Lachlan valley annual surface water quality report: 2022–2023

Key Points

- Flow during July 2022 to June 2023 was characterised by heavy rain falling across much of the catchment. This rain resulted in several large flow events.
- The heavy rains led to substantial increases in water storage levels.
- A fish kill at Jemalong Creek in December 2022 was attributed to low dissolved oxygen, likely caused by Jemalong weir pool causing low dissolved oxygen floodwater to back up in Jemalong Creek.
- Flooding was the main driver of water quality in the Lachlan catchment. The water quality index indicated of the 10 sites in the catchment, one was rated as good, 8 as moderate and one as poor. Compared to the 2021–2022 results, the water quality index score improved at one site and 2 sites declined.
- The Lachlan River at Forbes exceeded the Basin Plan agriculture and irrigation salinity target of 833 µS/cm (microSiemens per centimetre). The Lachlan River at Forbes also exceeded the End-of-Valley salinity targets of 460 µS/cm (for the median) and 693 µS/cm (for the 80th percentile).
- Wyangala Dam, Carcoar Dam, and Lake Brewster received the majority of red alerts for blue-green algae blooms in 2022–2023. Upgrades to the embankments at Lake Cargelligo saw water drawn to Lake Brewster, resulting in low numbers of red alerts for recreational use.

The water quality data used in this report is collected on a monthly frequency at 10 sites in the Lachlan valley for the State Water Quality Assessment and Monitoring Program. The program is responsible for collecting, analysing and reporting the ambient water quality condition of rivers in NSW. This annual report summarises the surface water quality data collected in the Lachlan Valley from July 2022 to June 2023. The location of monitoring sites is shown in Figure 1.

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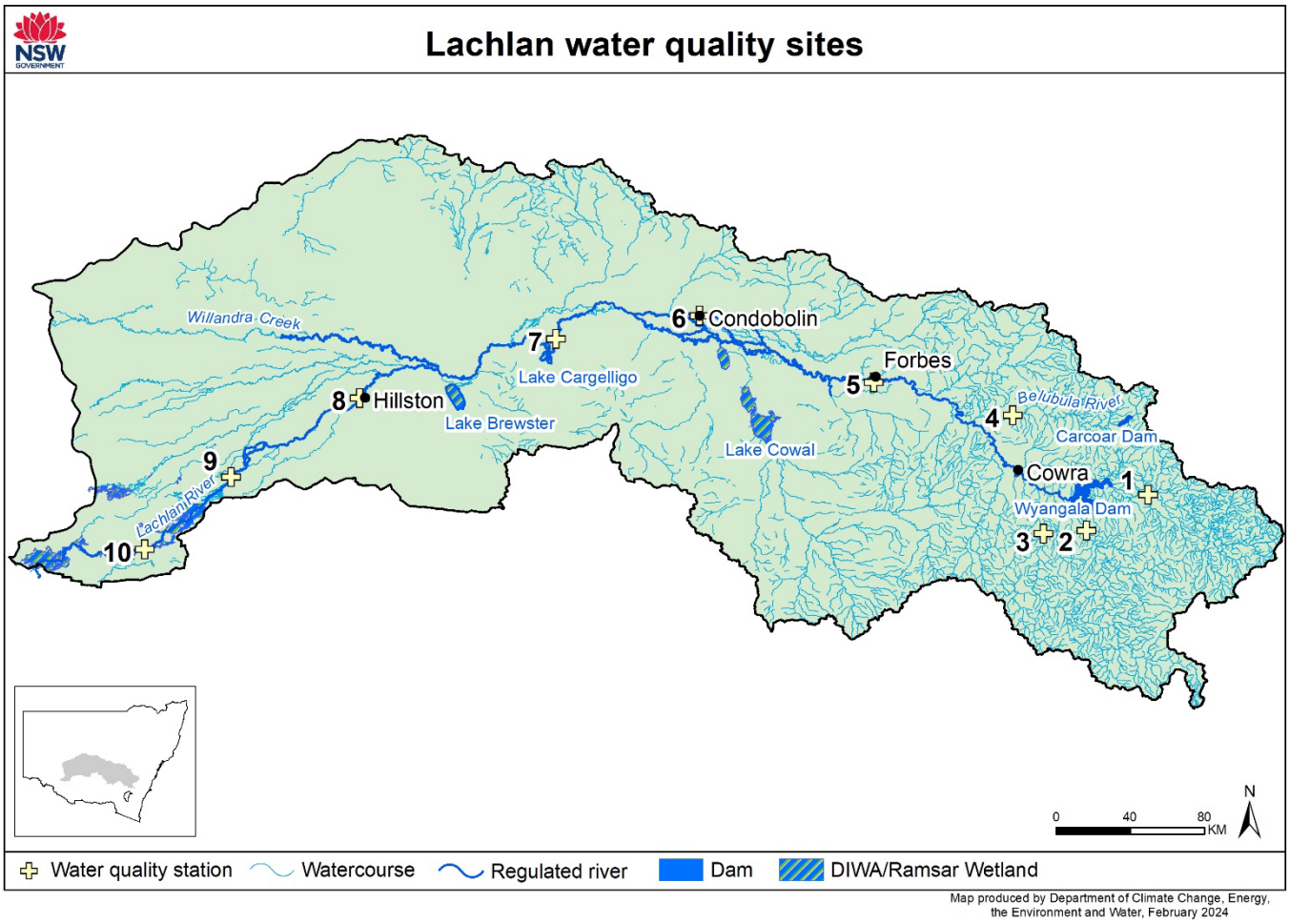

Figure 1: Location of routine water quality monitoring sites in the Lachlan valley

Table 1: Site information for each monitoring site in the Lachlan River catchment. Refer to Figure 1 and site numbers for location of each site.

Site number	Site name	Water Quality Zone	Station number
1	Abercrombie River at Camping Area	Lachlan Montane	41210123
2	Lachlan River at Reids Flat	Lachlan Unregulated uplands	412027
3	Boorowa River at Prossers Crossing	Lachlan Unregulated uplands	412029
4	Belubula River at Canowindra	Lachlan Regulated uplands	412009
5	Lachlan River at Forbes	Lachlan Regulated uplands	412004
6	Lachlan River at Condobolin	Lachlan Lowland	412006
7	Lachlan River at Lake Cargelligo Weir	Lachlan Lowland	412011
8	Lachlan River at Hillston	Lachlan Lowland	412039
9	Lachlan River at Booligal	Lachlan Lowland	412005
10	Lachlan River at Corrong	Lachlan Lowland	412045

Catchment description

The Lachlan River is located in central western NSW and covers an approximate area of 90,000 km^2. The Lachlan River is a terminal river that rises near Lake George in the Central Tablelands and ends 1,400 kilometres to the west in the Great Cumbung Swamp near Oxley. Only during times of very high floods do river flows reach the Murrumbidgee River.

The Lachlan River catchment is made up of several main tributaries including the Abercrombie River, the Boorowa River, the Belubula regulated river, the Crookwell River and Western Bland Creek. The Lachlan River for the main part is regulated. Wyangala Dam is a large storage located on the Lachlan River with the smaller Carcoar Dam located on the Belubula River. A number of natural lakes have also been modified for use as storages, the largest of these being Lake Cargelligo and Lake Brewster. The Lachlan River diverges into a number of effluent creeks (including Willandra, Merrowie and Middle Creeks) at the downstream end of the catchment. These creeks are not regulated unlike the main branch of the river. Major instream structures within the unregulated part of the Lachlan River catchment include:

- Lake Rowlands (3,150 ML) currently used for town water supply purposes
- Water Supply Dam on Kentgrove Creek (400 ML) used for town water supply purposes
- Darbys Weir
- Boorowa Weir.

The Lachlan catchment has a number of natural features listed as being of national importance. This includes 9 nationally important wetlands:

- Booligal Wetlands
- Murrumbidgil Swamp/Lake Merrimajeel
- Cuba Dam
- Merrowie Creek
- Great Cumbung Swamp
- Lachlan Swamp
- Lake Brewster
- Lower Mirrool Creek Floodplain
- Lake Cowal/Wilbertroy wetlands.

Land use in the Lachlan valley is largely grazing in the upper catchment with dryland cropping mainly occurring downstream of Wyangala Dam and through the middle reaches of the catchment where moderate winter rainfalls occur (DoIW 2016, 2018).

Catchment conditions during 2022–2023

Flow during 2022–2023 was characterised by continued heavy rainfall in 2022 with the heaviest falls in October and November resulting in extensive flooding across the Lachlan catchment (Figure 2A). Rainfall figures were much lower in 2023. Throughout 2022–2023 Carcoar and Wyangala dams remained near full capacity (Figure 2B). From July to November 2022 the cumulative inflow to Wyangala Dam was over 1,600,000 ML. In November 2022, Lake Cargelligo filled to over 180% capacity. Discharge in the Lachlan River at Reids Flat peaked above 99,000 megalitres per day (ML/day) on 1 November 2022 (Figure 2C). Similarly, discharge at Forbes peaked around 100,000 ML/day on 17 November. Other large flow events (over 25,000 ML/day) occurred in the Lachlan River at Reids Flat and Forbes between July and December 2022. Discharge at Booligal was consistent throughout the year due to water spreading across the floodplains of the lower Lachlan valley, peaking at 5,674 ML/day on 15 November 2022.

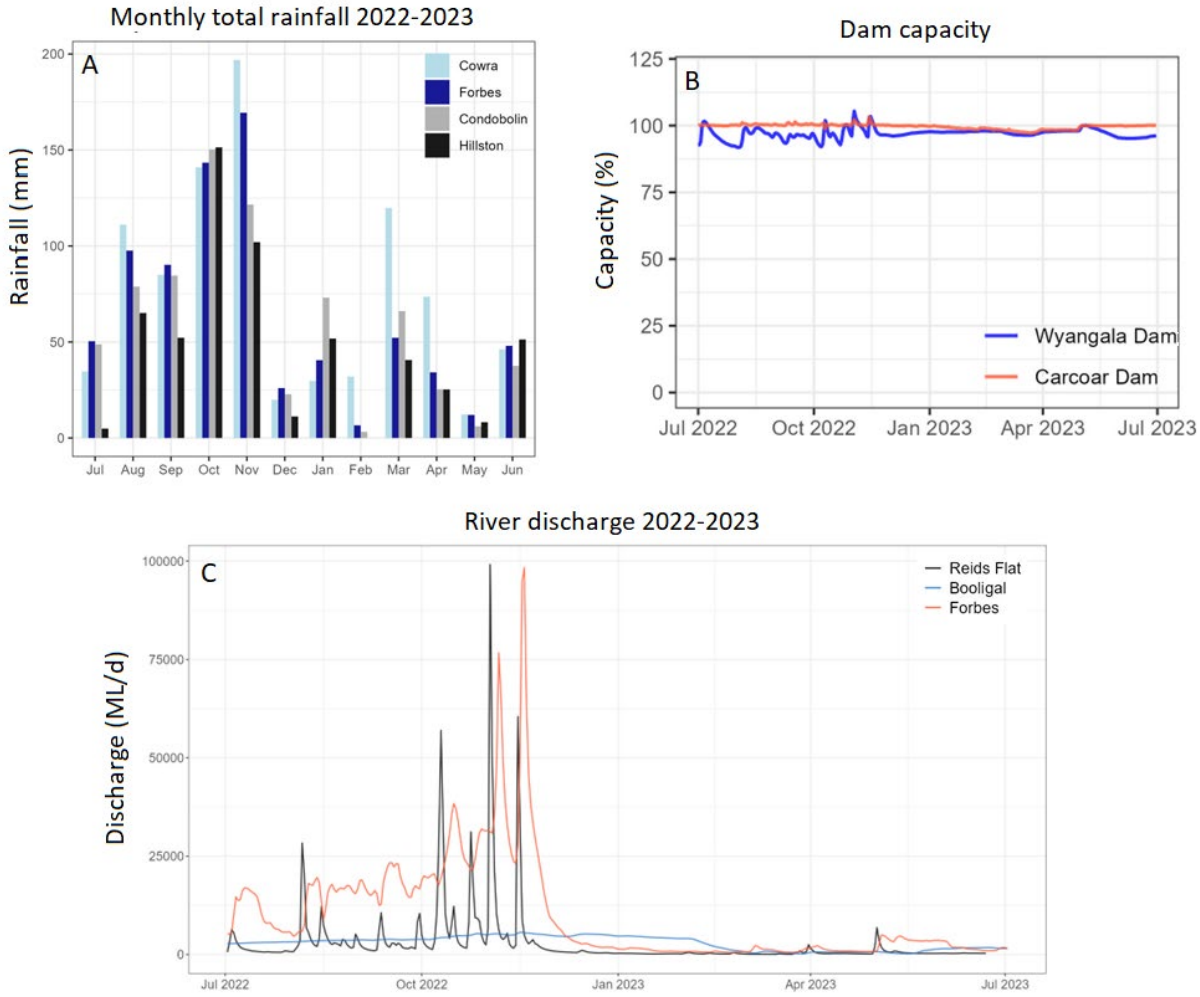

Figure 2: Catchment conditions for selected stations in the Lachlan catchment from July 2022 to June 2023. A: Monthly total rainfall (mm) B: Dam capacity (%) and C: River discharge (ML/day).

Water quality for water dependent ecosystems

NSW uses a Water Quality Index (WaQI) as a tool to communicate complex and technical water quality data in a simple and consistent way. The WaQI score was calculated for each monitoring site using total nitrogen, total phosphorus, turbidity, pH, dissolved oxygen and electrical conductivity. The index compares the monthly water quality results against a set of predetermined water quality targets to calculate a score between 1 and 100. A score of 100 represents a site in pristine condition, while a score of one is a very highly degraded site. This value can then be categorised to rate the general water quality at a monitoring site. The results from the WaQI are summarised in Figure 3. Sites where there has been a change of less than 5 points in WaQI score, have been identified with horizontal arrows. Arrows pointing up or down indicate the score has increased/decreased by more than 5 points.

The water quality index category ratings in the Lachlan Valley improved in 2022–2023 for one of the 10 sites while one site declined compared to 2021–2022. The ratings remained the same for the other 8 sites.

- The Lachlan River at Reids Flat improved from moderate to good.
- The Lachlan River at Booligal declined from good to moderate.
- The Lachlan River at Forbes remained poor.
- The 7 remaining sites listed in Table 1 remained moderate.

The high index score at Reids Flat was due to lower total phosphorus and pH levels remaining within their water quality targets.

The low index score at Forbes was due to high turbidity and nutrient concentrations detected during extensive flooding and high flows.

The index scores for the Lachlan River at Condobolin, Hillston Weir, Booligal and Corrong declined with high electrical conductivity being the main factor. After flood waters had receded, electrical conductivity began increasing as shallow saline groundwater and inflows from naturally saline tributaries discharged into the Lachlan River. The Lachlan water quality allowance was utilised to dilute rising electrical conductivity in the Lachlan River at Cowra until the end of June 2023. There is insufficient volume available in the water quality allowance to provide dilution flows to the lower Lachlan valley.

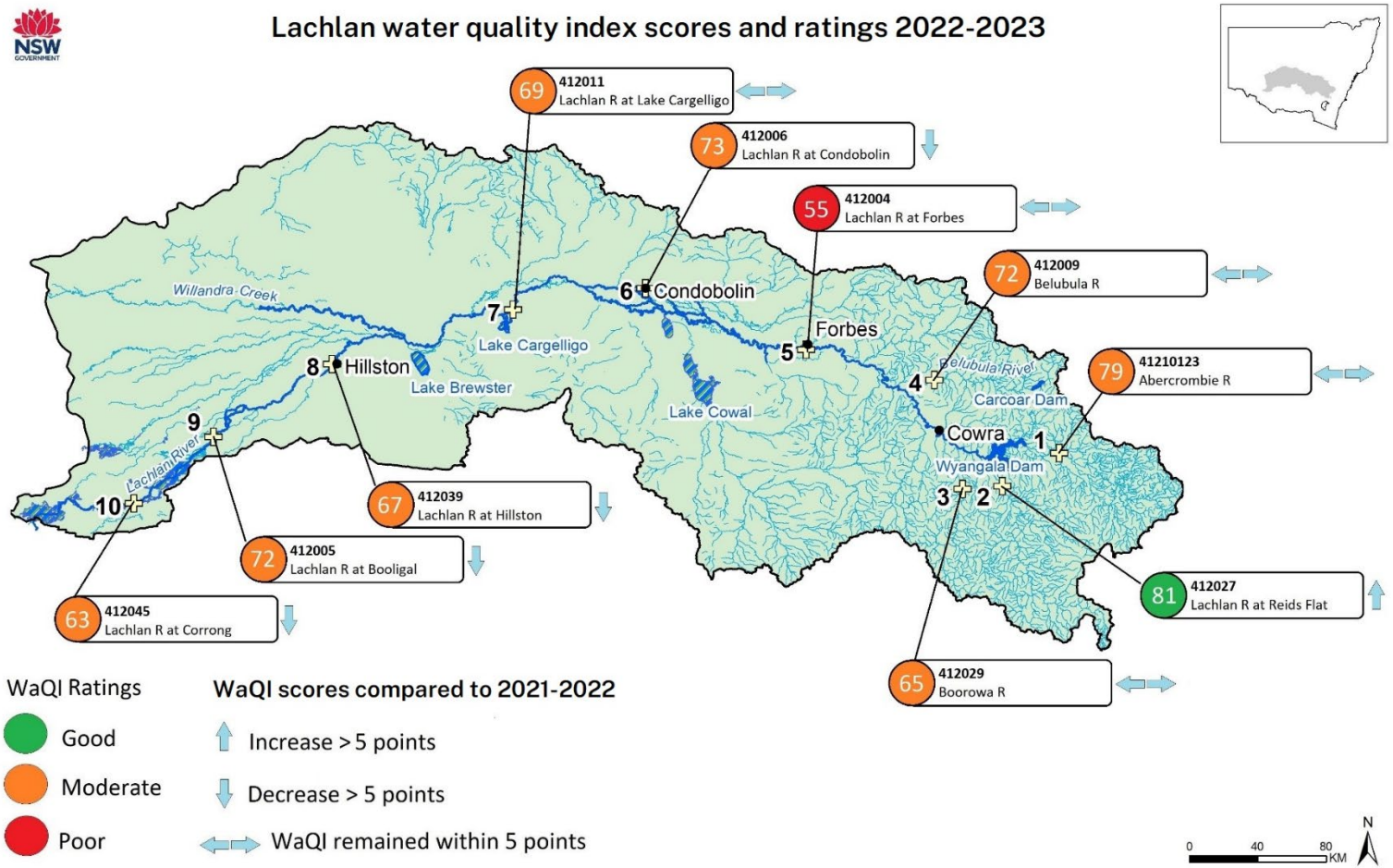

Figure 3: Water quality index scores and ratings for the Lachlan valley

There is a general trend of increasing turbidity and nutrient concentrations down the catchment until the Lachlan River at Lake Cargelligo Weir. This reflects the impact of the cumulative effects of land use, soil disturbance and human activity on water quality. Turbidity, total suspended solids and total phosphorus concentrations declined at the 3 monitoring sites on the Lachlan River downstream of Lake Cargelligo (Hillston, Booligal and Corrong). This could be due to the very low slope of the lower Lachlan floodplains causing water velocity to decrease and allowing sediment and any attached phosphorus to drop out of suspension. This deposition of nutrients could result in increased algal growth in the coming years. Total nitrogen concentrations remained high at the lower sites.

The pH was relatively consistent throughout the Lachlan valley with most values varying between 7 and 8. This would not impact the health of aquatic ecosystems or agricultural enterprises.

Dissolved oxygen levels declined with distance down the catchment. The lowest dissolved oxygen readings were in the lower catchment, where high turbidity reduces light penetration, reducing aquatic plant growth and higher water temperature reduces the solubility of oxygen in the water column. In addition, major flooding resulted in the flushing of organic matter off the lowland floodplains and into waterways. The rapid breakdown of this material by bacteria can cause dissolved oxygen levels to decline.

Boorowa River had the highest median electrical conductivity followed by the Belubula River. There is limited opportunity for irrigation from Boorowa River, so the risk of impacts to agriculture production and soil structure is low. There is a large salt store in the geology and soils of these two catchments. These salts could be mobilised over the coming years following the heavy rainfall and recharge of shallow groundwater during 2022–2023. High flows maintained low electrical conductivity in the lower Lachlan River.

Summary statistics for the key water quality parameters at each monitoring site in the Lachlan valley have been displayed as box plots (Figure 4). The box plots show the annual 25th, 50th and 75th percentile values, with error bars indicating the 10th and 90th percentile values for each site.

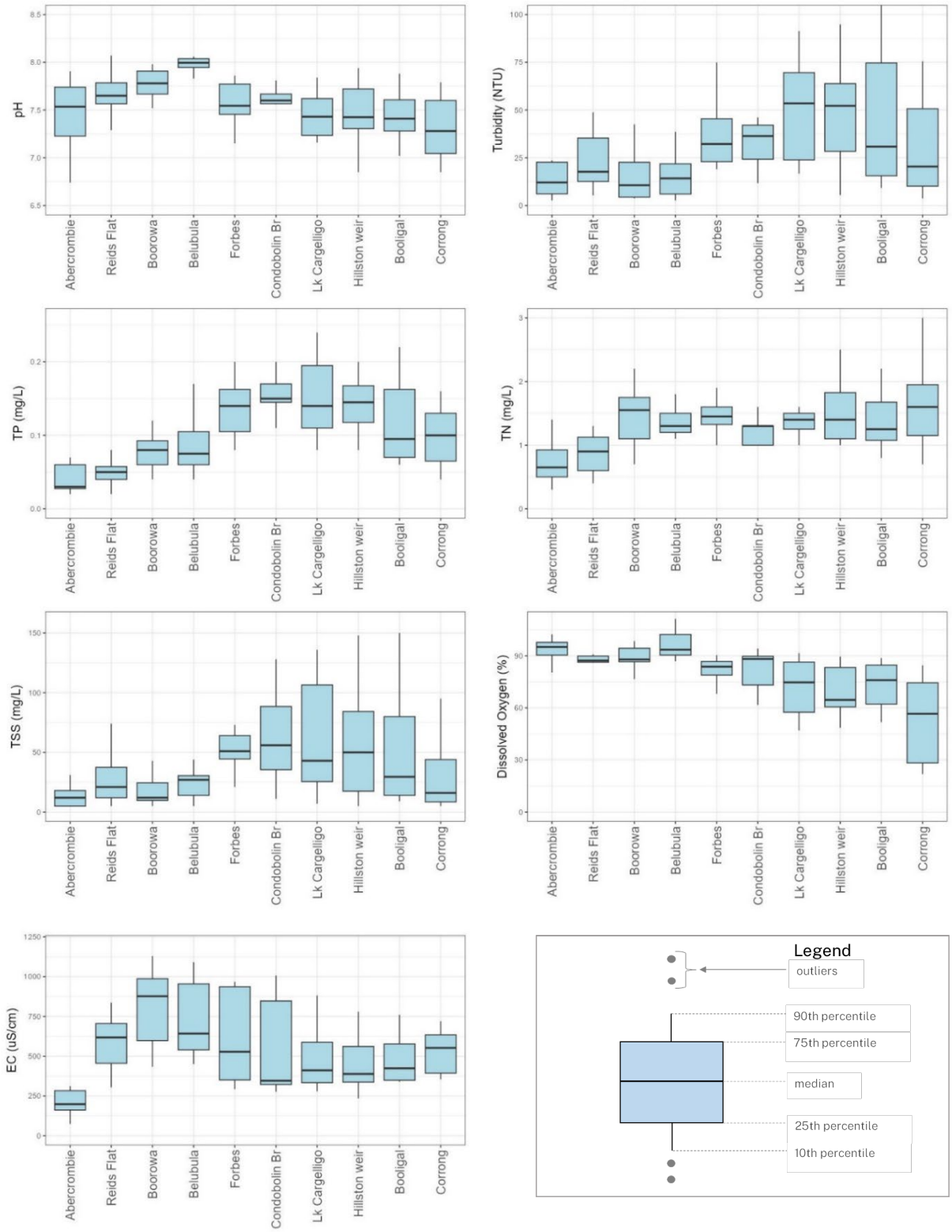

Figure 4: Water quality data by site, moving upstream to downstream from left to right. The water quality parameters shown are pH, Turbidity, Total phosphorus (TP), Total nitrogen (TN), Total suspended solids (TSS), Dissolved oxygen, and electrical conductivity (EC).

Irrigation and salinity

There are 15 continuous electrical conductivity monitoring sites in the Lachlan valley, with stations located on the regulated Lachlan River and known saline tributaries. Many sensors were buried by sediment during the 2022 flooding making them inoperable. There is one Irrigation Infrastructure Operator in the Lachlan River WRPA (Jemalong Irrigation Limited).

During 2022 to 2023, the 95th percentile electrical conductivity in the Lachlan River at Forbes (960 µS/cm) (the closest monitoring station to the Jemalong offtake) was higher than the Basin Plan agriculture and irrigation salinity target of 833 µS/cm. Figure 5 highlights electrical conductivity in the Lachlan River at Cowra, Forbes, Condobolin and Booligal was low throughout the latter half of 2022 with high flows diluting salts. Once the flooding had subsided, discharge from saline shallow saline groundwater and inflows from saline tributaries results in increased electrical conductivity.

Due to the major flooding in the Lachlan catchment, there was reduced planting of summer crops and low water demand in the lower Lachlan valley. This low water demand was able to be met by inflows from saline unregulated tributaries, reducing the need to release the less saline stored water from Wyangala Dam. The result was increased electrical conductivity in the Lachlan River.

The Basin Salinity Management Strategy End-of-Valley salinity targets for the Lachlan River at Forbes are:

- the median electrical conductivity does not exceed 460 µS/cm
- the 80th percentile electrical conductivity does not exceed 693 µS/cm and
- the annual salt load does not exceed 257,500 t/year.

The annual median (484 µS/cm) and 80th percentile (960 µS/cm) were above the respective End-of-Valley targets and the annual salt load of 816,137 t/year also exceeded the target value.

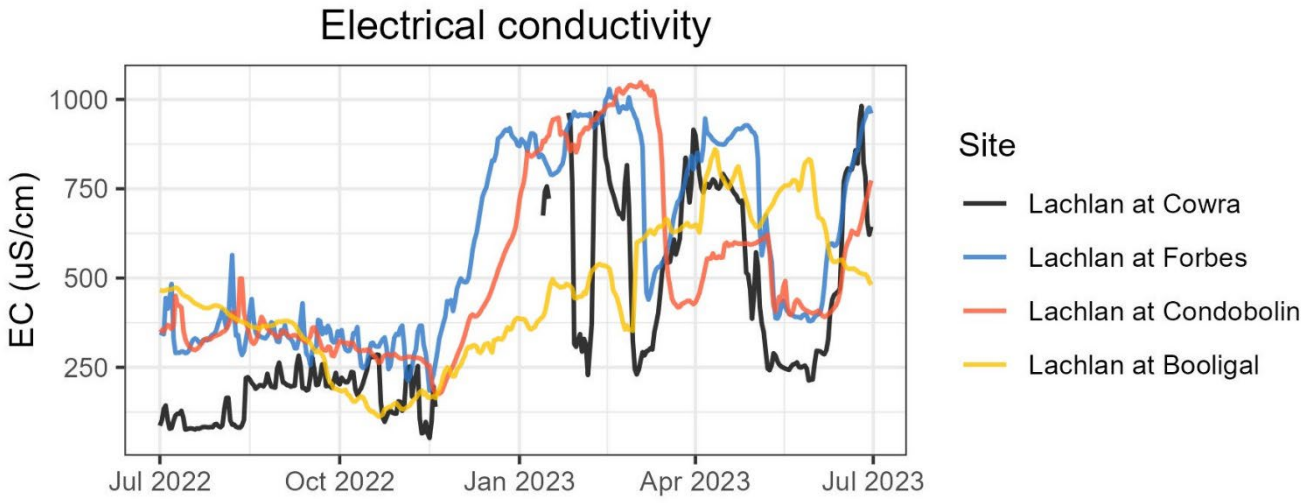

Figure 5: Electrical conductivity (µS/cm) at selected sites in the Lachlan valley

Recreation

Exposure to blue-green algae (cyanobacteria) through ingestion, inhalation or contact during recreational use of water can impact on human health. A colour alert scale is used with a green alert warning indicating low numbers of blue-green algae but requiring monitoring, an amber alert warning being a heightened level of alert with increased sampling and surveillance, and a red alert warning being a state of action where waters are unsuitable for recreational use. For more information about blue-green algae and algal alerts see the WaterNSW algae web page (Algae - WaterNSW).

Blue-green algae have historically been an issue at Wyangala Dam, Carcoar Dam, Lake Cargelligo, and Lake Brewster. They receive water from the upper catchment high in nutrients. Combined with still warm water, blue-green algal blooms occur most summers. Table 2 indicates the distribution of algal alerts during 2022 to 2023, highlighting that these areas received the majority of red alerts for recreational use, occurring mostly from December until June 2023, after flooding had subsided. Upgrades to Lake Cargelligo's embankment in June 2023 saw water drawn down to 50% capacity by April 2023 and moved to Lake Brewster (WaterNSW, 2023). This may have attributed to the low numbers of red alerts for recreational use at Lake Cargelligo for 2022–2023.

Table 2: Distribution of algal alert levels in the Lachlan Valley July 2022 to June 2023

	Jul					Aug				Sept					Oct				Nov				Dec					Jan				Feb				Mar				Apr				May				Jun				
Wyangala Dam	*	*	1	1	1	1	*	*	*	*	*	*	*	*	*	1	1	1	1	1	1	1	*	2	2	3	3	3	3	3	3	2	2	2	3	3	3	3	2	2	2	3	3	2	2	2	2	1	1	*	*	*	*
Wyangala Dam downstream	*	*	*	*	*	*	1	1	1	1	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3	3	3	3	3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	1	1	*	1	1	1	1	1
Carcoar Dam	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2	2	2	2	2	1	*
Carcoar Downstream (Belubula River)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	2	2	2	2	2	2	2	1	*	*	*	*	1	*	*	*	*	*	*	1	1	*	*	*	1	2	2	2	2	1	1
Lachlan River at Cottons Weir (Forbes)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	2	*	*	*	*	*	*	*	*	*	*	*	*	*
Lachlan River at Condobolin Bridge	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	2	2	2	2	*	*	*	*	*	*	*	*	*
Lake Cargelligo Weir	1	1	*	1	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	2	2	2	2	2	2	1	1	2	2	2	1	1	*	*	*	*	*	*	*	*	*
Lake Cargelligo	2	2	2	2	2	1	1	*	*	1	*	*	*	*	*	*	*	*	*	*	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2
Lake Brewster	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	2	2	2
Lachlan River at Willandra Weir	*	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	2	2	2	1	2	2	3	3	3	2	3	3	3	3	2	2	2	2	2	2	2	2	1
Lachlan River at Hillston	2	2	1	1	1	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Lachlan River at Booligal	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Lachlan River at Corrong	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	2	2

Key : * = Nil/Low alert | 1 = green alert | 2 = amber alert | 3 = red alert

Extreme water quality events

Spring 2022 was the wettest spring on record (since 1900) for New South Wales. In October, heavy rainfall led to widespread flooding in the Murray–Darling Basin, impacting many towns in inland New South Wales (Figure 6 - BoM, 2023 and Figure 7). The heavy rains led to substantial increases in water storage levels, with many storages spilling. With flooding on this scale came an increased risk of hypoxic blackwater events.

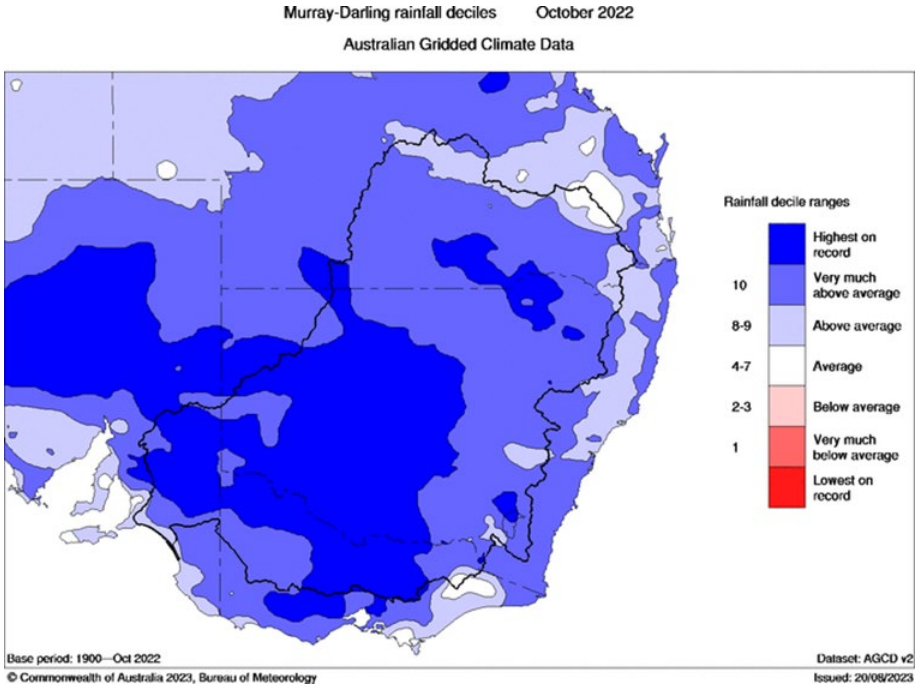

Figure 6: Murray Darling rainfall deciles for October 2022. (Source: BoM)

Figure 7: Floodwaters near Forbes, 17 November 2022. (Source: Planet Explorer)

NSW Fisheries investigated a report of thousands of small dead carp in Jemalong Creek in December 2022. The suspected cause was the high-water level in the Jemalong weir pool causing low dissolved oxygen floodwater to back up in Jemalong Creek and not drain freely into the Lachlan River channel. High amounts of decaying organic material reduced the dissolved oxygen in the water below the threshold needed for fish to breathe and survive. The best available means to prevent further fish deaths was to draw down the water level in Jemalong Weir to allow the poor-quality water being held up in Jemalong Creek to drain into the Lachlan River. As the water level in Jemalong Weir was being drawn down, to mitigate possible impacts in the Lachlan River, water from the Lachlan water quality allowance was released from Wyangala Dam to assist with the dilution of the poor-quality water and flushing it downstream. Fish kills in NSW are listed on Department of Primary Industries website.

Electrical conductivity in the Lachlan River at Cowra is governed by the release of low salinity water from Wyangala Dam, combined with the naturally saline unregulated inflows from the Boorowa River and other smaller saline tributaries upstream of Cowra. With continued low releases from Wyangala Dam in 2023, the electrical conductivity at Cowra had increased and began to impact on the quality of Cowra's raw water supply. The Lachlan water quality allowance was utilised to increase dilution flows from Wyangala Dam and maintain electrical conductivity below 800 µS/cm at Cowra.

The flushing of nutrients into storages and waterways by floodwaters may have contributed to the high potentially harmful blue-green algal numbers in Wyangala and Carcoar dams, Lakes Cargelligo and Brewster and numerous sites on the Lachlan River.

Summary

The quality of the water in a river or stream reflects underlying climate and geology and the multiple activities and land uses occurring in a catchment area. Numerous factors contribute to the observed results.

In 2022 to 2023, flooding was the key driver for water quality. Increased runoff carries high volumes of sediment and attached nutrients into waterways resulting in 9 out of 10 water quality monitoring sites being rated as moderate or poor. High flows maintained electrical conductivity below irrigation targets through 2022, but as river levels dropped, shallow saline groundwater and inflows from naturally saline catchments discharging into the Lachlan River pushed electrical conductivity up in 2023.

Hypoxic blackwater is a feature of Australian lowland river systems and occurs when organic material, such as sticks, leaves, bark and grass is broken down in the floodwater or washed off the floodplain into the river. The breakdown of this material by bacteria can rapidly use up all the oxygen in the water. The dark appearance of the water is due to the release of tannins as the organic matter decays. NSW Fisheries investigated one fish death report in the Lachlan Valley during 2022 to 2023. A hypoxic event in Jemalong Creek resulted in thousands of dead carp and hundreds of freshwater crayfish.

Although hypoxic blackwater events may result in the loss of fish and other aquatic life, the impacts of these events on the environment are usually short-term, as the river water re-oxygenates again as the flooding subsides. Naturally occurring events such as these underpin the broad health of rivers. They provide nutrients to drive the overall production of our river and wetland systems. In the longer term, native fish, water birds and other organisms benefit from the increased production in the river, boosting food supplies and supporting breeding cycles.

For more detailed information about water quality degradation issues in the Lachlan catchment see the Lachlan surface water quality technical report (https://www.industry.nsw.gov.au/__data/assets/pdf_file/0010/305749/Water-quality-technical-report-for-the-Lachlan-surface-water-resource-plan-area-SW10.pdf).

Long-term water quality trends

Analysis of WaQI scores from 2012–2013 to 2022–2023 shows consistent WaQI ratings in the Lachlan Valley (Figure 8). All sites have a long term median WaQI rating of good or moderate with the Lachlan River at Condobolin and at Lake Cargelligo Weir having the highest scores. There is a decreasing trend in scores with distance down the lower Lachlan valley. The Boorowa River at Prossers Crossing had the lowest median score for the 10-year period.

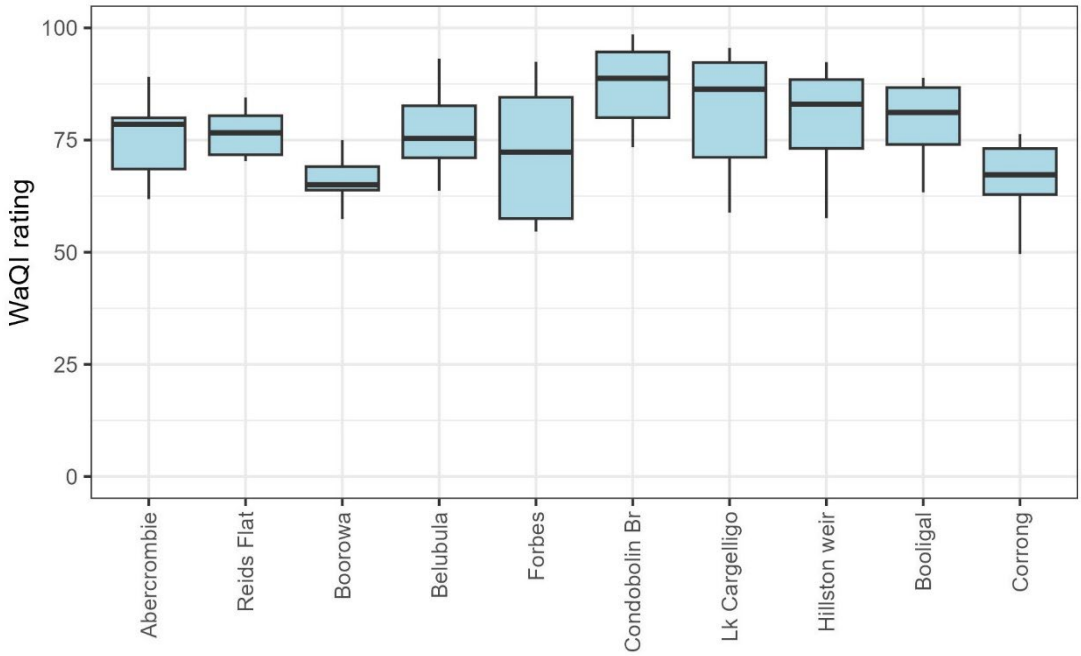

Figure 8: Boxplots showing long-term (2012–2013 to 2022–2023) WaQI scores for every site in the Lachlan valley

The number of sites with ratings of good, moderate and poor followed a similar trend over time to other inland rivers, fluctuating from year to year in response to significant droughts and floods (Figure 9). The number of sites with a good rating has been declining since 2013–2014 (8 sites) down to one site in 2022–2023. Over the same time period the number of sites with a moderate rating have increased from 2 to 8. The highest number of poor sites was in 2016 coinciding with flooding and a hypoxic blackwater event in the Lachlan valley.

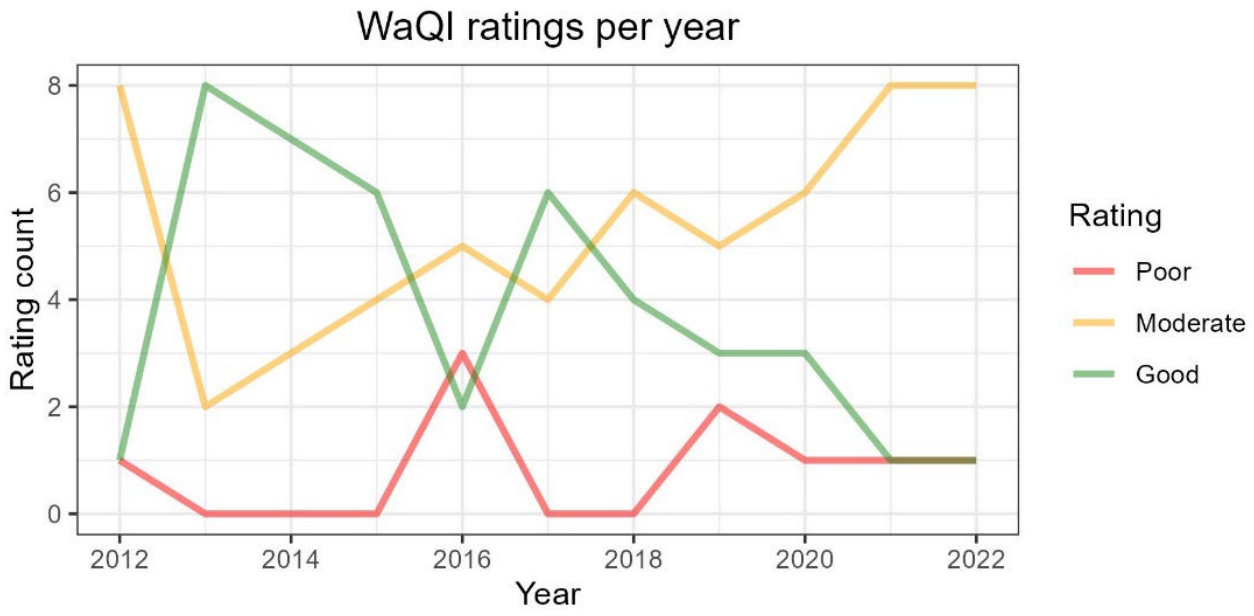

Figure 9: Graph summarising long-term water quality index ratings (2012–2013 to 2022–2023) for every site in the Lachlan Valley by year

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