

Wambuul / Macquarie-Castlereagh valley annual surface water quality report: 2021-2022

Key Points

- Flow during July 2021 to June 2022 was characterised by heavy rain falling across much of the catchment. This rain resulted in several large flow events throughout the catchment.
- The heavy rains led to substantial increases in water storage levels.
- Flooding was the main driver of water quality in the Wambuul / Macquarie-Castlereagh catchment. The water quality index indicated that of the 15 sites in the catchment, 2 were rated as good, 5 as moderate and 8 as poor. Despite the flooding, only 3 sites returned a lower water quality index score in 2021–2022 compared to 2020–2021.
- All sites were below the Basin Plan agriculture and irrigation salinity target of 957 $\mu\text{S}/\text{cm}$ (microSiemens per centimetre). The median End-of-Valley salinity target was exceeded for the Castlereagh River but not for the Wambuul / Macquarie or Bogan Rivers.
- There were fewer red alert warnings for blue-green algae than in previous years for Burrendong dam. Windamere dam experienced the most red alerts over the summer months.

The water quality data used in this report is collected on a monthly frequency at 15 sites in the Wambuul / Macquarie-Castlereagh 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 Wambuul / Macquarie-Castlereagh Valley from July 2021 to June 2022. The location of monitoring sites is shown in Figure 1.

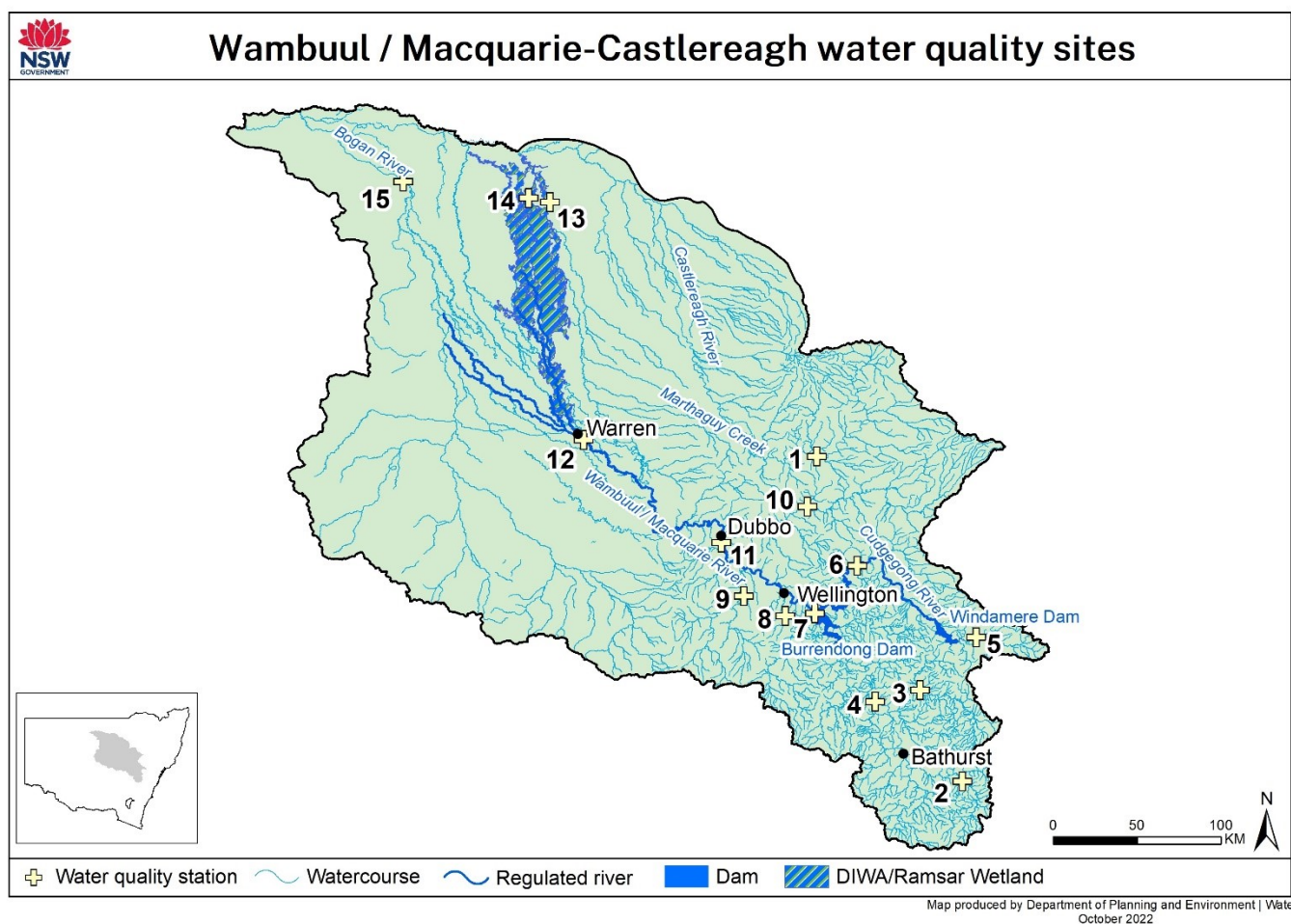


Figure 1: Location of routine water quality monitoring sites in the Wambuul / Macquarie-Castlereagh valley

Table 1: Site information for each monitoring site in the Wambuul / Macquarie-Castlereagh catchment. Refer to Figure 1 and site numbers for location of each site

Site number	Site name	Water Quality Zone	Station number
1	Castlereagh River at Mendooran	Castlereagh - Talbragar uplands	420004
2	Fish River at Hazelgrove	Wambuul / Macquarie montane	42110171
3	Turon River at Bathurst Point	Wambuul / Macquarie - Cudgegong unregulated uplands	42110170
4	Wambuul / Macquarie River at Bruinbun	Wambuul / Macquarie - Cudgegong unregulated uplands	421025
5	Cudgegong River at Rylstone	Wambuul / Macquarie - Cudgegong unregulated uplands	421038
6	Cudgegong River at Yamble Bridge	Wambuul / Macquarie regulated uplands	421019
7	Wambuul / Macquarie River downstream Burrendong Dam	Wambuul / Macquarie regulated uplands	421077
8	Bell River at Newrea	Wambuul / Macquarie unregulated tributaries uplands	421018
9	Little River at Arthurville	Wambuul / Macquarie unregulated tributaries uplands	421176
10	Talbragar River at Elong Elong	Castlereagh - Talbragar uplands	421042
11	Wambuul / Macquarie River at Molong Rail Bridge	Wambuul / Macquarie regulated uplands	42110101

12	Wambuul / Macquarie River at Warren Weir	Wambuul / Macquarie regulated uplands	421004
13	Marthaguy Creek at Carinda	Wambuul / Macquarie lowlands	421011
14	Wambuul / Macquarie River at Bells Bridge	Wambuul / Macquarie lowlands	421012
15	Bogan River at Gongolgon	Wambuul / Macquarie lowlands	421023

Catchment description

The Wambuul / Macquarie–Castlereagh catchment covers more than 75,000 km² in the State's central west. The area comprises of three major river networks that flow north-west to the Barwon River: the Castlereagh, Wambuul / Macquarie and Bogan Rivers.

The Castlereagh River is approximately 549 km in length and rises in rugged terrain in the Warrumbungle Range at an elevation of approximately 850 m. The Castlereagh River flows through Timor Dam on its way to joining the Wambuul / Macquarie River downstream of the Wambuul / Macquarie Marshes.

The Wambuul / Macquarie River is approximately 960 km in length. It is formed by the joining of the Campbells and Fish Rivers, which drain a high plateau area centred near Oberon with a general elevation of 900 to 1,000 m above sea level. The river flows northward through steep gorge country in the Hill End area and is impounded by Burrendong Dam upstream of Wellington. The Cudgegong River rises in the sandstone tableland country east of Rylstone. It is impounded by Windamere Dam upstream of Mudgee, and then flows through Mudgee before flowing into Burrendong Dam. Downstream of Burrendong Dam, the Wambuul / Macquarie River continues to flow in a northwest direction through Wellington and Dubbo and is joined by 3 major tributaries; the Talbragar, Bell and Little rivers. At Narromine the Wambuul / Macquarie River takes a dramatic turn to the north and commences a complex system of anabranches and effluent creeks that connect the Wambuul / Macquarie, Darling and Bogan Rivers. The Wambuul / Macquarie Marshes are located toward the end of the catchment and comprise a meandering network of effluent channels and anabranches with shallow swamps, lagoons and floodplains. The Wambuul / Macquarie Marshes are Ramsar-listed and are one of the largest semi-permanent wetland systems and colonial waterbird breeding sites in inland Australia. The Wambuul / Macquarie River emerges from the wetlands before joining the Castlereagh River and then flowing into the Barwon River near Brewarrina.

The Bogan River is approximately 590 km in length. It rises in the Harvey Ranges between Parkes and Peak Hill and flows northwest through a broad, flat landscape through Nyngan to join the Darling River near Bourke. Major streams of the lower valley include the Albert Priest Canal (artificial), and Gunningbar and Duck Creeks, which deliver regulated flows from the Wambuul / Macquarie River to the lower Bogan River.

Land use in the Wambuul / Macquarie-Castlereagh is largely grazing in the upper and lower sections of the catchment with increased cultivation through the mid-catchment downstream of Dubbo and Gilgandra.

Catchment conditions during 2021-2022

Flow during 2021–2022 was characterised by heavy rain falling across much of the catchment (Figure 2A). By September 2021, Burrendong Dam was over 100% capacity, with water releases

made to create space (Figure 2B). By the end of June 2022, the storage capacity of Burrendong Dam was 112%, Windamere Dam 59%, and Oberon Dam 100%. In November 2021, NSW experienced one of its wettest months on record resulting in flooding in all catchments across the Northern and Southern Basin. Discharge in the Wambuul / Macquarie River at Dubbo peaked at above 55,000 megalitres per day (ML/day) on 28 November 2021. High flows continued as far downstream as Warren Weir which peaked at 15,344 ML/day in mid-December 2021. However, these flows did not reach as far as Carinda which never exceeded 2,100 ML/day (Figure 2C).

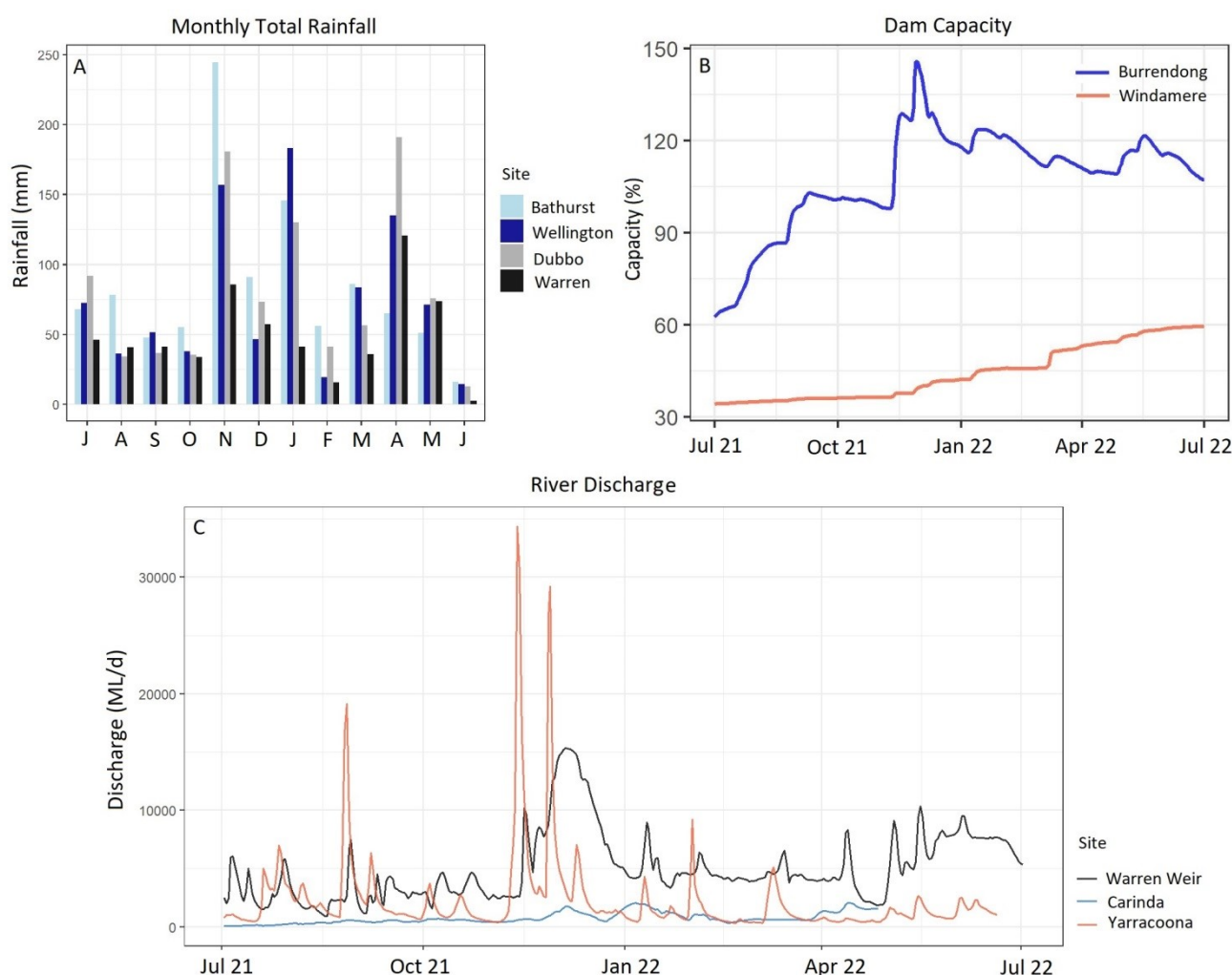


Figure 2: Catchment conditions for selected stations in the Wambuul / Macquarie catchment from July 2021 to June 2022 for A: Monthly total rainfall (mm) B: Dam capacity (%) and C: River discharge (ML/day).

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. 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.

Two sites were rated as having good water quality during 2021–2022, Turon River at Bathurst Point and Wambuul / Macquarie River at Bells Bridge. The majority of sites rated as poor due to high turbidity and nutrient concentrations caused by heavy rainfall and high flows. Five sites were rated as moderate.

Despite the flooding, of the 15 monitoring sites in the Wambuul / Macquarie-Castlereagh catchment, 6 sites showed minimal change in water quality index score between 2020–2021 and 2021–2022 and 6 sites had an improvement in index score. The 3 sites returning a lower score were Castlereagh River at Mendooran, Fish River at Hazelgrove and Bogan River at Gongolgon.



Wambuul/Macquarie-Castlereagh water quality index scores 2021-2022

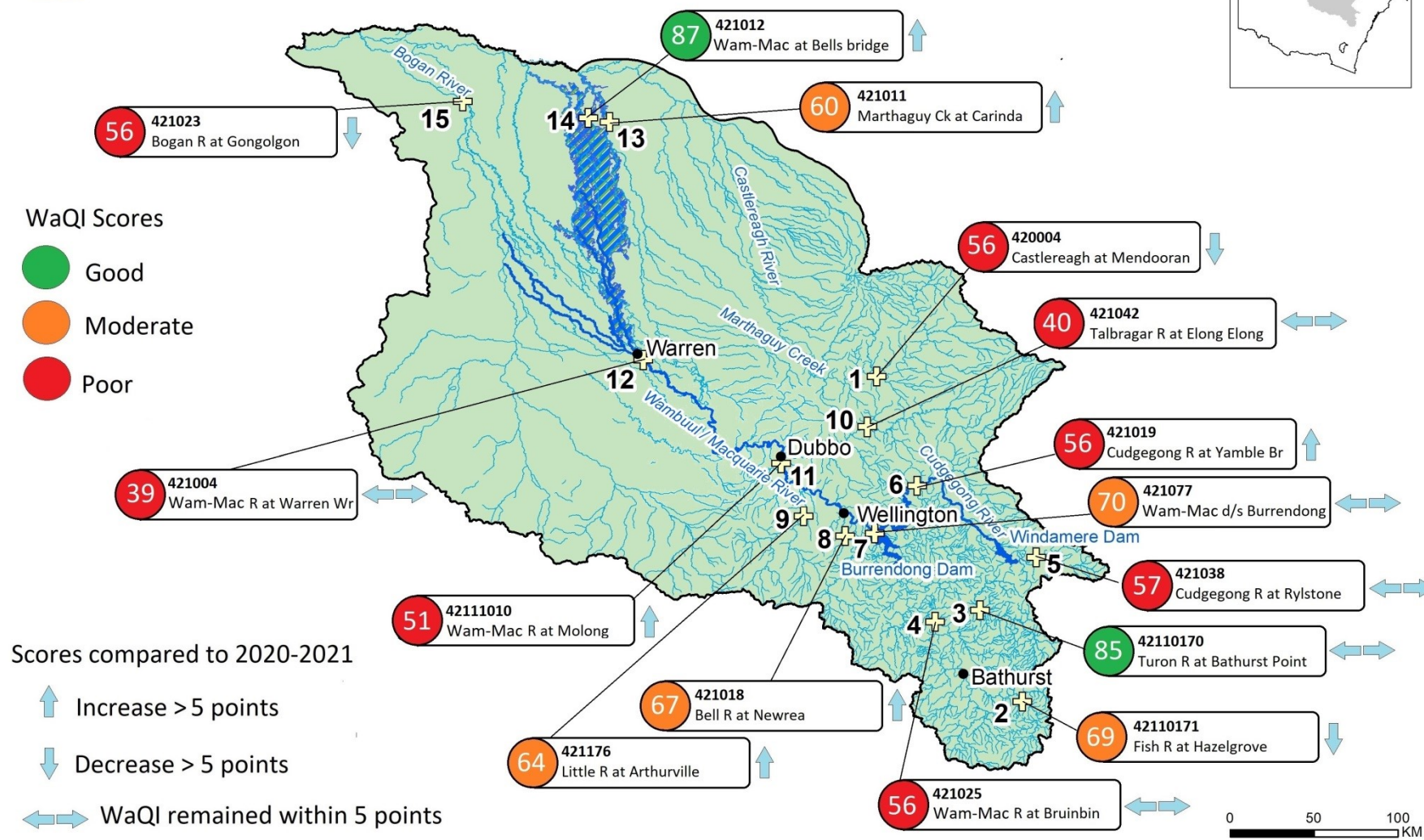
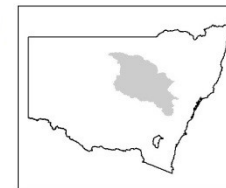


Figure 3: Water quality index scores for the Wambuul / Macquarie-Castlereagh valley

There is a general trend of increasing turbidity and nutrient concentrations down the catchment with high results in Talbragar River at Elong Elong, Marthaguy Creek at Carinda and Bogan River at Gongolgon, reflecting the impact of the cumulative effects of land use, soil disturbance and human activity on water quality. The low turbidity and total phosphorus in the Wambuul / Macquarie River at Bells Bridge may have been due to the filtering benefits of the water flowing through the Wambuul / Macquarie Marshes.

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 Castlereagh and Wambuul / Macquarie floodplains and into waterways. The rapid breakdown of this material by bacteria caused dissolved oxygen levels to decline to critical levels for fish health in January 2022.

The Talbragar, Little and Bell rivers had the highest median electrical conductivity. The elevated electrical conductivity is caused by localised areas of high salinity in these unregulated catchments. Similarly, salinity in the area around Goolma causes high readings in the Cudgegong River at Yamble Bridge. The electrical conductivity at other sites is low.

Summary statistics for the key water quality parameters at each monitoring site in the Wambuul / Macquarie-Castlereagh 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.

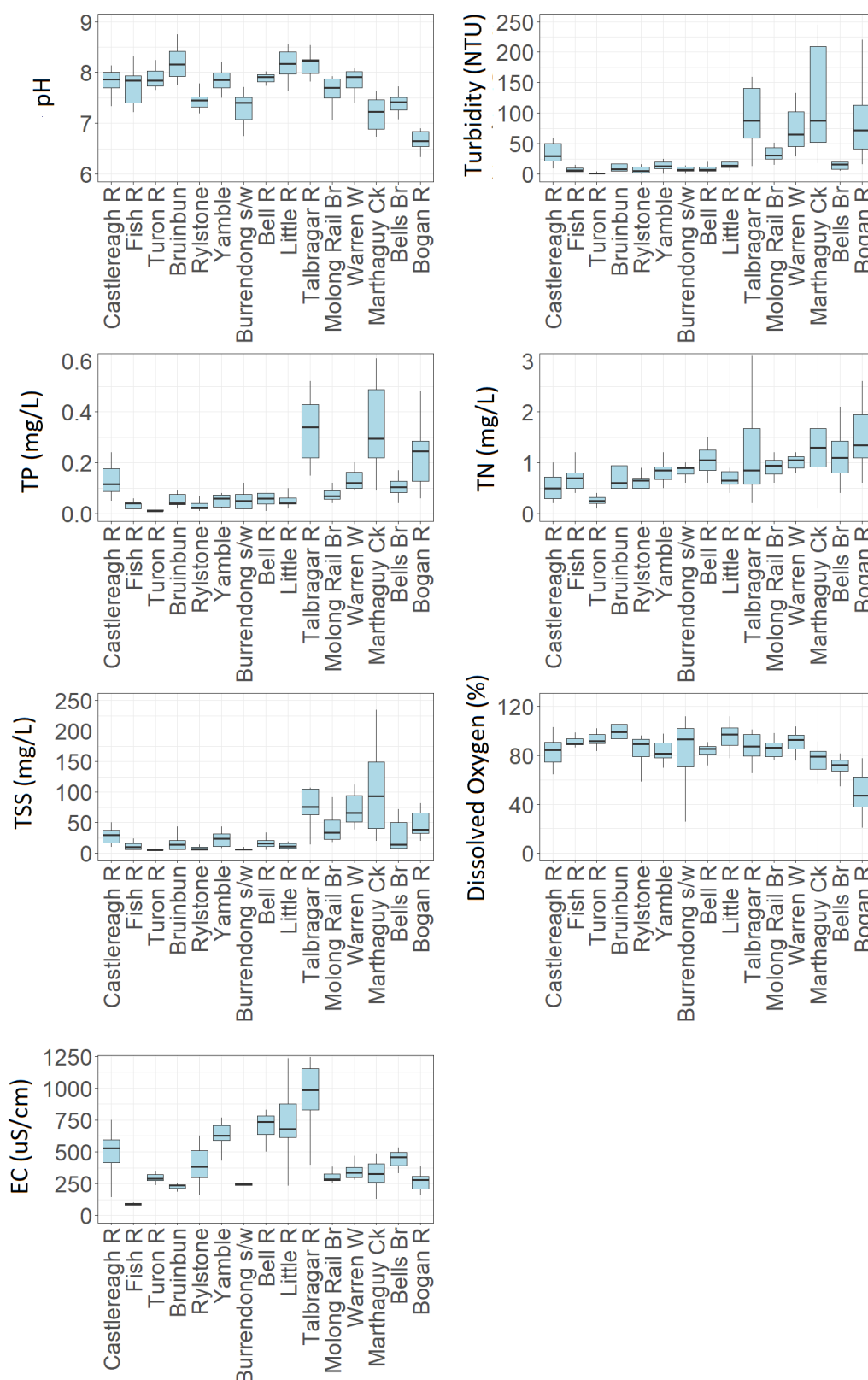


Figure 4: Water quality data for water quality parameters by site

Irrigation and salinity

There are 16 continuous electrical conductivity monitoring sites in the Wambuul / Macquarie-Castlereagh valley. Selected sites plotted in Figure 5 show that heavy rainfall and high flows kept electrical conductivity low throughout 2021 to 2022.

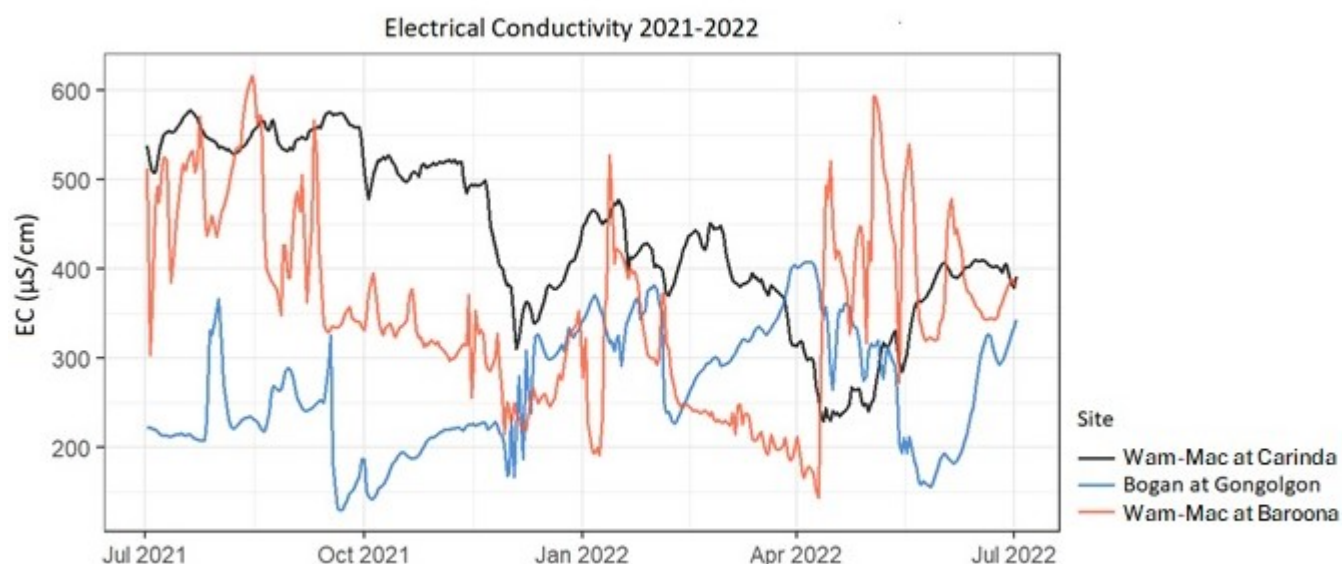


Figure 5: Electrical conductivity ($\mu\text{S/cm}$) at selected sites in the Wambuul / Macquarie-Castlereagh valley

The Narromine Irrigation Board of Management is the only irrigation infrastructure operator in the Wambuul / Macquarie valley. Water is diverted to the irrigation area from the Wambuul / Macquarie River at Narromine. Wambuul / Macquarie River at Baroona (closest monitoring site to Narromine) had a 95th percentile electrical conductivity of 532 $\mu\text{S/cm}$, which is lower than the Basin Plan agriculture and irrigation salinity target of 957 $\mu\text{S/cm}$.

There are 3 Basin Salinity Management Strategy End-of-Valley salinity target sites in the Wambuul / Macquarie-Castlereagh catchments:

- Castlereagh River at Gungalman Bridge
- Wambuul / Macquarie River at Bells Bridge (Carinda)
- Bogan River at Gongolgon.

Table 2 compares the electrical conductivity results to the target values (target values in brackets).

The median electrical conductivity in Castlereagh River at Gungalman Bridge did not meet the Basin Salinity Management Strategy End-of-Valley salinity target. High flows transported high salt loads that exceeded targets in all three systems. The electrical conductivity sensor at Gungalman Bridge

failed during the major flooding at the end of November 2021. Despite this instrumentation malfunction resulting in data loss, the Castlereagh River still exceeded the salt load target.

Table 2: End-of-Valley salinity results for Castlereagh, Wambuul / Macquarie and Bogan valleys (targets in brackets)

Assessment site	Median electrical conductivity ($\mu\text{S}/\text{cm}$)	80 percentile electrical conductivity ($\mu\text{S}/\text{cm}$)	Salt load (t/year)
Castlereagh River at Gungahman Bridge	409 (368)	N/A	26,433 (8,910)
Wambuul / Macquarie River at Bells Bridge	426 (504)	536 (744)	100,793 (25,760)
Bogan River at Gongolgon	260 (456)	329 (581)	43,169 (34,830)

* values in red indicate readings have exceeded the salinity target

Recreation

Exposure to blue-green algae (cyanobacteria) through ingestion, inhalation or contact during recreational use of water can impact 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 blooms have historically been a major issue in Windamere and Burrendong dams during the summer period due to low flows and warmer temperatures. Table 3 indicates the distribution of algal alerts during 2021 to 2022. Due to wetter conditions and cooler temperatures, there were fewer red alerts however, Windamere dam still received red alerts throughout October and for the majority of the summer months.

Table 3: Distribution of algal alert levels in Wambuul / Macquarie-Castlereagh valley July 2021 to June 2022

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Chifley Dam	*	*	*	*	*	*	*	*	*	*	*	*
Windamere Dam	*	*	*	*	*	*	*	*	*	*	*	*
Cudgegong River (downstream of Windamere Dam)	*	*	*	*	*	*	*	*	*	*	*	*
Burrendong Dam	*	*	*	*	*	*	*	*	*	*	*	*
Wambuul/Macquarie River (downstream Burrendong dam)	*	*	*	*	*	*	*	*	*	*	*	*
Wambuul/Macquarie River (upstream of Wellington)	*	*	*	*	*	*	*	*	*	*	*	*

Key: * Nil/Low alert Green alert Amber alert Red alert

Extreme water quality events

November 2021 was Australia's wettest November since national records began in 1900 (BoM, 2022). It was also the wettest November on record for New South Wales and for the entire Murray–Darling Basin. Flooding occurred in all catchments across the Northern Basin. 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.

Widespread flooding in the Castlereagh, Wambuul / Macquarie and Bogan valleys washed organic material into creeks and waterways, resulting in lower oxygen levels in the lower catchment. Despite flooding events, no fish deaths were reported.

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 2021 to 2022, flooding was the key driver for water quality. Increased runoff carries high volumes of sediment and attached nutrients into waterways resulting in 13 of 15 water quality monitoring sites being rated as moderate or poor. In contrast, the high flows maintained electrical conductivity low. Despite the flooding, only 3 sites returned a lower water quality index score in 2021-2022 compared to 2020-2021.

The flood flows resulted in a hypoxic blackwater event in the lower Castlereagh and Wambuul / Macquarie catchment which contributed to low oxygen levels in the Barwon and Darling rivers. The widespread flooding did not result in any fish deaths from hypoxic blackwater in these valleys, as was experienced in some other catchments across NSW.

For more detailed information about water quality issues in the Wambuul / Macquarie-Castlereagh catchment see the Wambuul / Macquarie-Castlereagh surface water quality technical report (https://www.industry.nsw.gov.au/_data/assets/pdf_file/0010/305758/Water-quality-technical-report-for-the-Macquarie-Castlereagh-surface-water-resource-plan-area-SW11.pdf).

References and further information

Bureau of Meteorology (BoM). 2022. Special Climate Statement 75 – Australia's wettest November on record. Issued 14 February 2022: <http://www.bom.gov.au/climate/current/statements/scs75.pdf?20220214>

MDBA regional fact sheet: <https://www.mdba.gov.au/sites/default/files/pubs/regional-fact-sheet-macquarie-castlereagh.pdf>

MDBA water management: <https://www.mdba.gov.au/water-management/catchments/macquarie-castlereagh>

NSW DPE water for the environment:
<https://www.environment.nsw.gov.au/topics/water/water-for-the-environment/macquarie>

<https://www.environment.nsw.gov.au/topics/water/water-for-the-environment/macquarie/annual-environmental-water-priorities>