacted by outflows from the LMWQCC, with nitrate spikes of up to 35mg/L being recorded earlier in the year. Levels dropped from April onwards, coninciding with the increased flow. The higher rainfall and flows also saw improvements in electrical conductivity and dissolved oxygen but said flows may also be responsible for exacerbating erosion issues in the catchment, leading to increased turbidity.

Macroinvertebrate (waterbug) numbers were low in autumn, with only six Orders detected. In spring, however, numbers and diversity improved with three types of mayfly nymphs detected as well as four types as caddisfly larvae. Unfortunately, European carp were seen jumping during the spring surveys. Carp are known to have a negative effect on macroinvertebrate numbers, predating heavily on most waterbugs and stirring up sediment in the water, increasing turbidity and making it harder for gill-breathing water bugs to survive.

Rubbish continues to be an issue at this reach, with large amounts of debris and litter noted after high flow periods.





## **Primrose Creek PRI1**

### **Headwaters to Molonglo River confluence**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Good	16
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Poor	2

#### **Reach Facts**

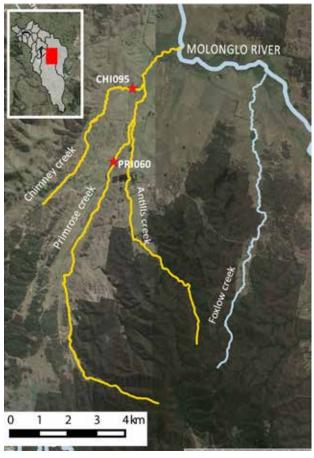
Reach network length: approx. 34km Dominant land uses: Conservation, grazing, rural

Primrose Creek is a chain of ponds flowing mostly through rural land. Its headwaters are 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. Except at the headwaters of Primrose Creek and Antills Creek, there is little or no native riparian vegetation, and just a scattering of exotic trees.

Higher nitrates, worsening riparian condition and a drop in macroinvertebrate numbers have all contributed to this year's lower overall rating. Increases in nitrates may be the result of an increase of runoff from animal manure and inorganic fertiliser from surrounding agricultural land, sparked by high rainfall.

With little or no native riparian vegetation, this reach received the lowest riparian score of the Molonglo catchment. Most likely exacerbated by the wet year, this rural catchment suffers from issues with erosion. This results in large exposed stretches of creek which become a haven for quick growing, invasive weeds. Nevertheless, small stands of native understory Acacia seedlings have started to appear, giving some hope for an improved riparian condition score in the coming years.

Stonefly nymphs were absent this year for the first time since 2018 which contributed to a reduced waterbug score. That said, twelve Orders were surveyed in spring, including scuds (Amphipoda), a rarity in the Molonglo catchment.





# **Queanbeyan River QUE1**

## **Upstream of Googong Dam**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	47
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	Good	1
Riparian condition	Fair	5

### **Reach Facts**

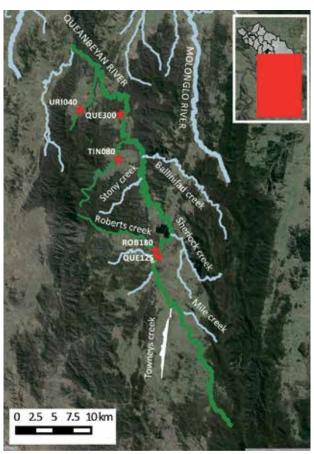
Reach network length: approx. 143km Dominant land uses: Conservation, grazing, rural residential

This reach is the largest in the catchment. The upper section of the Queanbeyan River runs from its origins on the southern slopes of the western Tinderry Ranges to Googong Dam in the north. The reach includes Sherlock, Urialla, Tinderry, Lyons, Roberts and Bradleys creeks.

Despite a period of low flow in January and February, the upper Queanebeyan River was in flood for most of the year, with Waterwatcher Des Cannon noting Urialla Creek was '...the highest it has been in some 10 years.' Large trees and woody debris, built up by floodwaters, caused havoc at Tinderry Creek. Reported by Waterwatcher Sandy Lloyd, "...huge flooding that went over roadway, taking trees and debris under and then blocking the bridge and which destroyed the floodgate upstream."

Due to flooding conditions, only the spring waterbug survey was able to be completed safely this year. This produced excellent diversity including stonefly nymphs, three types of mayfly, five types of caddisfly and three types of beetles. Encouraging numbers of glass shrimp 'in berry' (producing eggs) were also detected.

The riparian condition on this reach is variable, containing sections of both intact native riparian vegetation and cleared pastural land. Native sections on the reach have a high diversity of native flora, resulting in stunning display of wildflowers over spring.





## **Queanbeyan River QUE2**

### **Downstream of Googong Dam to city of Queanbeyan**

2021 CHIP Result B (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	38
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	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 and have their own Waterwatch sites. The Valley Creek flowing out of Cuumbuen Nature Reserve also feeds into this reach.

The Queanbeyan River here receives water from Googong Reservoir. It had excellent flows in 2021 with the dam overflowing for much of the year. This reach received a near perfect score for water quality, with one exception, electrical conductivity. This is in part owed to both Montgomery, Googong and Gorge creeks which regularly have high conductivity, suspected to be associated with the underlying geology. Readings across these three creeks ranged from 290-970  $\mu\text{S/cm}$  throughout the year.

Although the upstream sites on this reach have healthy riparian vegetation, the overall riparian score remains *fair*, as introduced woody species such as willow and poplar continue to dominate sites downstream. Gorge Creek has experienced extreme infestations of blackberry and honeysuckle in 2021, choking out any native understory and restricting access to the usual Waterwatch sampling site. Further adding to riparian condition issues, another housing development, upstream of Googong Creek (GGG010) has resulted in "all the reeds and vegetation …cleared and replaced with rock".

Waterwatcher Sue Gibson reported damage from feral pigs and deer in January. Especially troubling are sightings of domestic cats roaming loose in the Queanbeyan River Corridor at QUE455, a known Rakali hotspot.





## **Queanbeyan River QUE3**

## Queanbeyan city to Molonglo River confluence

2021 CHIP Result B- (Good)		
2020 CHIP Result C+ (Fair)		
Parameter Rating No. Survey		
Water quality	Excellent	13
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Good	
Waterbug	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 runoff from Queanbeyan and its suburbs, Cuumbuen Nature Reserve and the eastern slopes of Mt Jerrabomberra. The reach includes Barracks Creek and the Queanbeyan Weir.

Water quality remained consistent this year, with a slight improvement in electrical conductivity, likely helped by higher flows diluting salts and minerals that flow from creeks in upstream reaches.

Stonefly nymphs were detected for the first time at this reach in spring. While only present in small numbers, their presence has helped improve this year's waterbug score. A remarkable find due to the reach's proximity to Queanbeyan city, stonefly nymphs are extremely sensitive to poor water quality and pollution, and may have been coaxed downstream by high flows flushing sediment and sand out of riffle zones. Other pollution-sensitive waterbugs were found in healthy numbers, with four types of mayfly and caddisfly identified among the ten orders surveyed.

Riparian condition is varied with most of the reach being situated within Queanbeyan city. Much of the native vegetation in that section has long been removed, making way for exotic willow, oaks, and elms. In recent years, the ACT Heathy Waterways Program has made an effort to improve riparian condition, planting native canopy and mid-story species in the downstream section of this reach near Oak's Estate.





## **Sullivans Creek SUL1**

### Headwaters to Randwick and Flemington Road Pond, Mitchell

2021	CHIE	Racu	It C+	(Fair)
2021	СПІГ	. VE2n	IL CT (	(ган )

### 2020 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	Fair	7
рН	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	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, flowing through historical grazing land then into a concrete stormwater 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. The two Waterwatch sites are located at the inflow and outflow of the most downstream of these wetlands - Flemington Pond.

Nitrate concentrations of 3 and 4mg/L were detected on a number of occasions in 2021, well exceeding *degraded* levels. This is possibly due to the widespread rainfall causing run-off from nearby industrial areas as resulting in the build-up of rubbish in the gross-pollution trap, upstream of Flemington Pond.

Phosphorus was also high at times feeding the large amounts of filamentous algae observed during the spring waterbug survey. Although a healthy wetland will contain smaller amounts of filamentous algae, excessive amounts can have a negative effect. The low dissolved oxygen readings are most likely related because as the algae die and decompose, the process consumes dissolved oxygen.

While there was an absence of pollution-sensitive waterbugs, diversity was high with twelve and nine orders recorded respectively in the autumn and spring surveys. It is also one of the only sites where Pea shells were found. Pea shells are small freshwater bivalves, similar to a mussel, and, being filter feeders, can help improve water quality in wetlands.





A Black swan on Flemington Pond, SUL018.

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## **Sullivans Creek ANU SUL3**

### Lyneham Wetland to Lake Burley Griffin confluence

2021 CHIP Result C (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Fair	21
рН	Excellent	
Turbidity	Fair	
Phosphorus	Fair	
Nitrate	Poor	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Poor	3

### **Reach Facts**

Reach network length: approx. 3.7km Dominant land uses: Urban, recreation

Once known as Ngambri Creek, 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 the ANU campus. It passes Toad Hall Pond before continuing through the campus, flowing through some short reed-filled sections and on into Lake Burley Griffin.

This highly urbanised reach is one of a small number to only receive a *fair* result for water quality. Phosphorus concentrations remain a concern, reaching as high a 1mg/L in January 2021, and may influence algal blooms downstream in Lake Burley Griffin. The *poor* electrical conductivity score is typical of a catchment with an extensive network of concrete channels.

There was an absence of pollution-sensitive waterbug Orders during the surveys, with no caddisfly larvae detected for the first time since spring 2017. This may be related to the declining water quality issues experienced in 2021. Results were interesting nonetheless, uncovering hundreds of tiny black water mites (Acarina) and two large stick-like needle bugs (Nepidae). Both species are attracted to slower flowing water.

In November, Waterwatcher Michael Burton identified and reported Yellow flag iris growing downstream at site SUL765, closest to Lake Burley Griffen. Yellow flag iris is a fast growing and invasive riparian weed and could spell disaster if left unchecked to spread throughout the lake and downstream waterways.





Sullivans Creek looking downstream of SUL745.

## **Watson Wetlands and Ponds WAT1**

**Justice Robert Hope Park to Aspinall Street** 

2021 CHIP Result C+ (Fair)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	10
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	Poor	2
Riparian condition	Poor	2

#### **Reach Facts**

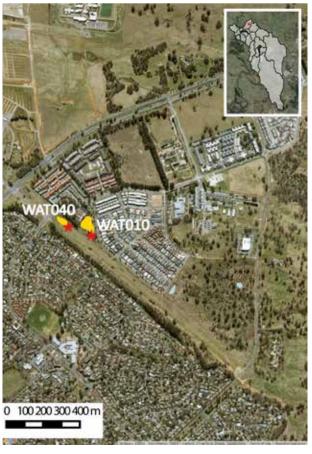
Reach network length: approx. 1.4km Dominant land uses: Conservation, urban

Watson Wetlands and ponds are on the lower western slopes of Mt Majura Nature Reserve, across the road but contiguous with the nature reserve. They comprise a drainage line, with two dams, in remnant Yellow box/Red gum grassy woodland at Justice Robert Hope Park, 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. The water then flows via pipes into Sullivans Creek.

Water quality is particularly good for an urban wetland, with most water quality parameters scoring well. Dissolved oxygen was the exception which may in part be due to a lack of in-stream vegetation (like at WAT010) as reduced oxygen levels are not balanced out with photosynthesising aquatic plants. A lack of shading due to missing canopy species downstream at WAT040 may also lead to decreased oxygen levels as warmer water retains less oxygen.

Despite the *excellent* water quality, low numbers of sensitive waterbugs have lowered the waterbug score and reduced overall rating for this reach. The riparian vegetation also lacks diversity and may be related to the lower waterbug numbers. Diverse riparian vegetation provides habitat for both juvenile waterbugs and their terrestrial parents, and provides shade to help reduce water temperatures.

Eastern gambusia are also a problem here and large numbers of this invasive fish were caught in the autumn and spring bug surveys.





## **Weston Creek WES1**

### **Headwaters to Molonglo River confluence**

2021 CHIP Result C (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Fair	30
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Poor	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	Fair	2
Riparian condition	Poor	3

### **Reach Facts**

Reach network length: approx. 6.7km Dominant land uses: Urban.This 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 on the southeast edge of the new Molonglo Valley suburban area. It then passes close to the eastern side of Coombs, where development is nearing completion, and on to the confluence with the Molonglo River. This year saw the addition of two new sites HOW005 and HOW020 at the Holder Wetlands. This series of wetlands was constructed in 2019 at part of the ACT Healthy Waterways program.

Varying amounts of water at the downstream site (WES450) come from underground storage to the south-east of the creek. This flows out into a small pool and on through a dense reed bed before flowing down a more natural, narrow channel to the Molonglo River.

High phosphorous and nitrate concentrations were evident across this reach through the year. Waterwatcher Gail Newman regularly recorded phosphorous levels of over 0.15mg/L at her two sites (WES450 and WES410). The Holder Wetlands, however, demonstrated their effectiveness in treating water quality. In June 2021 for example, nitrates were detected at 10mg/L and phosphorus at 0.1mg/L at the inlet. This dropped to 1mg/L and 0mg/L respectively at the outlet.

An illegal yabby trap was removed from the downstream site (WES450) for the second year in a row. Known to catch and drown air-breathing aquatic fauna such as Platypus and Rakali, these traps are banned in all waterways in the ACT.





The new Holder Wetlands are proving effective at treating stormwater that flows off the surrounding suburbs.

## **Woolshed Creek WOO1**

## **Headwaters to Molonglo River confluence**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	16
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Poor	2

### **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. It flows through highly modified rural land with some native riparian vegetation in the upper sections 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 with rare Silurian Period fossil beds.

Water quality ratings were identical to last year, electrical conductivity being of most concern once again. Given its hydrogeology and extensive historical land clearing, the Majura Valley has salt outbreaks in the landscape which can strongly affect electrical conductivity in the creek. Waterwatcher Terry Moore recorded high readings of over 700  $\mu\text{S/cm}$  throughout the year, well above degraded levels. Reeds in the upstream site (WOO010) have benefited from this year's rainfall, hastily taking over most of the channel and restricting access to sampling locations.

Invasive weeds like blackberry, hawthorn, willow and White poplar dominate this reach with native vegetation having been long cleared to make way for exotic 'improved' pasture grasses and woody weeds. Patches of native vegetation are still present upstream, and in-stream vegetation is surprisingly dense, supporting a diverse array of channel habitat. Due to its proximity to Majura Parkway, the downstream section of this reach accumulates large amounts of rubbish and debris.





## Yandyguinula Creek YAN1

## **Headwaters to Molonglo River confluence**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B+ (Good)		
Parameter Rating No. Survey		
Water quality	Excellent	10
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	Good	2
Riparian condition	Good	2

### **Reach Facts**

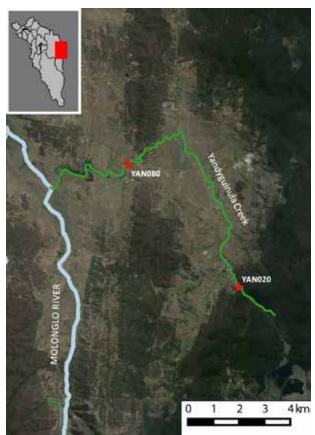
Reach network length: approx. 18km Dominant land uses: Conservation, grazing, wetlands

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 before flowing 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.

With its near perfect rating, water quality in this reach is some of the best in the upper Murrumbidgee catchment. Waterbug numbers were equally impressive, with twelve Orders found in autumn, including large numbers of mayfly nymphs and caddisfly larvae, as well as stonefly nymphs in spring.

Riparian condition on this reach is highly varied. Its upper site (YAN020) is situated in wet sclerophyll forest, with rich native flora diversity and habitat structure represented across all three layers (canopy, mid-story and groundcover). Downstream, historically grazing country, the creek is dominated by willows and blackberry, with very little native riparian vegetation remaining, barring a few pockets of ti- tree bunched on rocky sections of bank.

In early 2021, five to six large Eucalypt trees were felled and removed from YAN020. Despite the removal of the trees, and damage to mid-story and groundcover vegetation from logging trucks, riparian condition scores were largely unchanged, a testament to site's high riparian value.





The upstream section of Yandyguinula Creek (YAN020) is in pristine condition.

## Yarralumla Creek YAR1

### **Headwaters to Molonglo River confluence**

2021 CHIP Result C+ (F		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	48
рН	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Poor	5

#### **Reach Facts**

Reach network length: approx. 10km Dominant land uses: Conservation, urban

Yarralumla Creek includes three drainage lines which run largely in concrete channels, one along the west side of Mt Mugga Mugga, one from Farrer to Phillip, and one from Long Gully to Garran. The reach also includes the East O'Malley Pond. Yarralumla Creek then runs parallel with Curtin in a concrete stormwater channel and down to the Molonglo River, immediately below Scrivener Dam. This year saw the addition of two new sites MAW005 and MAW010 situated at Mawson Wetlands. This wetland was recently constructed to take overflow from the creek as it runs through Mawson.

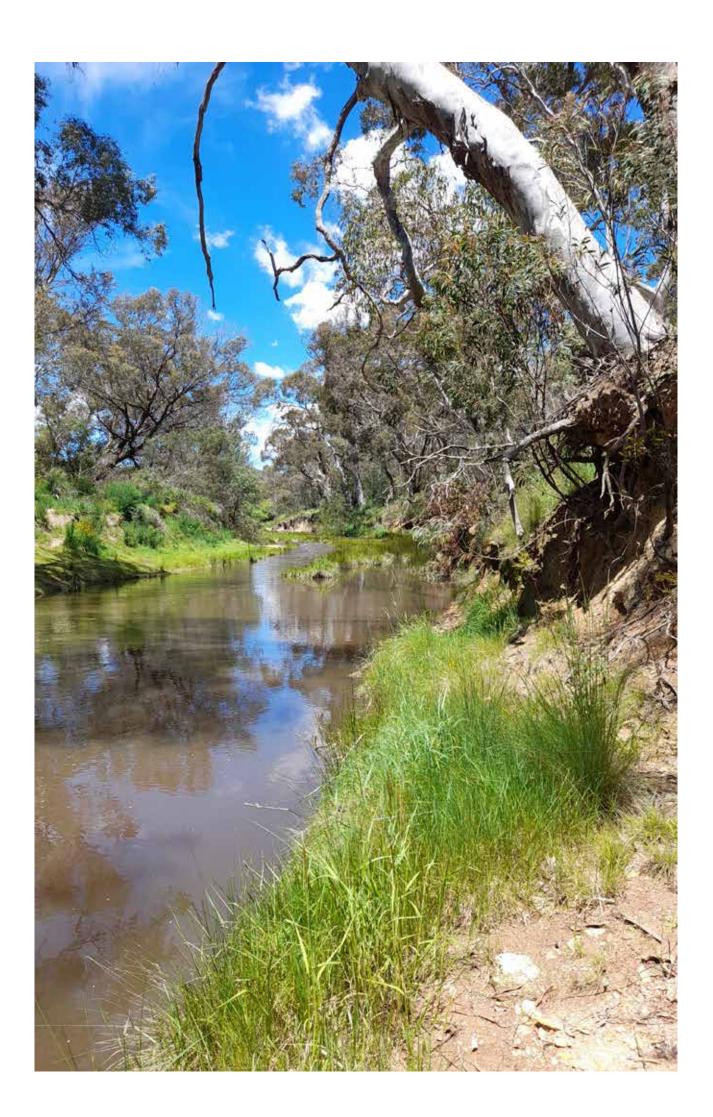
Water quality scored better than other reaches in the catchment that are highly urbanised and contain similar stretches of concrete stormwater channels. Typical of this kind of reach, however, is high electrical conductivity readings, as stormwater accumulates pollutants as it flows over large amounts of impermeable surface. Readings of over  $700\mu\text{S/cm}$  were detected over summer.

Various ACT Healthy Waterways projects have been undertaken on the network of concrete channels which form much of this creek. Aiming to reduce high flows and provide better filtration of sediment, unwanted nutrients and pollutants, these projects were completed in 2019 but will take several years to be fully functional, as plants grow and establish.

A big thank you to Waterwatcher Mike Sim, who has taken on both Mawson sites in addition to his other two sites at O'Malley Pond. Mike completed a whopping 42 water quality surveys throughout the year, a huge and highly appreciated effort.







## **Southern ACT Catchment Facts**

For the purposes of this report, the Southern ACT area is divided into ten main sub-catchments; the Murrumbidgee River, Naas River, Gudgenby River, Cotter River, Paddy's River, Orroral River, Lake Tuggeranong, Point Hut Pond, Stranger Pond and Guises Creek.

The headwaters of the Cotter, Naas, Gudgenby and Orroral River systems are at some of the highest elevations in the ACT, originating in the mountains of the Namadgi National Park. The Cotter River provides our main drinking supply and flows north, next to the Brindabella Ranges. Paddy's River is a smaller rural waterway flowing to the west of the Bullen Range, past forestry land and grazing properties to the immediate west of Canberra. Its catchment includes the Tidbinbilla Nature Reserve and Gibraltar Creek.

The Lake Tuggeranong, Point Hut and Stranger Pond systems are urban waterways in the southern half of Canberra with inputs flowing in from the east. The Lake Tuggeranong inflows are extensively engineered with pipes and concrete channels. The Point Hut Ponds were designed more recently and feature upstream wetlands and terraced, vegetated stormwater channels

Guises Creek is a small base flow creek on the eastern edge of the ACT adjacent to the Monaro Highway.

All of these waterways join the Murrumbidgee River in the ACT, which flows north from Angle Crossing, near Tharwa. For the purposes of this report, Southern ACT catchment finishes at Uriarra Crossing, just before the Molonglo River confluence in the north west corner of the ACT.

The Upper Murrumbidgee Demonstration Reach (UMDR) partnership works to protect and improve the health of all Murrumbidgee River. From 2019 it has expanded its region to include all of the Murrumbidgee main stem in the southern ACT.







### **Southern ACT Catchment Health Summary**

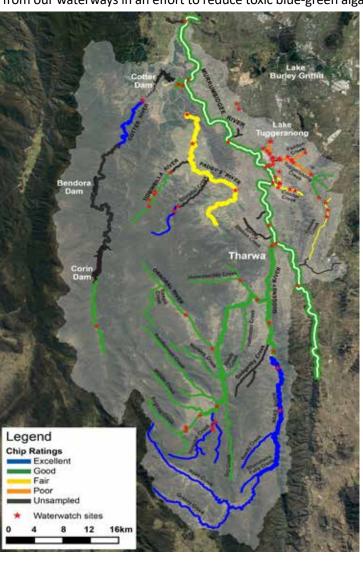
The Southern ACT catchment had a varied response to one of the wettest years on record. Every month other than April had above average rain with November being the wettest month since records began, with 153mm. Fifteen of our twenty-seven reaches received higher CHIP scores this year, eight remained the same and four got poorer scores.

While overall phosphorus concentrations were lower than 2020, high flows remobilised ash and sediment from the 2020 bushfires resulting in algal growth in reaches such as Hospital Creek. The upstream, conservation section of the Naas River was still producing phosphorus levels of 0.06mg/L and the more rural Paddy's River reach, had turbidity readings of 100NTU on five occasions. Plumes of sediment-laden water were regularly seen flowing from the Paddy's River into the much clearer Cotter River. That said, the continuous flushes improved overall water quality. This included better dissolved oxygen levels in most of our waterways and this was seen in the return of some key pollution-sensitive waterbugs to our rivers.

The Cotter River behaved largely like an unregulated system throughout the year with all three dams overflowing almost continuously from January onwards. Flows of over 1000ML/day were experienced in at least six months throughout the year. The Murrumbidgee to Cotter pipeline, which pumps water from the Murrumbidgee to the base of the Cotter Dam when flows are low, was not used once all year.

There was an increase in nutrient loads detected over the southern urban waterways. Concentrations of nitrates and phosphorus were often high in Isabella Pond and algae outbreaks at Point Hut Pond were most likely a result of the high phosphorus levels there. Lake Tuggeranong had the worst levels of phosphorus of all the lakes. Electrical conductivity was also higher on average across the urban waterways than in the neighbouring rivers.

That said, the ACT Government is continuing to work to improve water quality in our urban environs. A large 'floating wetland' was installed at the northern end of Lake Tuggeranong. Also, major dredging at Conder Wetlands took place to remove built up pollution and allow the regrowth of the water plants. Both projects will aim to draw out nutrients from our waterways in an effort to reduce toxic blue-green algal blooms.



## **Barney's Gully MMB1**

## Woodcock Drive, Gordon to confluence with Murrumbidgee River

2021 CHIP Result B- (Good)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	11
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	Fair	2
Riparian condition	Fair	1

#### **Reach Facts**

Reach network length: approx. 1km

Dominant land uses: Peri urban, conservation and recreation

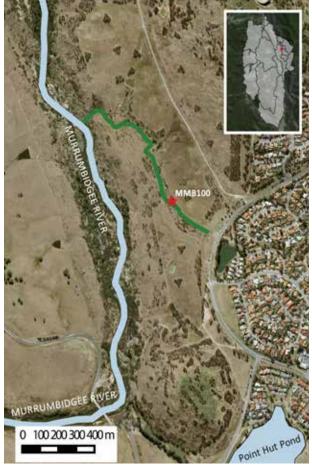
Barney's Gully is an ephemeral creek near Woodcock Drive, Gordon. This natural creek is connected to this suburb and flows into the Murrumbidgee just over a kilometre downstream of Point Hut Crossing. It is one of the last original clay bed creeks that form a chain of pools full of rushes, only flowing after periods of rain. Most other similar creeks in the Tuggeranong valley were converted to concrete stormwater channels and/or dammed to form urban lakes.

This small creek is showing the positive effects of years of hard work by the Parkcarers of Southern Murrumbidgee ('P.O.S.M'). Leaky weirs and erosion control works have promoted abundant reeds and ground cover with lush, green growth reported in the channel as well as the riparian zone throughout the year.

In November, renowned Waterwatcher and POSM member, Deb Kellock, found a large frog egg mass and noted that the Common eastern froglets had been making a lot of noise since July. The pest fish, Eastern gambusia, was also reported in large numbers throughout the warmer months.

This is the first *good* health report card since 2017. Mostly due to an improvement in waterbug numbers with the creek enjoying medium to high water levels all year. Yabbies were caught in autumn for the first time in two years.

The water here regularly has *poor* electrical conductivity due to salts leaching from clay soil.





## **Bogong Creek Catchment BOG1**

## **Headwaters to Yankee Hat trail bridge**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	27
рН	Good	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Poor	
Waterbug	Good	2
Riparian condition	Fair	1

### **Reach Facts**

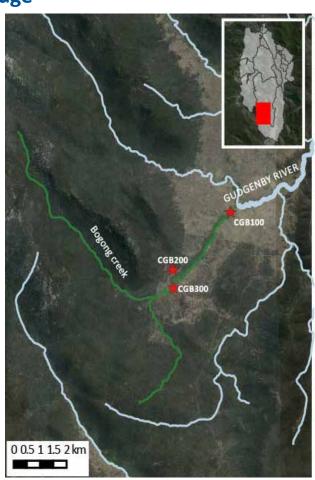
Reach network length: approx 13km Dominant land uses: Conservation

This reach is in the Namadgi National Park and is part of the Gudgenby River catchment. At its downstream end Bogong Creek is a wide and mostly treeless upland creek/bog.

Recovery from the 2020 fires in this part of Namadgi has been slow. Phosphorus is still slightly higher than pre-fire levels and is mostly being detected in the most downstream site (CGB100) with the upstream sites stabilising. Low dissolved oxygen concentrations were measured in the low flows at the start of the year but this is fairly typical of these upland big systems. Slightly lower pH readings of 6.5 were measured throughout the year, particularly at the lower site but also upstream though this is also a fairly common result in this catchment.

Waterbug surveys at the northern site showed signs of recovery with an increase in diversity and greater abundance of key sensitive species between autumn and spring. 'Cow shrimp', a type of isopod, were detected in spring, being one of the few sites in the upper Murrumbidgee where they have been found.

Riparian condition showed little improvement, with all the understory, much of the canopy and most of the leaf litter still missing in the sites surveyed. The bog sites became heavily infested with many species of exotic thistles. On a positive note, the ACT Venturers noted that native tussock grasses returned 'in force' by November. They had established on the sediment and ash that accumulated on the flats surrounding the upper bog site (CGB300).





## **Cooleman Ridge Dams RAN1**

### Two dams on Cooleman Ridge

2021 CHIP Result C (Fair)		
2020 CHIP Result C- (Fair)		
Parameter	Rating	No. Survey
Water quality	Fair	18
рН	Poor	
Turbidity	Good	
Phosphorus	Poor	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	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 (MBK100) is a small dam in Cooleman Ridge Nature Park. It was made to provide water for horses as part of the Bicentennial Trail. The 'Old Dam' (CMC100) is on the eastern slopes of Cooleman Ridge and has a stock exclusion fence with off-dam watering for cattle installed since 2019.

For the first time since 2017 the dams were full all year and overflowing by November. Turbidity was the best ever this year. While phosphorus fluctuated just below *degraded* concentrations of 0.1 mg/L it is an improvement on last year. Electrical conductivity was also lower (ranging between  $90\text{-}210\mu\text{S}$ ) as the rainfall diluted the salts and minerals.

That said, both dams consistently suffered from low dissolved oxygen and pH around 5.5. This is a likely legacy of both dams being empty for most of 2019 when terrestrial plants flourished in their muddy basins. When rain returned the plants were submerged and decomposition of the resulting dead vegetation by bacteria is known to consume oxygen and produce acidic conditions.

Aquatic life did, however, return. Late in the year Waterwatcher Pat Ryan reported the regrowth of native Swamp lilies *Ottelia ovalifolia* and also sighted an Eastern long-necked turtle. The charismatic Needle bugs and Water scorpions, that have delighted children and Waterwatchers alike, made a welcomed return in spring.





a welcomed return to Kathner St Dam in 2021.

## **Cotter River COT1**

### **Headwaters to Corin Dam**

2021 CHIP Result B (Good)		
2020 CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	6
рН	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	Fair	2
Riparian condition	Fair	1

### **Reach Facts**

Reach network length: approx. 12km Dominant land uses: Drinking water catchment and conservation

This reach covers the top of the Cotter River above Corin Dam in the Bimberi Wilderness area. Much of this reach's catchment is dominated by a low eucalyptus canopy. Access to the public is restricted as, along with COT2, it forms part of the ACT's main drinking water supply. Monitoring began in September 2020 and is conducted by ACT Parks and Conservation staff. Feral deer are a significant issue.

The riparian assessment of this reach conducted in spring 2020 still reflects the devastation of the fires earlier that year. Trees had their canopy burnt and there was no understory or leaf litter to be found. A survey due in 2022 will hopefully bring news of regeneration.

The reach had medium flows most of year with evidence of high flows in late spring. The water quality overall was *excellent* however the effects of the fires may still be evident in the lower pH and slightly increased nitrates.

Two waterbug surveys both produced similar bugs and low diversity. Apart from hundreds of Blackfly larvae most the waterbugs found were highly sensitive types including some impressive predatory Eusthenid stonefly nymphs. Consecutive heavy rain events in late spring resulted in high flows, making surveying by Woo and Danswell difficult. 'Ideally we would have waited for the river to drop and bugs to better re-establish but the high flows have persisted'.





## **Cotter River COT2**

### **Pipeline Road Crossing to Vanity's Crossing**

2021 CHIP Result A- (Excellent)		
2020 CHIP Result A- (Excellent)		
Parameter	Rating	No. Survey
Water quality	Excellent	19
рН	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	Good	2
Riparian condition	Good	2

### **Reach Facts**

Reach network length: approx. 11km

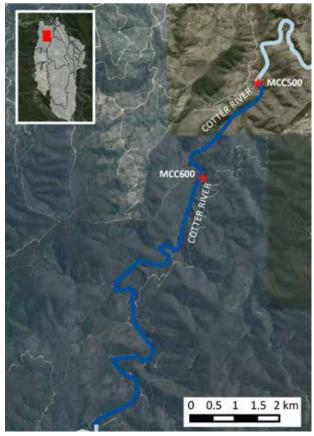
Dominant land uses: Drinking water catchment and conservation

This reach runs along the stretch of the Cotter River between the Bendora and Cotter dams. Releases and overflows from Bendora are key drivers of water quality in this reach. 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 in part due to the area being a significant part of the ACT's drinking water supply as well as having a remnant population of the endangered Macquarie Perch. Waterwatch monitoring is exclusively conducted by Waterwatch and ACT Parks and Conservation staff.

This section of the Cotter River behaved like an unregulated system for much of 2021. Bendora Dam was overflowing for all but a handful of weeks which occurred mostly in the earlier part of the year. By early December recordings of 1500ML/day were spilling over the dam wall.

The electrical conductivity readings are some of the lowest in the entire upper Murrumbidgee catchment, ranging between 30-60 $\mu$ S/cm all year. Like in the Cotter reach above Corin Dam, the pH is slightly lower with regular readings of 6 and 6.5.

The autumn bug survey, assisted by a team of ACT Parks and Conservation rangers, found eleven different waterbug Orders at Vanity's Crossing. A member of the public arrived during the survey and within minutes caught a Rainbow trout. While the spring waterbug survey detected lower diversity at the Order level, there was an abundance of pollution-sensitive bugs with hundreds of stonefly and mayfly nymphs and seven different types of caddisfly larvae.





## **Cotter River COT3**

### **Cotter Dam to Murrumbidgee River confluence**

2021 CHIP Result B- (Good)		
2020 CHIP Result B+ (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	18
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	Poor	2
Riparian condition	Fair	2

### **Reach Facts**

Reach network length: approx. 2.5km Dominant land uses: Recreation

Water flowing through this reach is sometimes influenced by water from the Murrumbidgee River that is pumped from the Cotter Pumphouse to the base of the dam wall (known as the 'M2C' flows). This flow assists with environment releases during the dam filling phases and during drought conditions. Additional inflows from the Paddy's River can also significantly affect the water quality flowing past the Cotter Campground.

The riparian vegetation only ever achieves a *fair* assessment as this reach is managed for public amenity. Although there is a healthy population of Casuarinas, large, exotic deciduous trees are abundant and there is little debris and understory that contribute to a healthy riverbank.

This section of the Cotter River behaved like an unregulated system for much of 2021. The Cotter Dam was overflowing for all but a handful of weeks and the M2C pump was not required once all year. The minimum baseflow for this section of river is 15ML/day but flows of over 1000ML/day were experienced in at least six month throughout the year. In July, Waterwatcher for nearly 20 years Maree Blume, reported that 'the river was the highest level we have ever seen' and that there were 'uprooted trees and low-lying branches litter[ing] both sides of the river'.

The persistant high flows affected waterbug diversity and abundance as the bugs rarely got a chance to re-establish before being flushed downstream. While some pollution-sensitive types such as stoneflies, were detected, the waterbug score for this reach was the worst since 2015.





## Gibraltar Creek GIB1

### **Headwaters to Woods Reserve**

2021 CHIP Result A (Excellent)		
2020 CHIP Result A (Excellent)		
Parameter	Rating	No. Survey
Water quality	Excellent	19
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	Good	2
Riparian condition	Excellent	2

### **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 form upland bogs. The catchment also has a high recreational use and a popular commercial facility at Corin Forest.

This reach regularly receives one of the highest CHIP scores in the entire upper Murrumbidgee catchment. The medium to high water flows all year meant no nutrients were detected and the water temperature remained below 17°C even at the height of summer.

Although burned in 2020, a survey of the riparian condition this year produced an *excellent* result. The complex structure of the native vegetation with its underlying debris and leaf litter remained intact. The canopy had also shown significant recovery. There was little sign of the weed infestations that plagued other fire affected locations.

The waterbug surveys also told a story of recovery. In April the creek had to be sampled twice to find only six waterbug Orders and ash from the fires was still present in the creek bed. It was the worst result Waterwatch has seen at Woods Reserve. Happily, by October, there was the return of hundreds of stonefly and mayfly nymphs along with many families of caddisfly larvae and a large 'Toe-biter' (Dobsonfly larvae). The Toe-biter is a top order predator and is very sensitive to pollution despite its scary name.

A native Mountain galaxias fish was also caught during the spring bug survey - always a nice find.





## **Gudgenby River Catchment CGG1**

## Headwaters to the Murrumbidgee River confluence

2021 CHIP Result B- (Good)		
2020CHIP Result B (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	23
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	Fair	2
Riparian condition	Fair	3

### **Reach Facts**

Reach network length: approx 35km

Dominant land uses: Conservation and rural grazing

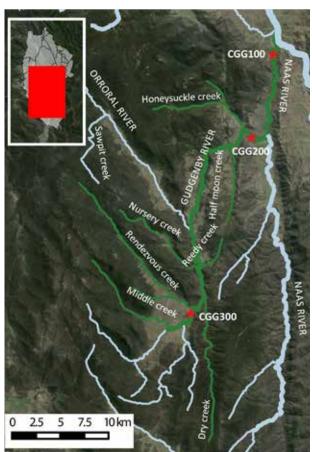
This reach includes the full length of the Gudgenby River from the headwaters in Namadgi National Park to the confluence with the Murrumbidgee River near Tharwa. Seven kilometres flow through the northern end of the park while the remainder runs mostly through mixed grazing properties.

The riparian vegetation in the national park still lacks understory and healthy leaflitter as a result of the 2020 fires. This stretch saw heavy incursions of weeds. Dead trees were noted falling, along with logs being washed into the river. Pleasingly, strong native regrowth was noted in the national park by November.

The riparian vegetation in the grazing section lacks significant native tree cover and understorey. The weeds flourishing here in January were mostly washed away by significant flooding in March.

The same rains led to a temporary bridge being washed away which prevented access to the national park and the Naas Valley for several weeks and caused significant local erosion. This was evident at the downstream site (CGG100) in March where a big turbidity spike of 160NTU was recorded.

Only four types of waterbugs were detected at this downstream site in April. The survey notes state that the river 'has been transformed by recent floods' with sand completely smothering the river substrate, resulting in very limited available habitat for waterbugs. By September the waterbug diversity had improved with the reappearance of very sensitive stonefly nymphs and an alderfly larvae.





Flooding in March resulted in the Gudgenby River being completely smothered in sand at CGG100.

## **Guises Creek Catchment GUI1**

## **Headwaters to confluence with Murrumbidgee River**

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	15
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	Good	2
Riparian condition	Poor	3

### **Reach Facts**

Reach network length: approx 120km

Dominant land uses: Conservation and rural grazing

This reach is a permanent spring sitting on Ignimbrite bedrock adjacent to the Monaro Highway on the eastern border of the ACT. The reach extends from its head, due west of Royalla, to a large dam on a property 4 km south of Rosevue Homestead property. The three sites were chosen to capture changes to water quality as it passes past the homestead.

The creek passes through rural grazing properties and the riparian vegetation is mostly comprised of weed species and exotics trees. Native revegetation would significantly improve the riparian condition score and the overall catchment health.

High rainfall has led to medium flows for most of the year. The water was clear but still has high electrical conductivity with up to  $780\mu\text{S/cm}$  recorded in January. It is difficult to say whether the frequently high electrical conductivity is due to the underlying geology or surrounding land use. The ignimbrite rock is associated with clay rich sediments which may leach minerals into the creek. While nitrate levels still got as high as 10mg/L in January, concentrations were considerably lower throughout the year, compared to 2020.

Waterbug surveys conducted at Rosevue often give pleasant surprises. This year both seasons found great diversity. In April there were three Families of mayfly nymphs, two Families of caddisfly larvae and many diving beetles along with shrimp, water mites, damselflies, water boatmen, worms and snails. Eleven different types in all. In October the diversity grew to include two Families of stonefly nymphs and a freshwater pea clam.





## **Hospital Creek Catchment HOS1**

## Headwaters to the confluence with the Gudgenby River

2021 CHIP Result A- (Excellent)		
2020 CHIP Result B+ (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	36
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Waterbug	Excellent	2
Riparian condition	Fair	1

#### **Reach Facts**

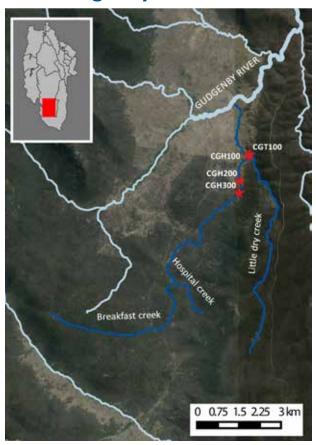
Reach network length: Hospital Creek arm (on the left) 12km, Little Dry Creek arm (on right) 7km Dominant land uses: Conservation

Hospital Creek is mostly a forested gully situated south east of Bogong Creek, in Namadgi National Park. It runs north, forming as upland bog before joining the Gudgenby River near its headwaters. Waterwatch sampling mostly occurs in the bog sections with one site being in the forested area.

High rainfall throughout the year improved the water quality and waterbug results, with this reach receiving an *excellent* rating for the first time in four years. Both bug surveys revealed healthy numbers and diversity with all key sensitive Orders present. The spring survey also found lots of tadpoles with four species of frogs calling during the day.

Significant algal growth was observed by 'Gudgenby Bushie' Waterwatcher Michaela Popham and team. This is most likely a symptom of some nutrient levels still being released after the fires. Phosphorus levels dropped gradually until August then rose again with high flows in November. This also brought dissolved oxygen levels down.

The low riparian condition score is based on a survey in July 2020 and recovery has been slow. The Brindabella Venturers Waterwatch team noted in January that catchment was heavily overgrown with weeds and there was little to no epicormic growth on fire-affected trees. In May; 'Lots of weeds. All trees in area dead'. By November some improvement; 'Dead [weeds] everywhere... Lots of Gum and wattle saplings. Mountain Kangaroo Apples (Solanum sp.) too'.





Algal growth was observed at the confluence of Little Dry and Hospital creeks, August 2021 (Photo: M. Popham).

# Isabella Pond ISA1 Large pond south of Monash

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C- (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	30
рН	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	Fair	2
Riparian condition	Poor	3

#### **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).

Isabella Pond underwent an extensive facelift from 2018 to 2019 with several hectares of wetland vegetation plantings. The aim is to trap nutrients that would otherwise be carried into the main lake which then contribute to toxic blue-green algal blooms.

Regular monitoring of Isabella Pond by Caroline Chisholm High School found that overall, the water quality had not improved on 2020 results. That said, there are some interesting results in this this highly urbanised landscape. In September there was a high flow event with both inlet GPT's (gross pollutant traps) overflowing. Phosphorus was a *degraded* 0.1mg/L at both inlets but had dropped to 0.02mg/L at the dam wall (TIP050). Also, while all sites saw nitrate levels consistently at *degraded* levels and electrical conductivity usually ranging between 200-400µS /cm, on average water quality improved slightly at the downstream site.

The two waterbug surveys were conducted 100m upstream from the dam wall among the wetland plantings. Unlike the previously surveyed sites in the pond, there are reasonably established stands of macrophytes and submerged water plants as well as significant debris. The difference was significant with over ten different types found. Waterbugs were mostly tolerant of pollution, but the diversity gave this reach its best waterbug score to date.





Isabella Pond (looking south from TIP210) continues to have some concerning water quality results.

## **Lake Tuggeranong Wetlands TLT1**

**Drakeford Drive weir to South Quay foot-bridge weir** 

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	17
рН	Good	
Turbidity	Good	
Phosphorus	Fair	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Poor	
Waterbug	Fair	2
Riparian condition	Poor	2

### **Reach Facts**

Reach network area: 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 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.

There is a healthy stand of Casuarinas on either bank of this stretch of the lake but very little in the way of other native plants. Part of the function of this body of water is to treat water quality before it enters Lake Tuggeranong proper.

The water quality results improved slightly on last year. The exception was electrical conductivity concentrations (the salts and minerals) which increased from an average of  $130\mu\text{S/cm}$  last year to  $210\mu\text{S/cm}$  this year. Dissolved oxygen levels were slightly better and phosphorus loads were down with a median of 0.05mg/L compared to 0.07mg/L in 2020. The degraded nitrate levels upstream at Isabella Pond appear to have been mostly dealt with by the time they reach this water body, where they rated as good. Turbidity issues that plagued this part of the lake when the Isabella Pond upgrades were happening from 2017 to 2019 have abated in the last two years.

The wetlands continued to host a *fair* population of waterbugs. More than seven types were found in both autumn and spring. Pollution-sensitive mayfly and two Families of caddisfly larvae were joined by many dragonfly and damselfly nymphs. Water boatmen, who are very pollution-tolerant, made up the bulk of the total waterbug numbers.





# Lake Tuggeranong TLT2 Main lake body

2021 CHIP Result D+ (Poor)		
2020 CHIP Result C- (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	42
рН	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	Degraded	2
Riparian condition	Degraded	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 thirteen south Canberra suburbs. Two major gross pollution traps are at the northern end of this reach. Lake Tuggeranong Wetlands, to the south, (TLT1) are immediately upstream of this reach. The riparian vegetation scores reflect the highly urbanised nature of the surrounding landscape.

A combination of *degraded* assessments has earned this water body its worst CHIP score yet recorded. High inflows from above average rain washed in pollutants from the surrounding suburbs. Very high concentrations of nitrates (up to 10mg/L) were measured by Waterwatcher Sijia coming out the stormwater systems at the northern end of the lake. Water flowing through these concreted 'creeks' often drives up electrical conductivity readings. Lower but still *degraded* concentrations of nitrates were also found near the Tuggeranong town centre. Dissolved oxygen levels were often below 75% which is also considered *degraded*.

The northern end of the lake had a 'floating wetland' installed in March. The aim being to absorb algae-fuelling nutrients from Kambah entering via the underground Village Creek. Phosphorus, the main target of the wetlands, was not measured in particularly high concentrations this year. Regardless, large blue-green algae (cyanobacteria) blooms appeared around the town centre from summer until April.

A native Carp gudgeon fish was caught during the autumn waterbug survey and was a pleasant surprise for Year 9 Waterwatcher, Gannu.





## Michelago Creek confluence to Tharwa Sandwash

2021 CHIP Result B (Good)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	18
рH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	Fair	2
Riparian condition	Fair	2

#### **Reach Facts**

Reach network length: approx. 24km

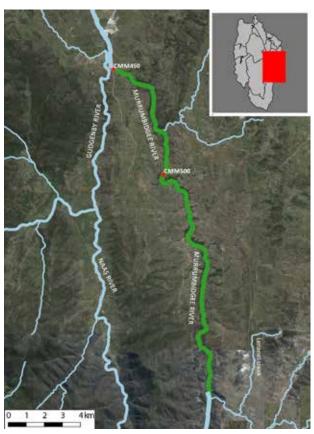
Dominant land uses: Rural grazing and conservation

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

Recreational fishing is banned in the ACT section of this reach and riparian vegetation is significantly healthier than downstream around the Tharwa township. Around Angle Crossing, however, there is a distinct absence of trees as well as limited amounts of emergent and edge vegetation.

Strong flows (e.g. 20 000 ML/day in February) have contributed to an *excellent* water quality result and this has been the main reason for a *good* overall assessment again this year. Dissolved oxygen levels for example were some of the best in the southern region. The amount of phosphorus was in lower concentrations than last year (median of 0.02mg/L) but was still higher than pre fire levels. Fine dark ash and silt is still being deposited on the banks after high flows. The riffle zone in autumn was covered in filamentous algae which may have been feeding on said phosphorus.

The abundant riffle zone at Angles Crossing, usually provides good habitat for many sensitive waterbugs such as stonefly nymphs. This year stoneflies were missing from the ten waterbug types caught in autumn and, although they returned in spring, only seven types were found altogether. This was most likely a result of the riffle zone being transformed into large rapids with the unrelenting high flows.





### **Tharwa Sandwash to Point Hut Crossing**

2021 CHIP Result B- (Good)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	22
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	Fair	2
Riparian condition	Poor	2

#### **Reach Facts**

Reach network length: approx. 10km

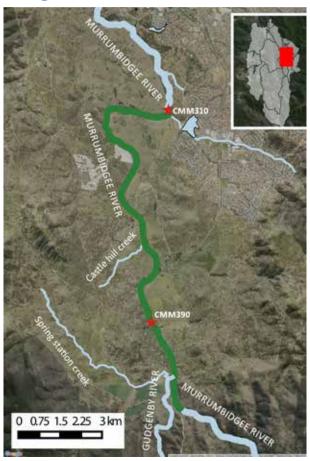
Dominant land uses: Rural grazing and conservation

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 in the Tharwa district.

The riparian vegetation in this reach is extremely poor with very few mature canopy species. The shallow gradient of this section of river also compounds the problem of sediment build up which reduces the chances for in-stream habitat, such as riffles, to establish. The shallow depths combined with a lack of shading, means the average water temperature at Tharwa is often warmer than at upstream or downstream sites. These areas of the river make passage difficult for aquatic fauna such as native fish and Platypus.

A series of Engineered Log Jams constructed over the past decade are aimed at deepening the adjacent channels in this reach with juvenile Murray cod and Murray river crayfish having been observed.

The constant high flows during 2021 resulted in cool, clear waters through this reach with consistantly high dissolved oxygen levels (median 89.5%). The flows made water bug surveys challenging at Point Hut Crossing. Only six types were found in autumn as it proved difficult to find an opportunity for bug numbers to re-establish. In spring, the river levels were still high but this time hundreds of pollution-sensitive stonefly nymphs were detected in addition to eight other waterbug types.





## **Point Hut Crossing to Kambah Pool**

2021 CHIP Result B (Good)		
2020 CHIP Result B- (Good)		
Parameter Rating No. Survey		
Water quality	Excellent	14
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	Fair	2
Riparian condition	Fair	2

#### **Reach Facts**

Reach network length: approx. 7km

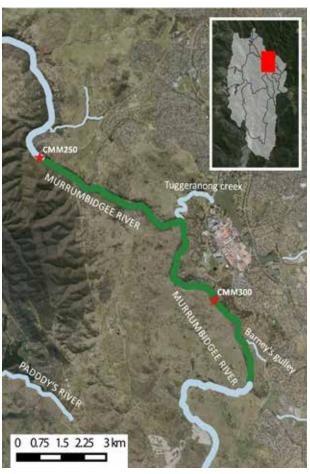
Dominant land uses: Urban, conservation and recreation

This reach covers the section of Murrumbidgee River from Point Hut Crossing to Kambah Pool, which includes Pine Island Reserve and Red Rocks Gorge. Urban inputs such as Tuggeranong Creek, Stranger Pond and Point Hut Ponds are also received into this section of the Murrumbidgee River.

This reach has deeper water and slightly more abundant bank vegetation than the mostly shallow treeless sections near Tharwa. That said, the riparian condition assessment still indicates that this section lacks significant native understorey and groundcover species.

Water quality was generally *excellent*, however there was an increase in nitrates with a recording of 3mg/L by Waterwatcher Richard at Pine Island in May. A turbidity spike of 100NTU was also recorded at Pine Island in November while the river was in flood.

The waterbugs surveys told similar stories to the upstream reaches with low diversity recorded in autumn after high flows, then receiving an *excellent* score in spring as diversity and numbers increased. By then Pine Island hosted all three key pollutionsensitive Orders, along with a highly sensitive, predatory waterbug known as a 'Toe-biter' (Family: Megaloptera). This is an indication of just how good the condition of the river was by late 2021.





## **Kambah Pool to Uriarra Crossing**

2021 CHIP Result B (Good)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Good	21
рН	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	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 it flows past old pine forest plantations and areas still used for grazing and farming. This section of the river receives inputs from both the Paddy's and Cotter Rivers entering just upstream of Casuarina Sands Reserve (CMM200).

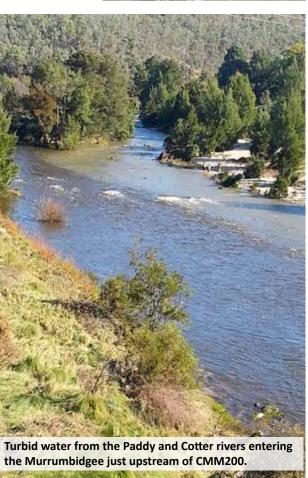
This stretch of the Murrumbidgee River is heavily influenced by the Cotter and Paddy's Rivers.

Turbidity is higher in this reach then in CMM9 and is likely coming from the rural Paddy's River catchment that has issues with erosion. Conversely, phosphorus levels were half that of upstream with said inputs meauring low levels of phosphorus and thus having a diluting effect on the Murrumbidgee waters.

Dark ash and sediment persisted on the banks at Casuarina Sands until October. A large amount of ash from the 2020 fires was noted as still being mobilised in the water column in September despite regular high flows throughout the year. Evidence of major flooding was observed by the volunteers at Casuarina Sands in December noting 'large logs jammed between trees..'.

This reach received some promising waterbug scores in 2021 with eight main types detected in autumn at Uriarra Crossing. While there were no stonefly nymphs found, plenty of mayfly nymphs and caddisfly larvae were seen along with freshwater pea clams in the shallow riffles. In spring the survey at Casuarina Sands found eight types again with all the key sensitive types, but in much lower numbers.





## **Naas River NAA1**

### **Headwaters to boundary of Namadgi National Park**

2021 CHIP Result A- (Excellent)		
2020 CHIP Result B+ (Good)		
Parameter Rating No. Survey		
Water quality	Excellent	6
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	Good	2
Riparian condition	Good	1

### **Reach Facts**

Reach network length: approx. 34km Dominant land uses: Conservation

This stretch of the Naas River runs next to the eastern border of the ACT in Namadgi National Park. Shanahan's Falls Creek joins Naas Creek near Horse Gully Hut in a steep gully to form the river proper which is then fed by numerous small creeks as it flows north through rocky dry sclerophyll forest between the Booth and Clear View Ranges.

The extremely wet conditions this year lead to flooding that washed out the Naas River Fire Trail making access impossible. That said, enough data was collected at the lowest site where there was a huge build-up of washed in sand and an abundance of invasive weeds such as thistles. Discussions with area rangers describe the upper Naas River catchment that was extensively burnt in 2020 as now being heavily eroded and weed infested, though there is also significant regrowth of native vegetation.

With concentrations as high as 0.06mg/L, the phosphorus in this reach was among the highest in the conservation areas of southern ACT. This was likely due to continued leaching of fire residues from the catchment. Electrical conductivity remained above  $100\mu\text{S/cm}$  but was a big improvement on last year.

The waterbug surveys were teeming with mayfly nymphs from the Family Baetidae. They are strong swimmers and often found in sandy riverbeds. Caddisfly larvae were also plentiful in autumn but there was notably more caddisfly diversity in spring, including 'stick', 'pebble house building' and the free living, predatory 'hunter' caddis.





## **Naas River NAA2**

## **Above Caloola Farm to Gudgenby River confluence**

2021 CHIP Result B (Good)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Excellent	12
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	Good	2
Riparian condition	Fair	2

#### **Reach Facts**

Reach network length: approx. 6km
Dominant land uses: Rural residential, grazing

This reach runs from just above Caloola Farm, below the boundary of Namadgi National Park, to the confluence with Gudgenby River. Historic and existing grazing activities have resulted in significant erosion and large amounts of sand and sediment being washed into this section of river and smothering available aquatic habitat.

The Actions for Clean Water (ACWA) Plan sets out a strategy for improving water quality (targeting turbidity) in the upper Murrumbidgee catchment. This reach is a high priority ACWA catchment with six key erosion sites identified.

The riparian condition assessment of *fair* reflects a combination of the Naas Valley Bridge site (NNN100) with its complete lack of trees and very few native plants, and Caloola Farm (NNN200) that has a native canopy but with a mostly weedy understorey and ground cover plants.

The increased flows from the high rainfall this year had a measurable impact with improvements from 2020 in both the water quality and waterbug scores. There were signs of regular flash flooding events with lots of branches and plant debris piled around bridge pylons along with a build-up of sand.

While phosphorus levels did get as high as 0.07mg/L on a couple of occasions, concentrations were lower than last year. It is hoped that phosphorus levels continue to decrease as the catchment recovers from the effects of the 2020 bushfires. Nitrates did show a slight increase in this reach compared to the one upstream but this is most likely attributed to runoff from the surrounding grazing lands.





Waterwatcher Sam Burns at NNN100 which has large amounts of sand and little in-stream vegetation.

## **Orroral River ORR1**

## **Headwaters to Gudgenby River confluence**

2021 CHIP Result B+ (Good)		
2020 CHIP Result B+ (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	10
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	Fair	1
Riparian condition	Good	1

### **Reach Facts**

Reach network length: approx. 26km

Dominant land uses: Conservation and Recreation

The Orroral River arises in the ranges east of the Cotter catchment in Namadgi National Park and flows east through a valley hosting an extensive upland fen wetland. This area hosts a range of submerged macrophytes (water plants) as well as large stands of Phragmites. The river then flows through rocky cascades, past Orroral campground, and ends at the confluence with the Gudgenby River.

The landscape was extensively cleared for grazing from the 1830s and from 1965 until the mid-1980s the valley hosted a NASA tracking station of which the foundations and surrounding landscaping still exists. The area near the tracking station site was the point where the Orroral Valley Fire began in January 2020.

The area is showing signs of recovery from the bushfires. The most notable water quality improvement was phosphorus which was detected in lower concentrations in 2021 as less ash and sediment was washed into the river. The electrical conductivity showed a notable difference between the top and bottom sites with salts and mineral becoming more diluted downstream. The Phragmites reeds in the fen wetlands had grown to shoulder height by May and were in flower.

A pack of 20 feral pigs, including adults and piglets, was observed at the Orroral River Footbridge (TOR200) during water testing in May. The Namadgi Park rangers were notified.





Upland fen wetlands on the Orroral River with evidence of the 2020 fires in the hills (Photo: D.Cahill).

## **Paddy's River PAD1**

## Tidbinbilla Road bridge to Murray's Corner

2021 CHIP Result C+ (Fair)		
2020 CHIP Result C+ (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	30
рН	Excellent	
Turbidity	Poor	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	Fair	2
Riparian condition	Poor	3

#### **Reach Facts**

Reach network length: approx. 24km

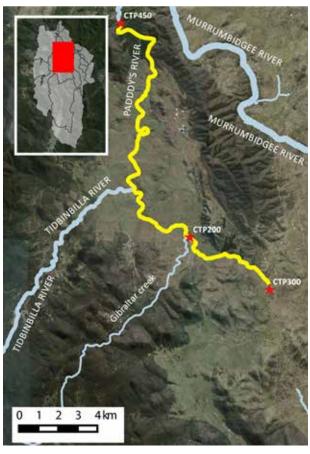
Dominant land uses: Rural grazing, forestry and recreation

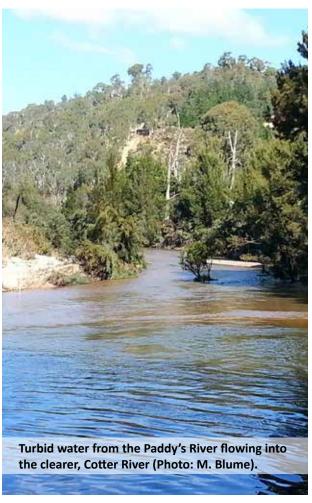
Paddy's River runs mostly through active grazing properties and softwood plantations that also provide public access dirt roads, popular with recreational off-road drivers. This reach covers the section below the headwaters on Booroomba Station.

The river is subject to erosion after large flooding events. The result is a sandy river bed lacking habitat complexity along much of its length similar to the Murrumbidgee near Tharwa. Steep unstable soils in the headwaters of the Booroomba Homestead are a key contributor. Much of the riparian zone along Paddy's River lacks significant native vegetation. The Waterwatch volunteers regularly comment on the extensive amount of weeds present such as blackberry.

Paddy's River did not see the improvements from high rainfall that many other reaches experienced in 2021. Instead, it had some of the most consistently turbid water in the region. The most upstream site at Tidbinbilla Road Bridge (CTP300) had readings of 100NTU on five occasions in 2021. The plume of sediment-laden water was regularly seen flowing into the much clearer, lower Cotter River and shortly then on to the Murrumbidgee River.

In a spring survey of waterbugs near the Tidbinbilla Road Bridge it was surprising to find some pollution-sensitive stonefly and mayfly nymphs living in the sandy riverbed. While hundreds of chironomid fly larvae were one of ten different waterbug Orders detected, abundance of other waterbugs was not particularly high.





## **Point Hut Ponds MPG1**

### **Headwaters of Conder Creek to Murrumbidgee River confluence**

2021 CHIP Result C (Fair)		
2020 CHIP Result C (Fair)		
Parameter	Rating	No. Survey
Water quality	Good	37 (1 dry)
рН	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Poor	
Waterbug	Poor	2
Riparian condition	Poor	4

### **Reach Facts**

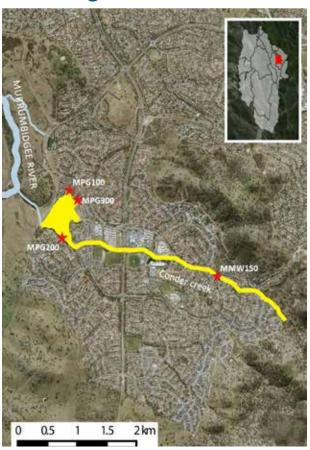
Reach network length: approx. 2.5km Dominant land uses: Urban

The drainage line that feeds this reach, flows down through the suburbs into Conder Wetland, which then drains to Point Hut Pond, a sediment control pond in Gordon. Together they make up a stormwater system that has been engineered with flow reduction features and verge vegetation to reduce some of the negative impacts from suburban runoff. The water from this system then flows into the Murrumbidgee River just downstream of Point Hut Crossing.

The riparian condition score is reduced significantly by the absence of an understory, debris and large native grasses that make up healthy shoreline habitats.

Cyanobacteria blooms reappeared this year with Waterwatcher Stephen Dellar noting in April that 'the colour of the water [was] intensely green'. His turbidity reading was 300NTU. There was an increase in nutrient loads recorded over the past four years, most likely due to better detection of frequent stormwater inflows. Phosphorus levels up to 0.07mg/L were recorded and this contributes to algal blooms.

In May the upper wetland pond site was completely drained and dredged by the ACT Government to improve water quality by 'reducing total pollution loads'. Afterwards Waterwatcher Vera Kurz found phosphorus levels had improved in the wetlands. High turbidity (mostly over 20NTU), low dissolved oxygen levels (60% saturation) and high electrical conductivity are all regular water quality issues for this reach.





# **Stranger Pond MSP1**Stranger Pond in North Bonython

2021CHIP Result C+ (Fair)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	21
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	Poor	2
Riparian condition	Fair	2

### **Reach Facts**

Reach network area: approx. 4Ha Dominant land uses: Urban

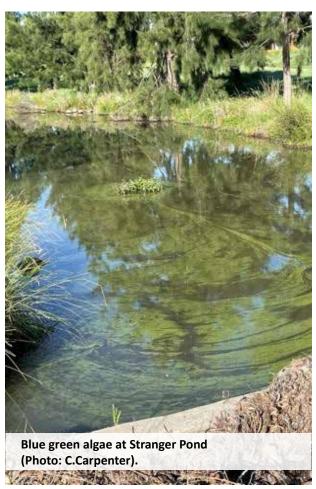
The 'Stranger Pond' system consists of Upper Stranger and Lower Stranger Ponds connected by a tapped pipe (normally closed) under Drakeford Drive. The whole system is immediately to the south of Lake Tuggeranong and provides storm water treatment to the suburb of Bonython. Overflow enters the Murrumbidgee River at Pine Island Reserve. Waterwatch monitoring has only been conducted at Lower Stranger Pond.

The water quality recorded here this year was the best of all the urban lakes in southern ACT. Nitrates were ever present and spiked up to 10 mg/L at the inlet after heavy rain in June. Electrical conductivity was elevated this year with the increased suburban runoff. It reached as high as  $570 \mu \text{S/cm}$  in December.

This pond also has the best riparian condition score of all the southern ACT lakes, albeit only receiving a *fair*. There is a large stretch of native vegetation near the dam end at the downstream monitoring site. Here can be found a dense stand of native trees, understory shrubs and grass tussocks. The build-up of leaf litter and woody debris is also largely undisturbed. This is vital for a healthy water edge habitat. This contrasts with the other riparian transects at the inlet end where there is the manicured shoreline more typical of urban lakes.

As riparian condition is integral to waterway health, allowing sections of lake frontage to exist in a 'natural' state may be a way of achieving a long term balance between catchment health and public amenity.





## **Tidbinbilla River TID1**

## Headwaters of Tidbinbilla River & Ashbrook Ck to Gilmores Rd crossing

2021 CHIP Result B+ (Good)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	41
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	Fair	3
Riparian condition	Good	6

### **Reach Facts**

Reach network length: approx. 8.5km

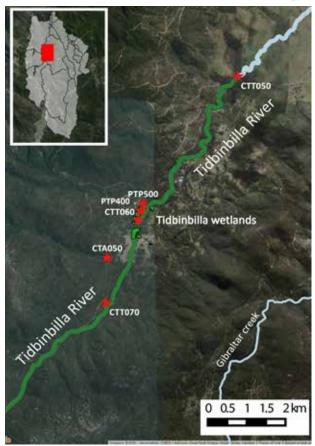
Dominant land uses: Conservation, tourism and rural grazing

This reach covers most of the Tidbinbilla River and the adjacent artificial wetlands in the Nature Reserve (the 'Sanctuary') and also includes Ashbrook Creek, a small upland stream on the western edge.

After Tidbinbilla Nature Reserve staff reviewed their management plan for the Sanctuary, Waterwatch moved its monitoring site after July from the bottom pond (Pond 5) to the main wetland section (Pond 4) to be more reflective of the Sanctuary's health. Pond 5 is an ephemeral water body allowed to dry out to improve the system's overall nutrient cycling, so water quality here is often be poorer than the rest of the wetland.

Good flows through the river and wetlands brought water quality back to *excellent* condition. While some sites like Ashbrook Creek had low dissolved oxygen levels at times, on average across all six sites, the reach was almost as good as its pristine neighbour, Gibraltar Creek. There were signs of damaging floods after the heavy rainfall of March including branches and debris in Ashbrook Creek.

All three water bug surveys in the Sanctuary discovered great diversity with over eleven types. That said, they were mostly pollution-tolerant Orders, hence the *fair* grading. Damselfly nymphs were ever present in the abundant water plants along with many types of water mites and flatworms also seen in the debris. Rarely seen waterbugs such as aquatic caterpillars and fresh-water pea clams helped make the sampling here exciting for the Volunteer Assist Program members.





## Tuggeranong Creek, Upper TUG1

### **Headwaters of Tuggeranong Creek catchment to Theodore**

2021 CHIP Result B (Good)		
2020 CHIP Result B- (Good)		
Parameter	Rating	No. Survey
Water quality	Excellent	20 (1 Dry)
рН	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Good	
Waterbug	Excellent	2
Riparian condition	Poor	2

### **Reach Facts**

Reach network length: Monks Creek (upper arm 3.2km), Tuggeranong Creek (lower arm) 4km Dominant land uses: Rural grazing

The system is fed from Monk's and Dunn's creeks to the east and Tuggeranong Creek to the south. The Tuggeranong Creek arm runs adjacent to the Monaro Highway. The upper creek arises from farming country with smooth Ignimbrite bedrock. The lower site, next to the Monaro Highway, is a hotspot for frequent rubbish dumping.

The headwaters site has no trees and little understory other than weeds. The riparian vegetation at the lower site is almost exclusively poplars with many of their wilding saplings as the understory.

The creek, dry at the start of the year, had low flows by February which continued until winter. Further high rainfall caused some flooding in spring with water seeping out of the surrounding landscape. Electrical conductivity in this reach is influenced by catchment geology and got as high as  $530\mu\text{S/cm}$  at the top of the catchment early in the year when the flows were still low. That said, concentrations became diluted once the flows increased and the overall score for electrical conductivity improved this year.

Stonefly nymphs went from being a surprise anomaly in the autumn waterbug survey to abundant by spring. Three Families of mayfly nymphs were also found in very high numbers. Free living and stick dwelling caddisfly larvae along with yabbies, dragonfly nymphs and beetles all contributed to one of the best waterbug results this reach has seen.





Upper Tuggeranong Creek was running cool and clear for much of 2021 (Photo: R.Knee).

# **Tuggeranong Creek, Middle TUG2**

Concrete drain system upstream of Isabella Pond

2021 CHIP Result D (Poor)								
2020 CHIP Result D+ (Poor)								
Parameter	Parameter Rating No. Survey							
Water quality	Fair	41						
рН	Good							
Turbidity	Good							
Phosphorus	Good							
Nitrate	Degraded							
Electrical Conductivity	Poor							
Dissolved Oxygen	Poor							
Waterbug	Waterbug Degraded 2							
Riparian condition	Degraded	4						

### **Reach Facts**

Reach network length: approx. 8km Dominant land uses: Urban.

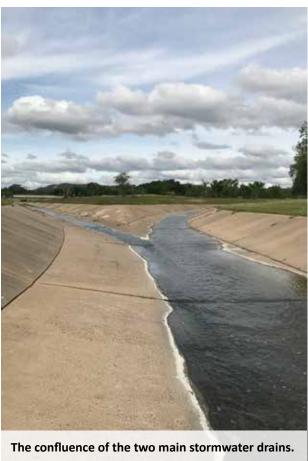
This reach consists of a Y shaped network of two concrete stormwater channels. The main arm runs north west from Leinhop Street in Theodore. This joins another channel flowing south west from Fadden near Isabella Drive where the channel then flows into Isabella Pond.

This reach consists entirely of concrete and has no riparian vegetation, some algal filaments, and almost no aquatic organisms. As a result CHIP assessments of this reach really only vary based on measured water quality. Consequently, the highest score this reach can attain is *fair* if all the water quality parameters are *excellent*. This reach is important in demonstrating the crucial roles waterbug and riparian surveys play in assessing waterway health. A concrete drain is a barren habitat.

Flows were mostly medium or lower in the drains. A sudden high flow event in September, however, occurred while conducting a water quality survey at the top site on Fadden Creek (TFF200). The water rose to dangerously swift levels within minutes. This survey also demonstrated how pollutants are mobilised during rain events in urban catchments like this one with the Waterwatcher detecting 0.25mg/L of phosphorous and turbidity of 100NTU.

Waterbugs do not often get mentioned here, but this year thousands of springtails (Class: Collembola) and a rarely seen gordian worm (Phylum: Nematomorpha) were found at the junction of the two drains.





# **Tuggeranong Creek, Lower TUG3**

# **Tuggeranong Creek to Murrumbidgee River confluence**

2021 CHIP Result B-(Good)								
2020 CHIP Result C+ (Fair)								
Parameter Rating No. Survey								
Water quality	Good	10						
рН	Excellent							
Turbidity	Good							
Phosphorus	Fair							
Nitrate	Good							
Electrical Conductivity	Fair							
Dissolved Oxygen	Good							
Waterbug Fair 2								
Riparian condition	Fair	1						

#### **Reach Facts**

Reach network length: approx. 1.8km Dominant land uses: Suburban reserve

This reach includes the last natural stretch of Tuggeranong Creek fed by Lake Tuggeranong. The creek enters the Murrumbidgee River two kilometres downstream of Pine Island Reserve.

Although well lined with Casuarinas, most of the understory along the creek consists of weed species. In-stream, the creek was heavily overgrown with algae for most of the year. This was driven by the high levels of nutrients often coming into the water from the surrounding catchment. Water quality is also affected by the same seasonal issues that occur in our other small creeks, including a loss of dissolved oxygen when water warms as it isn't able to hold as much oxygen as cooler water.

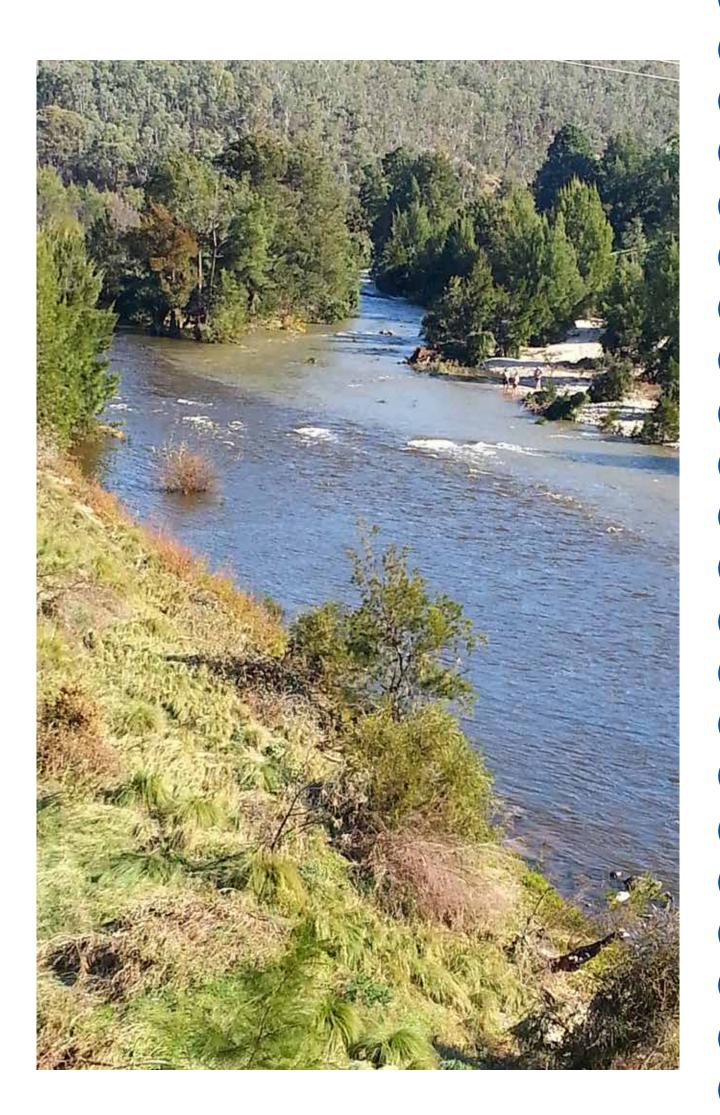
Although overall water quality was considered *good*, a high phosphorus reading of 0.2mg/L was detected in February. This was at the same time as 0mg/L was recorded in Lake Tuggeranong during a bluegreen alga (cyanobacteria) 'bloom'. Cyanobacteria is known to make quick use of phosphorus near the water's surface. This may account for the lake's low readings. It's possible that significant amounts of unconsumed phosphorus at lower depths was flushed out by the increased flows into the creek below.

For waterbug surveys, caddisfly larvae appeared in good numbers in autumn, otherwise pollutionsensitive waterbugs were low. Mayfly nymphs from the *Caenidae* Family were present but they have special covers on their gills and are adapted to living in silty conditions. While the diversity remained the same, there appeared to be a drop in overall abundance of bugs between autumn and spring.





native, mature Casuarina trees.



# **Yass Catchment Facts**

The Yass catchment is approximately 2,800km², and is situated to the north of the ACT. It is made up of two major rivers. The first is the Yass River that has its headwaters approximately 100km to the southeast around Wamboin. The river flows northwest past Sutton, through Gundaroo and continues on to the township of Yass. It then flows through steep gorge country before entering 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) below 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 deposits resulting from reduced flows and the impounded waters of Lake Burrinjuck. The natural river bed is smothered by the sand creating wide shallow sections with little or no in-stream structure.

A large portion of this catchment is cleared grazing land and, as a result, has issues with 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 region with the Yass Area Network of Landcare Groups (YAN) playing a major role.







# **Yass Catchment Health Summary**

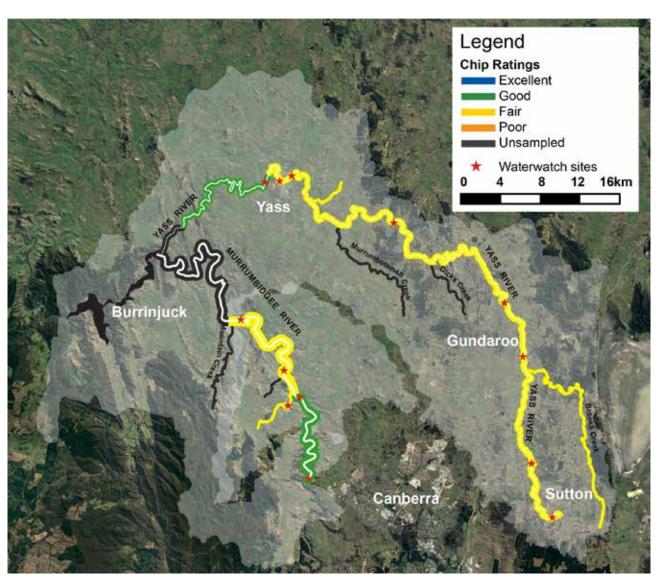
This is the seventh year that data has been collected in the Yass catchment - thanks to all the volunteer efforts. 2021 has been wet and mild, with the increased flows helping to maintain ecological processes and the integrity of the waterways.

Three reaches presented similar scores to last year, and three showed improvements with two of these jumping up from *fair* to *good*. The reaches in the *good* range saw an improvement in water quality readings (Murrumbidgee River at CMM12), and water quality and riparian condition (Yass River at YAS4). The fourth reach was the lower Murrumbidgee reach (CMM13) which improved slightly due to the waterbug score. This most likely resulted from the higher river levels engulfing the riparian zone and providing habitat for waterbugs.

Overall, the better flows helped to improve turbidity, nitrates, and electrical conductivity levels in the Yass catchment.

Following the 2020 bushfires, ash and sediment from fire affected areas were observed along the banks of the Murrumbidgee River all the way down to Burrinjuck Dam. The increased flows have seen much of the ash being flushed downstream. Last year Waterwatcher Fiona at Cavan Rd Crossing in CMM12 recorded very high turbidity levels, referring to the Murrumbidgee as the 'chocolate river'. Turbidity has now returned to *good* levels.

Water levels in the Murrumbidgee River were very high this year. During the Spring waterbug blitz, the Waterwatch team was not able to cross the Cavan Bridge (CMM100), as it was partially covered by flood waters. Also, at Taemas Bridge (CMM010), our volunteer has noted that he needed to take his water sample many metres above his usual site along the river.



# **Murrumbidgee River CMM12**

# Ginninderra Creek confluence to above Mullion Creek confluence

2021 CHIP Result B- (Good)								
2020 CHIP Result C+ (Fair)								
Parameter Rating No. Survey								
Water quality	Good	8						
рН	Excellent							
Turbidity	Good							
Total Phosphorus	Excellent							
Nitrate	Poor							
Electrical Conductivity	Good							
Dissolved Oxygen	Good							
Waterbug Fair 2								
Riparian condition	Fair	2						

#### **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 the confluence with Mullion Creek in Wallaroo.

The riparian condition varies considerably through this reach. The upper section contains some of the most intact remnant patches in the area with steep rough terrain providing refuge for native species. In contrast the lower section has many areas dominated by exotic weed species, which are surrounded by sheep farms. In a few notable places, private landowners are undertaking riparian vegetation replanting to improve streambank condition.

The most concerning parameter in this reach over the past few years is nitrate, where concentrations have reached up to 30 mg/L (degraded levels are >2.6 mg/L). The source of this is most likely the Lower Molonglo Water Quality Control Centre located upstream. The consistent flows in 2021 have improved water quality, especially for nitrates (0-7 mg/L) and electrical conductivity (120-270  $\mu$ S/cm) which both benefited from the high flows diluting concentrations.

Phosphorus returned to pre-fire levels after seeing extreme readings of 0.25mg/L in early 2020. Readings became slightly elevated in the second half of the year (0.02mg/L) when increased rainfall washed nutrients off the landscape. The ash from the bushfires has also reduced significantly along the river banks.





High flows on the Murrumbidgee River were covering Cavan Rd crossing (CMM100) in December 2021.

# **Murrumbidgee River CMM13**

# Mullion Creek confluence to Taemas Bridge above Burrinjuck Dam

2021 CHIP Result C (Fair)							
2020 CHIP Result C- (Fair)							
Parameter Rating No. Survey							
Water quality	Good	17					
рН	Excellent						
Turbidity	Good						
Total Phosphorus	Excellent						
Nitrate	Good						
Electrical Conductivity	Fair						
Dissolved Oxygen	Poor						
Waterbug	Poor	2					
Riparian condition	Poor	2					

### **Reach Facts**

Reach network length: approx. 20km

Dominant land uses: Rural

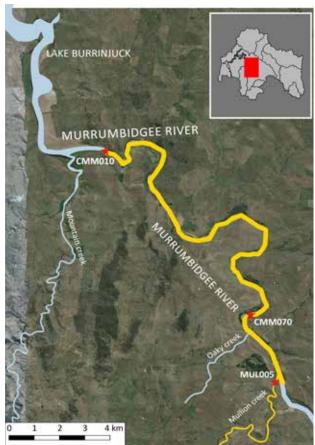
This reach is the most down

This reach is the most downstream of the 13 reaches on the Murrumbidgee River. The bottom site at Taemas Bridge is immediately upstream of the impounded waters of Lake Burrinjuck. Much of this catchment is cleared grazing land, with poor in-stream habitat and a narrow and degraded riparian zone. Stock have direct access to the river in many places, further impacting condition. These land use practices and the low flows resulting from the dam, have produced large 'sand slugs' (a large intrusion of sand within a river channel) around CMM010.

A new site (CMM070) was created this year in the middle section of this reach in order to create a more well-balanced picture of this section of the Murrumbidgee River.

This year our volunteer Richard noted the very high water level in Taemas bridge area (CMM010), where sampling took place within the trees near the bridge instead of the usual site a couple of metres down the river bank.

The overall CHIP score improved slightly this year, driven by a better waterbug result. The autumn survey only found four waterbug Orders with the water appearing turbid, little available habitat and brown filamentous algae present. By spring, however, the constant flows and higher water levels had provided more suitable conditions with mayflies and caddisflies forming part of the eight Orders detected.





# **Yass River YAS1**

# **Headwaters to Brooks Creek confluence, including Brooks Creek**

2021 CHIP Result C+ (Fair)								
2020 CHIP Result C+ (Fair)								
Parameter	Parameter Rating No. Survey							
Water quality	Good	19						
рН	Excellent							
Turbidity	Good							
Total Phosphorus	Good							
Nitrate	Excellent							
Electrical Conductivity	Poor							
Dissolved Oxygen	Degraded							
Waterbug	, i i							
Riparian condition	Poor	3						

#### **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. Although good ground cover is present throughout this reach, with the presence of tussock grasses, the overall amount of native vegetation is still limited.

In 2021, water levels were noted as medium to high during most of the volunteer's sampling events. This is unusual to this section of the Yass River, as mentioned by Waterwatcher Carol. During June and July, according to her notes, all the reeds in the centre of the river had been flattened, as well as the grasses along the edge of the river. Such regular flushes are important to maintain aquatic wildlife and plants in a healthy state.

Electrical conductivity, the salts and minerals present in the water, are often at degraded concentrations in the Yass River. This is partly due to historical land use and partly underlying geology. The increased flow in 2021 has improved this result slightly (a range of  $140-520\mu S/cm$ ) as the salt and minerals become more diluted.

A waterbug that is not often detected in the upper Murrumbidgee catchment but commonly found in the upper Yass River, is the scud (Amphipoda). Although similar to the terrestrial slater, scuds are aquatic and can swim quite well, often on their sides, giving them the other common name of 'sideswimmers'. Scuds are mostly detrivores, feeding on algae, organic material and decaying plant on the bottom of ponds and creeks.





# **Yass River YAS2**

# **Dicks Creek confluence to Manton Creek confluence**

2021 CHIP Result C+ (Fair)							
2020 CHIP Result C+ (Fair)							
Parameter Rating No. Survey							
Water quality	Good	11					
рН	Excellent						
Turbidity	Good						
Total Phosphorus	Good						
Nitrate	Excellent						
Electrical Conductivity	Poor						
Dissolved Oxygen	Degraded						
Waterbug	Fair	2					
Riparian condition	Fair	2					

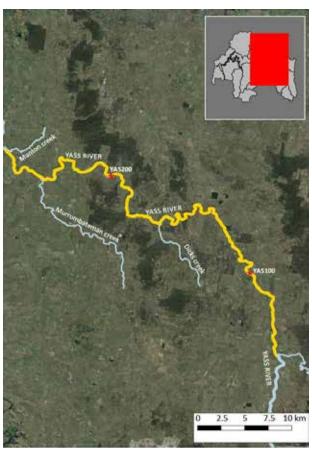
#### **Reach Facts**

Reach length: approx. 30km Dominant land uses: Rural

This mid-section of the Yass River contains the major tributaries of the Murrumbateman and Manton creeks. 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. Erosion and in-stream sedimentation, are issues in this reach, as is high electrical conductivity due to a combination of historical land use and geology.

A healthy and highly functional riparian corridor can be found at 'Goldenholm' (YAS200) with native canopy cover, midstorey and groundcover all present. Conversely Booth's Crossing (YAS100) has minimal canopy cover and depauperate groundcover, pulling the overall riparian score for the reach down to a *fair* rating.

In 2021, the increased rainfall across the catchment and higher flows on the Yass River were evident here. Water levels were noted as medium to high throughout the year. This diluted electrical conductivity readings, which generally ranged between 140 to  $630\mu\text{S/cm}$ . In April, however, following recent flooding and roadworks upstream Waterwatcher Kate noted some unusual readings at YAS200. Electrical conductivity peaked 1420 $\mu$ S/cm and phosphorus 0.07mg/L. It is possible the upstream disturbance mobilised phosphorus as well as salts and minerals from the landscape.





# Yass River YAS3 Yass township

2021 CHIP Result C- (Fair)							
2020 CHIP Result C- (Fair)							
Parameter Rating No. Survey							
Water quality	Good	10					
рН	Excellent						
Turbidity	Fair						
Phosphorus	Good						
Nitrate	Good						
Electrical Conductivity	Poor						
Dissolved Oxygen	Good						
Waterbug	Degraded	2					

**Poor** 

#### **Reach Facts**

**Riparian condition** 

Reach network length: approx. 10km Dominant land uses: Urban/Rural Fringe

This section of the Yass River includes the township of Yass. Flow is heavily influenced by Yass Dam located just above the town, as well as runoff from the surrounding urban landscape. There is ongoing habitat rehabilitation occurring in the Yass Gorge at the top of the reach. The township of Yass was named after Yarrh or Yharr, the word for running water in the Ngunnawal language.

The Yass Gorge (YAS350) is a heritage site and one of the most conserved sections of Yass River, with good representation of large, native trees, shrubs and lomandra shrubs. The Friends of Yass Gorge have been instrumental in restoring this landscape and controlling weeds.

The presence of in-stream vegetation in YAS370, such as native Ribbon weed, serves as habitat for waterbugs, fish and turtles. That said, there was low diversity of waterbugs recorded in 2021 with only six and five Orders detected in the two surveys. The waterbugs that were present were pollution-tolerant types, such as glass shrimp and water boatman. A carp gudgeon, a small native fish, was recorded in the spring sampling.

While nitrates in the Yass River mainstem were very low, consistently *degraded* levels (3-5mg/L) were present in Chinaman's Creek (YAS370). Waterwatcher Rebecca also mentions on a number of occasions that the creek here looks 'dark brown and murky'. On a better note, Rebecca observed a colony of Grey Headed Flying Foxes at her site during February and March.





# **Yass River YAS4**

# **Hattons Corner to Burrinjuck Dam**

2021 CHIP Result B- (Good)									
2020 CHIP Result C+ (Fair)									
Parameter Rating No. Survey									
Water quality	Good	4							
рН	Excellent								
Turbidity	Excellent								
Phosphorus	Excellent								
Nitrate	Degraded								
Electrical Conductivity	Poor								
Dissolved Oxygen	Excellent								
Waterbug	Waterbug Fair 2								
Riparian condition	Fair	1							

#### **Reach Facts**

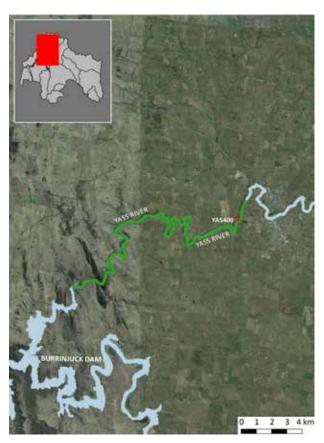
Reach network length: approx. 23km Dominant land uses: Rural Fringe

This downstream section of the Yass River runs through gorge country and farmlands before flowing into Lake Burrinjuck. This reach is marked by its scenic beauty and significant geological history. The Hume Limestone, which caps the escarpment above the River at Hattons Corner, is particularly rich in fossils. Habitat restoration projects are underway, led by landowners below the township. This should have a positive impact on the catchment health over the long term.

Despite the presence of reeds along the Yass River and some patches of native tree regeneration, generally, most of the riparian zone is lacking good canopy cover and shrubs. This is necessary to provide shade, erosion control, and habitat for birds and other fauna.

In 2021, however, there was an overall improvement for this reach and that was mainly attributed to an enhancement in the riparian vegetation score. An increase in native shrubs regeneration and fallen logs was recorded, which provides essential habitat for small vertebrates. The increased rainfall has possibly contributed to this positive regeneration score. Flood events have potentially also brought with them more logs on the higher flows.

This reach achieved the best waterbug score in the Yass River, with a total of twelve different Orders detected. Some waterbugs were observed for the first here, such as a water penny and a nematode.





# **Special Report**

# Data quality assurance to improve the assessment of catchment health

Rodney Ubrihien, former Citizen Science Data Analyst, ACT Government.

# **Background**

Upper Murrumbidgee Waterwatch (UMWW) is a citizen science that aims to report on the health of the Upper Murrumbidgee catchment. The objectives of UMWW include:

- Engaging the community in the environment through monitoring and caring for our catchments,
- Educating and raising awareness in schools and the community on issues concerning catchment health, and,
- Using data collected by volunteers to inform policy and on ground catchment management.

To meet these objectives it is essential that data are collected using appropriate methods and analysed and reported in an appropriate manner. A range of processes such as quality assurance/quality control days test the accuracy of the methods used and the volunteers' ability to collect water quality measurements that reflect catchment health. These processes ensure that the data used to produce the CHIP report are of the best possible quality for a citizen science catchment health program. As well as ensuring the quality of data, it is essential that the data analysis methods also produce results that are indicative of the health of the catchments. As a part of a continuous improvement program, the UMWW program regularly reviews the methods used, looking for areas where they can be improved to provide a more accurate assessment of catchment health.

The current framework used by UMWW for assessing catchment health was established in 2013 when a major review of the CHIP analysis was undertaken. This included an internal review as well as an external review conducted by the University of Canberra (Harrison et al., 2013). This review was conducted with the aim of assessing the existing program at that time and looking for ways to improve the program. A framework was developed that used the water quality, riparian condition and macroinvertebrate data collected by the UMWW program to report on catchment health. The overall framework is described in the appendices of the CHIP report. This report will focus purely on the data analysis method for the water quality data and the change that has been implemented to allow analysis to better reflect catchment condition.

#### **Current method**

The water quality assessment is based on the parameters dissolved oxygen, phosphorus, nitrate, turbidity, electrical conductivity, and pH data collected within each reach. For each of these parameters a score on a scale of 1-5 (excellent to degraded) is calculated for each reach. From a data analysis perspective this involves having an appropriate method of assessing the raw data for the parameter (for each parameter, for each reach, for each year) and calculating a score that is representative of the water quality. This may be viewed as determining what the average water quality for the reach was for the year, which from a statistical point of view involves a measure of central tendency. There are three common measures of central tendency used in data analysis:

Mean: the sum of all observations divided by the number of observations,

Mode: the most common observation in a dataset, and

Median: the middle number of a dataset when the numbers are arranged in order.

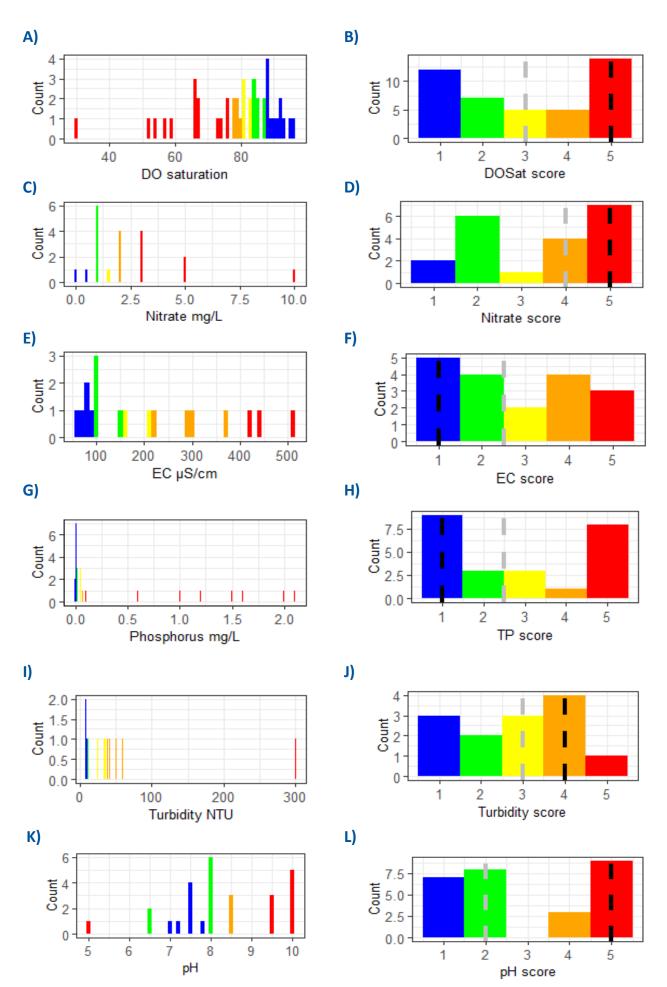


Figure 1. Results for water quality parameters. Raw data are displayed in figures A, C, G, I and K. Data transformed into scores based on CHIP parameter thresholds are displayed in figures B, D, F, H, J and L. Grey line refers to median and black line refers to mode in figures B, D, F, H, J and L.

The method of assessing central tendency can have a large effect on the outcome of analysis. When the framework for calculating CHIP scores was established in 2013, mode was established as the method to calculate central tendency for the water quality scores. This method was used based on a literature review and analysis of what other similar programs were using. Some of the analysis for the 2020 CHIP report uncovered some unexpected outcomes from the water quality calculations and led to questioning if mode was the best method for calculating the water quality score.

A review of the calculation of the water quality parameters was conducted which included testing different methods of calculating central tendency. As mean is not an appropriate statistical method for use on Waterwatch data, a comparison between the result of analysing the water quality data using mode and median was undertaken. The UMWW 2020 data was used to compare the methods. An example of the results from this comparison for each of the water quality parameters can be seen in Figure 1. It is noted that the examples chosen are from reaches where the median and mode were not aligned, however this was not the case for all reaches. Despite this, the examples show that using median rather than mode as a means of calculating central tendency produced results that were more representative results of the water quality in the catchment and that this can have a relatively large effect on the score for that parameter for the reach.

#### Results and discussion

In addition to the change to individual reaches examined in the examples above, it is important to consider the effect of changing from mode to median on all the scores for each of the parameters for all the reaches and the overall CHIP scores for the reaches. This will provide an indication of the extent of change that moving from mode to median will result in at a catchment assessment level. The effect of the change on the individual score can be seen in Table 1. The change from mode to median caused a change to 67 of the 98 of the reaches for the overall water quality score. The water quality score is combined with the macroinvertebrate score and the riparian vegetation score to calculate the final CHIP score. The change only led to small changes on the overall CHIP score in 17 of the 98 reaches (Table 2). These results show that the change from mode to median only has a small effect on the overall CHIP score. Despite this it is an important improvement to make the CHIP analysis more representative of catchment health.

Table 1 Summary of the changes in individual parameters and overall water quality score resulting from changing the assessment method from using mode to median. Number of reaches assessed was 98. Extent of change refers to the change in the individual parameter value (scale 1-5).

	Number of reaches changed	Extent of change – mean (min, max)
pH	4	0.8 (-3, 0.5)
Turbidity	24	1.25 (-1, 1.5)
Total phosphorus	23	0.9 (-1.5, 2)
Nitrates	10	0.9 (-1, 1)
Electrical conductivity	19	0.9 (-2, 1.5)
D. O. saturation	41	1.1 (-3, 2)
Water quality score	67	0.2 (-0.5, 0.41)

Table 2 List of reaches where the 2020 CHIP score would change because of altering the method of calculation for the water quality parameters from mode to median (a total of 98 reaches were assessed).

Reach	New score	Old score
CMM4	B-	В
NUM1	B-	C+
NUM3	В	B+
STR1	C+	С
GIN1	C+	С
MCW1	C+	B-
MFL1	C+	B-
MOL4	B-	C+
QUE3	C+	B-
CMM7	B-	В
CMM9	B-	C+
GUI1	С	C-
ORR1	B+	В
TUG1	B-	C+
TUG2	D+	D
CMM13	C-	С
YAS3	C-	D+

The result from changing this method is a small but important step to improving the methods used in the CHIP analysis to reflect catchment health. The difference in the overall CHIP scores resulting from the change in the water quality parameter calculation method from mode to median is modest in terms of overall CHIP result. Despite this, the importance of the change is in accurately representing the data for the individual parameters. When the CHIP report is produced, an important component is the individual reach report cards that include the results for individual parameters and a discussion of key findings for the year. To fully understand the water quality within the reaches and describe the key findings, it is critical that methods used for data analysis produce results that accurately reflect the data collected in the reach for the year. The use of mode can sometimes misrepresent this data as demonstrated by examples for each of the water quality parameters in Figure 1. The use of median rather than mode will lead to the results from the analysis being more representative of what is occurring in the catchments and therefore be more meaningful in assessing catchment health.

Through a robust quality assurance program with appropriate quality control methods and regular critical review of the program the UMWW looks to provide a rigorous and accurate assessment of catchment health in the Upper Murrumbidgee catchment. To maintain this quality, it is essential to continually look for opportunities to improve this assessment and the change of method from mode to median is an example of this.

# Frogwatch 2021 Highlights

# By Frogwatch Coordinator, Anke Maria Hoefer

The ACT and Region Frogwatch Program (Frogwatch) is run by the Ginninderra Catchment Group. Frogwatch has been engaging volunteers since 2002 to monitor, restore and protect local frog habitat, and to raise awareness and educate. The program covers the ACT and its surrounding NSW region from Cooma in the South to Gundaroo in the North and from the Cotter River in the West to Captains Flat in the East. Since 2020 Frogwatch and Waterwatch have adopted a more formal partnership to bring together these two highly successful citizen science programs and enable them both to better inform the management on our aquatic habitats and creatures within them.

2021 was by no means less challenging than 2020. Rain, rain and more rain meant that quite a few projects virtually went under and had to be deferred or cancelled altogether. Covid-19 was vibrant and unpredictable as we know it. Group activities remained a no-no, and a full-blown lockdown put an end to the annual October FrogCensus as we knew it. Sounds disastrous for a small citizen science project, but luckily Frogwatch has a good track record when it comes to facing adverse conditions.



Frogwatchers in action at Blundells Flat in the Brindabella Ranges.

# **Frogwatch Census**

When training new volunteers was a no-go zone, the chance of a successful FrogCensus seemed doomed. Unless... Frogwatchers from previous years could be mobilised to stepping up to the massive task. And so, our experienced volunteers did what was thought to be impossible- they pulled off the most comprehensive FrogCensus in Frogwatch's 20 years history!

78 survey teams of between two and six citizen scientists joined forces for the big frog hunt in the name of Frogwatch. Thanks to their unbelievable efforts 224 out of the active 228 Frogwatch sites were monitored-which is a whopping 98.3%!! The vast majority of sites was visited twice in October, with some sites getting as many as six visits. More details can be found in the annual Frogwatch Census Report.

Covid safe monitoring practices in action Photo by Isabella Shaw



### Frog dying events

The record-breaking uptake of frog-surveillance activities might have had something to do with a general love for frogs spiced up by Covid-boredom. However, alarming reports of frog mass dying events along the East coast, which started to emerge from mid-year, might also have contributed to the strong urge "to do something about it". Thanks to the keen eyes and ears of our Frogwatchers we could confirm that ACT frogs were seemingly doing ok. Only a small number of individual dead frogs were observed, which may have been caused by natural attrition.



Tadpole collage. Photo: Lyn Yates

### Frogs and Turtles team up

Chasing frogs at night and turtles during the day- can it get any better? Frogs and turtles are fascinating creatures, share the same habitats and are well loved by the public. The glorious Frogwatch-Waterwatch team, Anke Maria and Bruno, supported by so many extremely dedicated volunteers, researched how urbanisation effects the distribution and survival of frogs and turtles in the ACT (2020-21, funded through Community Environment Program Grants: Fenner and Canberra). Based on very interesting initial findings, this project has been continued to further investigate turtle nesting behaviour and expand turtle nest protection (ACT Environment Grant Nesting in the City) and to expand the data collection on turtle population structure, and the persistence and functionality of urban aquatic and terrestrial wildlife corridors (ACT Government funded).

# **Tadpole Kits**

With the ACT lockdown extending into Term 4 of the school year, online learning was the real deal. The Tadpole Kits for Schools program (funded by Icon Water) was quickly rejigged to allow teachers to get their hands onto some tadpoles either at the start of term 4, halfway through the term or in term 1/2022, depending on their classroom settings and school specific Covid policies! This turned the office into a busy tadpole nursery, to make sure that no student would miss out observing the amazing transformation of tiny vegetarian aquatic tadpoles into meat-eating land-lobbing frogs.

### Fogs From The Ashes - Landcare Bushfire Recovery Grant

In January 2020, the Orroral Valley fire burnt 80% of Namadgi National Park (82,700 hectares), including extensive frog habitat. To understand the current status of frogs in fire affected areas in comparison to historical frog observations Frogwatch set up twelve remote long-term frog survey sites in the Cotter Hut region (2), Orroral Valley (2), Mount Clear area (4), along Naas Fire Trail (2) and Bogong Creek area (2). Volunteer interest for this project has been very strong throughout but had to be scaled back due to Covid concerns and various road closures. So far, no monitoring has been missed thanks to extraordinary efforts to reach the survey sites by kamikaze car trips, epic mountain bike rides or long walks, interspersed with sleeping in old huts or under the stars.

# **Volunteer list**

# Cooma

Jim Wharton

Mark Shubert

Mark Kent

Melinda Kent

**Scott Conroy** 

**David Harkins** 

Maria Linkenbagh

Mike Mannile

**Edel Stephans** 

**Erich Stephans** 

Anne Henkel

Kerryn Milligan

**Phil Irons** 

Mick Castles

**Alistair Bestow** 

Rita Brademann

Sarah Stonnill

Gill Robinson

**Tony Robinson** 

Alison Fleming

Phil Thurbon

**George Downes** 

Julee Harden

Tim Scrace

Quentin Moran

**Robert Jenkins** 

Louise Jenkins

Mary Ziesack

Kathryn McMahon

Brian McMahon

**Sharon Schulz** 

Kelly Ophel

Richard Dromgold



# **Ginninderra**

Lesley Harland

John FitzGerald

**Gregg Berry** 

Johanna Wallner

Samantha Burn

Julia Boyd

Luke Wensing

Jim Grenfell

Charley-Maree Baum

**David Fitzsimmons** 

Mike Bassanelli

**Bruce Cowell** 

Fleur Leary

Ana Maria Londono

**Connor Skeels** 

Angela Kaplish

Jennifer Grant

Elizabeth Kretschmer Scouts ACT - Environment

team

Nicole Sergent

Louis Tucker

Chris Heazlewood

Liz White

Ann Harvey

**Trevor Harvey** 

Rod Ubrihien

**Grant Warner** 

Susan Pettersson

Ross Pettersson

Ange Callis

Tyson Powell

Rachel Eland

**Bridie Noble** 

Diana Race

# Molonglo

Angela Braniff

Anna van Dugteren

**Bethany Reczek** 

**Chad Burton** 

**David Bromhead** 

Des Cannon

Elvira Currie, Meisha and Tristan

Fernando Villegas

Fraser Argue

Gail Neumann

Glenn & Colleen McMahon

Janelle Friend

John Bissett

John Hyam

John Moore

Joselhin Medina

Joshua Hindson

Karen Khoo

Kat Vincent

Kerry Smith

Louise Amos

Lyn Grigg

Maree Latimer

Melissa Varty

Michael Burton

Michael Moore

Mike Sim

Miranda Gardner

**Nick Loades** 

Peter Abbott

Peter Robertson

Deb Shaw

Philippa Russell Brown

Rachel Eland

Tyson Powell

**Ross Taylor** 

Rosanna Shamshudin

Sandy Lloyd

Sarah Essex

**Shelley Owen** 

Sue Gibson

Terry Moore

Tony Patis

. .

Wendy & Steve Hodgman

Woo O'Reilly

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Sue Sutton)

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Friends of Stranger Pond (Colin Carpenter)

Friends of Tidbinbilla Parkcare group

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Icon Water (Kate Rhook)

Paddy's River Waterwatch group (Maree Blume & Jill

Smith)

Parkcarers of Southern Murrumbidgee(P.O.S.M)

(Deb Kellock)

'Sands' Waterwatch group (Wendy Rainbird & Anne

l'Ons)

Southwell Scout Group Venturers

Tidbinbilla Sanctuary Volunteer Assist Program

Uriarra Parkcare group (Barbara Mackin)

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Rebecca Widdows Rachel Eland

Carol Boughton Bridie Noble

Clive Boughton Shaun Young



# **Glossary**

**Baseline monitoring:** The collection of data prior to a planned intervention/project

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 north America also known as Mosquito fish

**Electrical conductivity:** A measurement of the total combined salts/minerals in 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 dieoff 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 intense 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

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 in the CHIP

Rakali: Indigenous name for the native Water-rat

**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:** Water that flows into a waterway after rain from through the urban stormwater system

**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)

mg/L: Milligrams per Litre

μS: MicroSiemens

NTU: Nephelometric Turbidity Units

N: Nitrogen

QAQC: Quality Assurance, Quality Control RARC: Rapid Appraisal of Riparian Condition

TSR: Travelling Stock Reserve

UMDR: Upper Murrumbidgee Demonstration Reach

# **Appendix I**

# Cooma region CHIP scores by parameter

Reach	pН	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BAD1	1	1	1	1	1	3.5	1.42	1	2.5	1.64	A
BAD2	1	1	1	1	1	4	1.5	2	3	2.17	B+
BRD1	1	1	2	2	2	2	1.67	1.5	3	2.06	B+
BRD2	1		2	1	2	5	2	3	4	3	C+
CMM1	2	1	1	1	1	1	1.17	2	4	2.39	В
CMM2	1	1	1	1	1	1	1	1	4	2	B+
СММЗ	1	1	1	1	1	2	1.17	3	2.5	2.22	B+
CMM4	2	1	1	1	1	1	1.17	2.5	4	2.56	В
CMM5	1	1	2	2	1	1	1.33	4	4	3.11	C+
CMM6	1	2	1	1	2	4	1.83	3	2.5	2.44	В
COB1	1	1	4	1	5	5	2.83	3	4	3.28	C+
COO1	2	1.5	5	2	5	5	3.42	4	4	3.81	C-
COO2	1	1	5	2	5	5	3.17	2.5	4.5	3.39	С
COO3	1	1	5	1	5	5	3	3	4	3.33	C+
GUD1	1	1	1	1	5	3	2	1.5	4	2.5	В
KYB1	1	1	2	1	2	4	1.83	1.5	4	2.44	В
MIC1	1	1	1	1	4	5	2.17	3	4	3.06	C+
NUM1	1	1	1	1	2	3	1.5	2	4	2.5	В
NUM2	1	1	2	1	2	2.5	1.58	1	3	1.86	<b>A</b> -
NUM3	1	1	1	1	1.5	2	1.25	2	3	2.08	B+
NUM4	1	1	2	1	2	2.5	1.58	2	3.5	2.36	В
ROC1	1	1	2	1	5	3	2.17	3		3.39	С
STR1	1	1	2	1	2	2	1.5	2	4	2.5	В
				. (=)		4-1		101			
	Excell	ent (A)	Good	1 (B)	Fair	(C)	Poo	r (D)	Degrad	ded (E)	

# Molonglo region CHIP scores by parameter

Reach	pН	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BUR1	1	1	1	1	4	5	2.17	2.5	4	2.89	B-
DIC1	1	3	1	1	2	4	2	4	3	3	C+
JER1	1	1.5	1	2	4	5	2.42	2.5	3	2.64	В
JER2	1	3	2	1	4	4	2.5	3	4	3.17	C+
LYN1	2	3	2	2	3	5	2.83	4	4	3.61	С
MOL1	1	1	1	1	1	5	1.67	2	4	2.56	В
MOL2	1	1	1	1	2	5	1.83	2	1	1.61	Α
MOL3	1	1	2	1	3	5	2.17	2.5	4	2.89	B-
MOL4	1	1	2	1	3	3	1.83	2	3	2.28	B+
MOL5	1	2	2	2	3	5	2.5	3	4	3.17	C+
MOL6	1	3	2	1	3	1	1.83	3	3	2.61	В
MOL7	1	2.5	2	5	4	2	2.75	4	3	3.25	C+
PRI1	1	1	1	2	4.5	5	2.42	3	4.5	3.31	C+
QUE1	1	1	2	1	1	5	1.83	2	3	2.28	B+
QUE2	1	1	1	1	4	2	1.67	2.5	3	2.39	В
QUE3	1	1	2	1	3	2	1.67	2.5	4	2.72	B-
SUL1	1	2	2	5	4	4	3	3	4	3.33	C+
SUL3	1	3	3	4	4	5	3.33	3	4	3.44	С
SUW1	1.5	2.5	2	3	2	5	2.67	5	3	3.56	С
SUW2	1	3	2	2	2	5	2.5	4	3	3.17	C+
WAT1	1	1	1	1	2	5	1.83	4	4	3.28	C+
WES1	1	1	4	4	4	4.5	3.08	3	4	3.36	С
W001	1	1.5	2	1	4.5	5	2.5	3	4	3.17	C+
YAN1	1	1	1	1	1.5	3.5	1.5	2.5	2.5	2.17	B+
YAR1	1	2	1	1	4	5	2.33	3	4	3.11	C+
	Excelle	ent (A)	Good	i (B)	Fair	(C)	Poor	r (D)	Degrad	led (E)	

# **Ginninderra region CHIP scores by parameter**

Reach	pН	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
CMM11	1	1	2	2	2	2.5	1.75	2.5	4	2.75	B-
GDC1	1	2	1	1	3.5	3.5	2	3	4	3	C+
GIN1	1	2	1	2	4	2.5	2.08	3	4	3.03	C+
GIN2	1	1	1	2	4	4	2.17	4	4	3.39	С
GIN3	1	1	1	1	4	5	2.17	4	4	3.39	С
GIN4	1	2	2	2	4	4	2.5	3	4	3.17	C+
GIN5	1	1	2	2	4	3	2.17	4	4.5	3.56	С
GIN6	1	1	1	2	4	2	1.83	4	3	2.94	B-
GOO1	1	1	2	2	5	5	2.67	3	4.5	3.39	С
GUN1	1	1	2.5	1	5	4	2.42	3	4	3.14	C+
GUN2	1	1	1	2	4	4	2.17	4	4	3.39	С
KIP1	1	2.5	4	3.5	4.5	3.5	3.17	3	4	3.39	С
MCW1	1	1	2	2	3	5	2.33	3	4	3.11	C+
MFL1	1.5	2	2.5	1	1	5	2.17	3	3.5	2.89	B-
YER1	1	1	1	2	4	4	2.17	3	4	3.06	C+
	Excelle	ent (A)	Good	d (B)	Fair	(C)	Poo	r (D)	Degrad	ded (E)	

# **Southern region CHIP scores by parameter**

Reach	pН	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BOG1	2	-	2	1	1	4.5	_	2		2.31	B+
CGG1	1	1	2	1	2	2	1.5			2.83	B-
CMM10	1	3	1	1	2	4	2	2.5	3.5	2.67	В
CMM7	1	1	2	1	2	1.5	1.42	3	3.5	2.64	В
CMM8	1	1.5	2	1	2	1	1.42	3	4	2.81	B-
CMM9	1	1	2	2	2	2	1.67	3	3	2.56	В
COT1	2	1	1	2	1	3	1.67	3	3	2.56	В
COT2	2	1	1	1	1	2	1.33	2.5	2	1.94	A-
сотз	1	1	1	2	1	3	1.5	4	3	2.83	B-
GIB1	1	1	1	1	1	2	1.17	2	1	1.39	A
GUI1	1	1	2	2	5	5	2.67	2.5	4	3.06	C+
HOS1	1	1	2	1	2	3	1.67	1	3	1.89	A-
ISA1	1	2	2	5	4	3	2.83	3	4	3.28	C+
MMB1	1	1	1	1	4	5	2.17	3	3	2.72	B-
MPG1	1	3	2	2	3	4	2.5	4	4	3.5	С
MSP1	1	1	1	2	3	3	1.83	4	3.5	3.11	C+
NAA1	1	1	4	1	2	1.5	1.75	2	2	1.92	A-
NAA2	1	1	2.5	2	2	2.5	1.83	2	3.5	2.44	В
ORR1	1	1	1	2	1.5	3.5	1.67	3	2	2.22	B+
PAD1	1	4	1.5	2	1	3	2.08	3.5	4	3.19	C+
RAN1	4	2	4	1	2	5	3	4	4	3.67	С
TID1	1	1	1	1	1	3	1.33	3	2	2.11	B+
TLT1	2	2	3	2	3	4	2.67	3	4	3.22	C+
TLT2	1	2	1	5	3	5	2.83	5	5	4.28	D+
TUG1	1	1	2	1	3	2	1.67	1.5	4	2.39	В
TUG2	2	2	2	5	4	4	3.17	5	5	4.39	D
TUG3	1	2	3	2	3	2	2.17	3	3	2.72	B-
	Excelle	ent (A)	Good	d (B)	Fair	(C)	Poo	r (D)	Degrad	ded (E)	

# Yass region CHIP scores by parameter

	ass region of in scores by parameter										
Reach	рН	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
CMM12	1	2	1	4	2.5	2.5	2.17	3	3.5	2.89	B-
CMM13	1	2	1.5	2	3	4	2.25	4	4	3.42	С
YAS1	1	2	2	1	4	5	2.5	3	4	3.17	C+
YAS2	1	2	2	1	4	5	2.5	3	3.5	3	C+
YAS3	1	3	2	2	4	2.5	2.42	5	4	3.81	C-
YAS4	1	1	1	5	4	1	2.17	3	3	2.72	B-
	Excellent (A)		Goo	d (B)	Fair	(C)	Poo	r (D)	Degrad	ded (E)	

# **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. Multiple complex calculations are involved in producing the CHIP, and numerous catchment groups around Australia produce similar (albeit slightly different) CHIPs. Specific details regarding these CHIPs are not generally forthcoming and so this document aims to clearly outline the underlying philosophy and methodology regarding the Waterwatch CHIP reports.

### **Multiple Types of Data**

Waterwatch volunteers and coordinators collect data relating to water quality, macroinvertebrate 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 coordinators also collect aquatic macroinvertebrate 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 coordinators 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 parameters are combined into the CHIP. Finally, additional data regarding algae abundance, river flow and height, diversity and frog abundance and Platypus abundance are used to provide context regarding catchment health. These, however, 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 elsewhere (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 coordinators, that are included in the CHIP.

	Parameter	Frequency	Number of sites
Water Quality	рН	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
Macroinvertebrates	SIGNAL 2.0	Biannual (Spring & Autumn)	Key sites (min 1/reach)
Riparian Condition	RARC	Biennial	All sites

#### **Macroinvertebrates**

Aquatic fauna (and flora) are ideal indicators of catchment health, as they are entirely dependent on the waterway for their existence. Aquatic macroinvertebrates 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 macroinvertebrate assemblages (eg. AUSRIVAS, SIGNAL, ALT) and are similar in many respects. Waterwatch uses SIGNAL 2.0, with macroinvertebrate 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 based on the diversity of macroinvertebrates found at a site. We have included an additional criteria 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 (Water Quality, Waterbugs and RARC). This number is transformed into an index score (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.

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 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, Macroinvertebrate and RARC Data**

Using the scores calculated for water quality, macroinvertebrates and RARC assessments, these values are averaged for each site. Currently, water quality, macroinvertebrates 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 by 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**

### **Background**

As part of the continual process of improving the rigour and transparency behind the calculation of CHIP scores, Waterwatch re-evaluated the process regarding how macroinvertebrate survey data contributes to producing final reach scores.

Throughout the 2013-2014 and 2014-2015 CHIP reports, macroinvertebrate 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 macroinvertebrate sensitivities and and abundance, as defined by SIGNAL 2.0 (Chessman 2003).

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

Macroinvertebrate 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  $\leq$  5.5 and  $\leq$  7 taxa would result in a CHIP score of *Poor*.

Unfortunately, this did not fit well with our five 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 macroinvertebrates.

# Adjusting the score to 5 levels

To make the adjustment to a 5-level scoring system for macroinvertebrates, Waterwatch incorporated an additional criteria to the computation of the CHIP score for each macroinvertebrate 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 waterbugs – 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 previous two CHIPs, 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 has on the CHIP report is providing greater differentiation between *Good*, *Fair* and *Poor* reaches. Furthermore, is now 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 macroinvertebrate 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 (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 all reports following the 2015-2016 CHIP, Waterwatch has used the new macroinvertebrate scoring methodology.

# References

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

Marchant, R., Barmuta, LA., and Chessman, B. (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 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	
рН	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/cm)	<= 65	<= 200	<= 350	<= 400	> 400	
Turbidity (NTU)	<= 10	<= 12.5	<= 15	<= 20	> 20	
Dissolved oxygen (mg/L)	(Not included in CHIP)					
Dissolved oxygen saturation (%)	95 – 105	85 <b>–</b> 95 or 105 <b>–</b> 110	75 <b>–</b> 85	65 – 75 or 115 – 120	< 65 or > 120	
Phosphorus (mg/L)	< 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 were 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 Waterwatch treated them as based upon expert knowledge.

For the 2014–2015 CHIP report, Waterwatch aimed to develop a new set of thresholds based upon water quality data collected in the ACT region. The key issues in developing these thresholds are outlines below.

### 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 data 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 macroinvertebrate 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 Waterwatch 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*) percentile. 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.

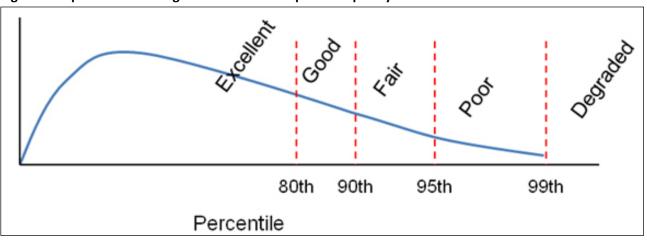


Figure 2. Depiction of defining thresholds based upon a frequency distribution of data.

## 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 could 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 2).

Table 2. 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 Reservior site 7	1994-2015	TN, TP
Corin Reservior 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. Waterwatch chose to combine data from the Cotter River and Goodradigbee River to produce electrical conductivity thresholds for the CHIP as this will better reflect the apparent naturally higher electrical conductivity readings from other areas in the catchment such as the Molonglo and Ginninderra.

#### **Current thresholds**

Table 3 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 3: Water quality CHIP thresholds.

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Parameter	Excellent	Good	Fair	Poor	Degraded
	66.70	6.1 – 6.5,	5.7 – 6.0,	5.4 – 5.6,	54.06
рН	6.6 – 7.8	7.9 - 8.0	8.1 – 8.2	8.3 – 8.6	< 5.4, > 8.6
EC (μS/cm)	≤ 98	99 – 156	157 – 212	213 – 404	> 404
Turbidity (NTU)	≤ 10	11 – 16	17 – 36	37 – 90	> 90
DO (mg/L)		(N	ot included in CH	IP)	
DO 5-+ (0/)	00 00	04 07 100	81 – 83,	78 – 80,	.70 <b>.</b> 11E
DO Sat. (%)	88 – 99	84 – 87, 100	101 – 106	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'.

