

# Regional Water Strategy

Macquarie–Castlereagh

October 2023





**Published by NSW Department of Planning and Environment**

[dpie.nsw.gov.au](http://dpie.nsw.gov.au)

**Title** Regional Water Strategy

**Sub-title** Macquarie–Castlereagh

**First published** October 2023

**Department reference number** PUB23/707

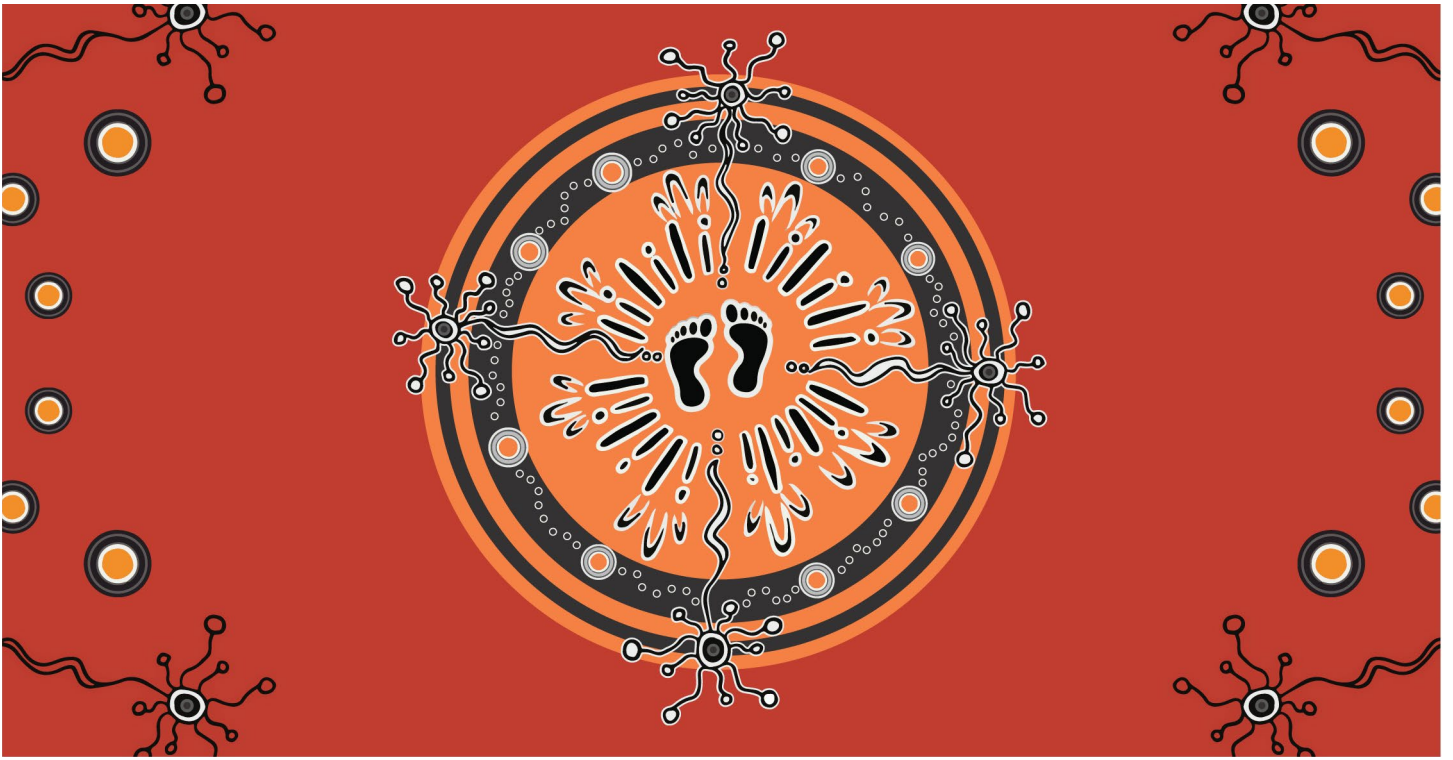
**Cover image** Image courtesy of Destination NSW. Macquarie River Rail Bridge, Dubbo.

**More information** [water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies](http://water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies)

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# Acknowledging First Nations people

The NSW Government acknowledges First Nations people as the first Australian people and the traditional owners and custodians of the country's lands and water. First Nations people have lived in NSW for over 60,000 years and have formed significant spiritual, cultural and economic connections with its lands and waters.

Today, they practise the oldest living culture on earth.

The NSW Government acknowledges the Gomeroi/Kamilaroi/Gamilaroi/Gamilaraay, Ngemba, Ngiyampaa, Wailwan and Wiradjuri nations from the Macquarie–Castlereagh region as having an intrinsic connection with the lands and waters of the Macquarie–Castlereagh Regional Water Strategy area. The landscape and its waters provide the First Nations people with essential links to their history and help them to maintain and practise their traditional culture and lifestyle.

We recognise the Traditional Owners as the first managers of Country. Incorporating their culture and knowledge into management of water in the region is a significant step towards closing the gap.

Under this regional water strategy, we seek to establish meaningful and collaborative relationships with First Nations people. We will seek to shift our focus to a Country-centred approach, respecting, recognising and empowering cultural and traditional Aboriginal knowledge in water management processes at a strategic level.

We show our respect for Elders past and present through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places where First Nations people are included socially, culturally and economically.

As we refine and implement the regional water strategy, we commit to helping support the health and wellbeing of waterways and Country by valuing, respecting and being guided by Traditional Owners/First Nations people, who know that if we care for Country, it will care for us.

We acknowledge that further work is required under this regional water strategy to inform how we care for Country and ensure First Nations people/Traditional Owners hold a strong voice in shaping the future for all communities.

Artwork by Nikita Ridgeway.

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Image courtesy of Nicola Brookhouse, Department of Planning and Environment. Monkeygar Lagoon, South Macquarie Marshes.



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# About the Macquarie–Castlereagh Regional Water Strategy

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# 1

Image courtesy of Destination NSW. Sunset, Lake Burrendong.



Secure, reliable and resilient water supplies are critical to regional and remote communities in NSW. Water contributes to the appeal and prosperity of rural areas, and regional towns and cities. Rivers, creeks and wetlands create cultural connections to Country and support community wellbeing. Water in the right places at the right times is also vital for healthy regional landscapes and sustainable ecosystems.

Changing demands for water, increased climate variability and shifting community expectations mean we need to plan for and invest in improved long-term regional water security.

The Macquarie–Castlereagh Regional Water Strategy identifies the key water-related regional challenges we need to tackle over the coming decades and outlines the actions to respond to them. The best and latest climate evidence, along with a wide range of tools and solutions, has been used to chart a progressive journey for water needs for the next 20 years and beyond.



Image courtesy of Department of Primary Industries. Furrow irrigation of cotton, Warren.



# The regional water strategies

Across NSW, precious water resources are under pressure. A more variable climate, as well as changing industries and populations, means difficult decisions and choices must be made about how to balance the different needs for this essential resource and manage water efficiently and sustainably into the future.

The Macquarie–Castlereagh Regional Water Strategy is one of a suite of catchment-based strategies across the state (Figure 1). The strategies identify critical challenges that we need to tackle over the coming decades and outline the priorities and actions that we will undertake to respond to those challenges.

**Figure 1. Map of NSW regional water strategy regions**





# Objectives of regional water strategies

Regional water strategies set out a long-term 'roadmap' of actions to deliver 5 key objectives (Figure 2). Each regional water strategy describes the key challenges that impact the ability to achieve the objectives and identifies priority actions that address the challenges and works towards meeting at least one regional water strategy objective.

**Figure 2. Regional water strategy objectives**



The aim is for each strategy to have a comprehensive, balanced package of actions that delivers on all the regional water strategy objectives and aligns with the priorities and actions of the NSW Water Strategy.

When formulating plans to share water, the NSW Government must take all reasonable steps to prioritise the protection of water sources and their dependent ecosystems.<sup>1</sup>

When all or part of a water sharing plan has been suspended because of an extreme event, such as

drought, the focus is on securing water for critical human needs. At these times, under section 60 of the *NSW Water Management Act 2000*, critical human needs are the first priority; the taking of water for domestic purposes by persons with basic landholder rights, and domestic purposes or essential town services with an access licence is the second priority and the environment is the third priority. Outside of these extreme events, there is greater flexibility to deliver across all the objectives.

1. Subsections 9(1)(b), 5(3)(a) and 5(3)(b) of the *Water Management Act 2000*.

# Fitting regional water strategies with other water plans and policies

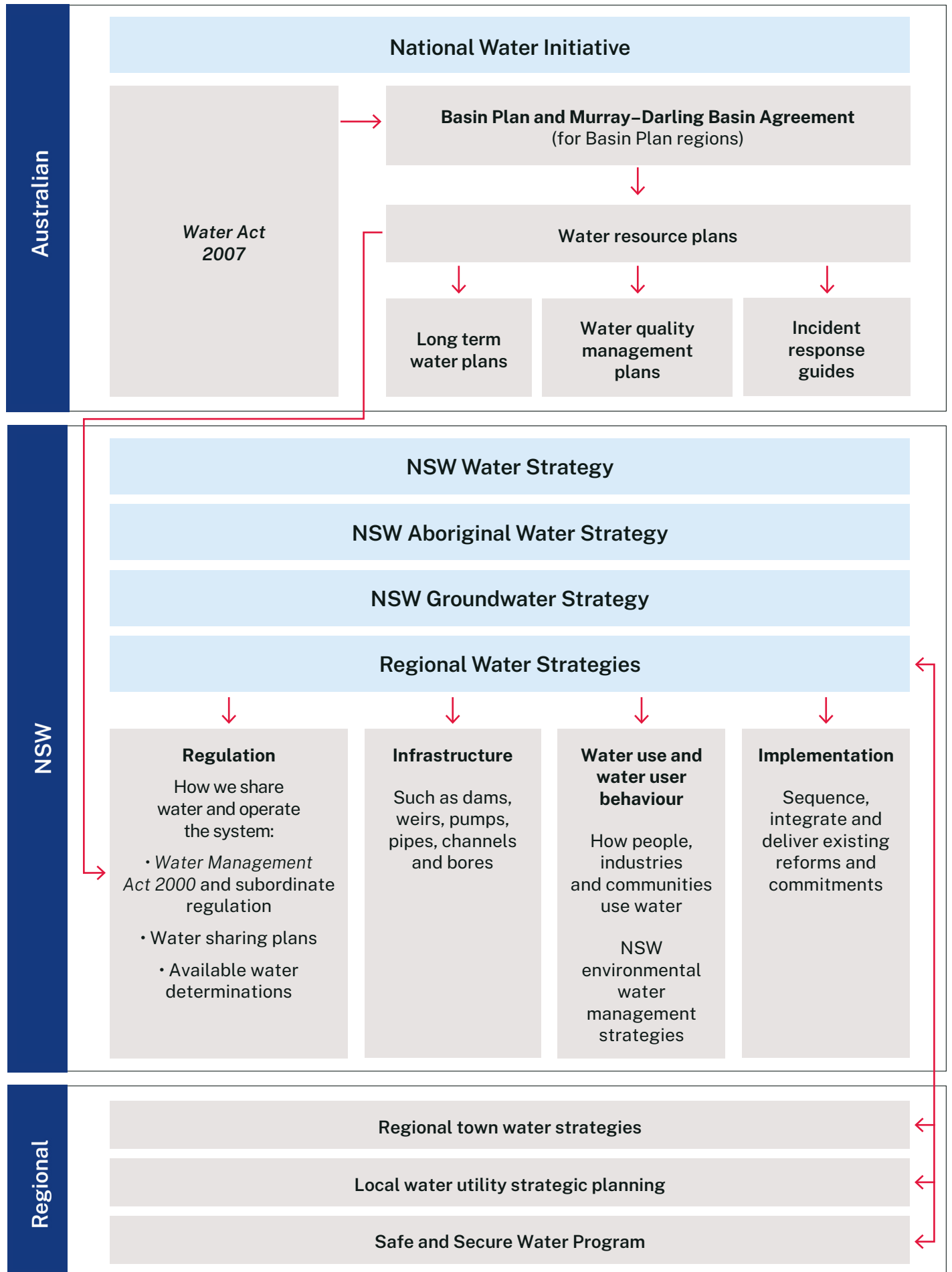
Each regional water strategy across the state sits within a broader policy and planning context, including a range of policies and plans that guide the management of water resources in NSW (Figure 3).



Image courtesy of Destination NSW. Aerial overlooking Nielson Park, Coonabarabran.



Figure 3. NSW water policy and planning context



The strategic planning framework for water management in NSW includes the NSW Water Strategy,<sup>2</sup> which aligns with a range of catchment-based regional, metropolitan and statewide water strategies. The NSW Water Strategy was developed in parallel with these strategies and guides the strategic, state-level actions. The regional water strategies prioritise how those statewide actions, as well as other region specific, place-based solutions, are to be staged and implemented in each region.

The NSW Water Strategy and the Macquarie–Castlereagh Regional Water Strategy also complement other whole-of-government strategies, including government commitments to Net Zero, the State Infrastructure Strategy<sup>3</sup> and the Central West and Orana Regional Plan 2041.<sup>4</sup>

Regional water strategies primarily relate to strategic water resource management. For example, regional water strategies set out actions to:

- reduce water security/drought risks, which can act as an input to local and statewide disaster planning
- mitigate flooding through natural or hard infrastructure, for example actions relating to catchment revegetation or potential alterations to dams which may also influence flood behaviour and can be investigated in flood risk management studies in accordance with the Flood Risk Management Manual – to inform local or state disaster planning
- mitigate the secondary effects of disasters, for example, actions to address fish kills and water quality, can also inform state disaster planning.

Local and statewide disaster and extreme event planning will be covered in the NSW Disaster Mitigation Plan and local disaster adaptation plans currently under development by the NSW Reconstruction Authority.<sup>5</sup>

The Authority will collaborate with councils to develop local disaster adaptation plans, so communities and stakeholders can identify the disaster risks and vulnerabilities in their unique regions.

The Authority is currently also leading the review of the NSW Recovery Plan. It was last updated in late 2021. The new NSW Recovery Plan will be a practical, action-oriented document, supported by a robust training program, and will outline the responsibilities, authorities and mechanisms for disaster recovery in NSW.

Further information relating to local council and state agency roles and responsibilities in relation to flooding is included in a breakout box under proposed action 1.2.

## The regional water strategy's response to flooding

The role of regional water strategies is to support the delivery of healthy, reliable and resilient water resources that sustain a liveable and prosperous region. Local councils are primarily responsible for managing flood risks in their local government areas as outlined in the Flood Risk Management Manual. The Department of Planning and Environment is the lead NSW flood risk management agency and provides technical advice and financial support to assist councils' flood risk management activities.

Further improvements to flood risk mitigation have been considered through the 2022 NSW Flood Inquiry and the NSW Government's response to the inquiry.<sup>6</sup>

Action 1.2: Establish a coordination approach involving all levels of government for implementing actions under Priority 1, in this strategy is intended to complement holistic flood management taking place through these channels.

2. [water.dpie.nsw.gov.au/plans-and-programs/nsw-water-strategy](http://water.dpie.nsw.gov.au/plans-and-programs/nsw-water-strategy)

3. [sis2022.infrastructure.nsw.gov.au/](http://sis2022.infrastructure.nsw.gov.au/)

4. [www.planning.nsw.gov.au/plans-for-your-area/regional-plans/central-west-and-orana-regional-plan-2041](http://www.planning.nsw.gov.au/plans-for-your-area/regional-plans/central-west-and-orana-regional-plan-2041)

5. Statewide disaster planning is primarily the responsibility of the NSW Reconstruction Authority, which was established in response to the 2022 Flood Inquiry. This is currently in development and will take a prevent, prepare, respond and recover approach. Further information is available at [www.dpie.nsw.gov.au/about-us/our-agencies/nsw-reconstruction-authority](http://www.dpie.nsw.gov.au/about-us/our-agencies/nsw-reconstruction-authority)

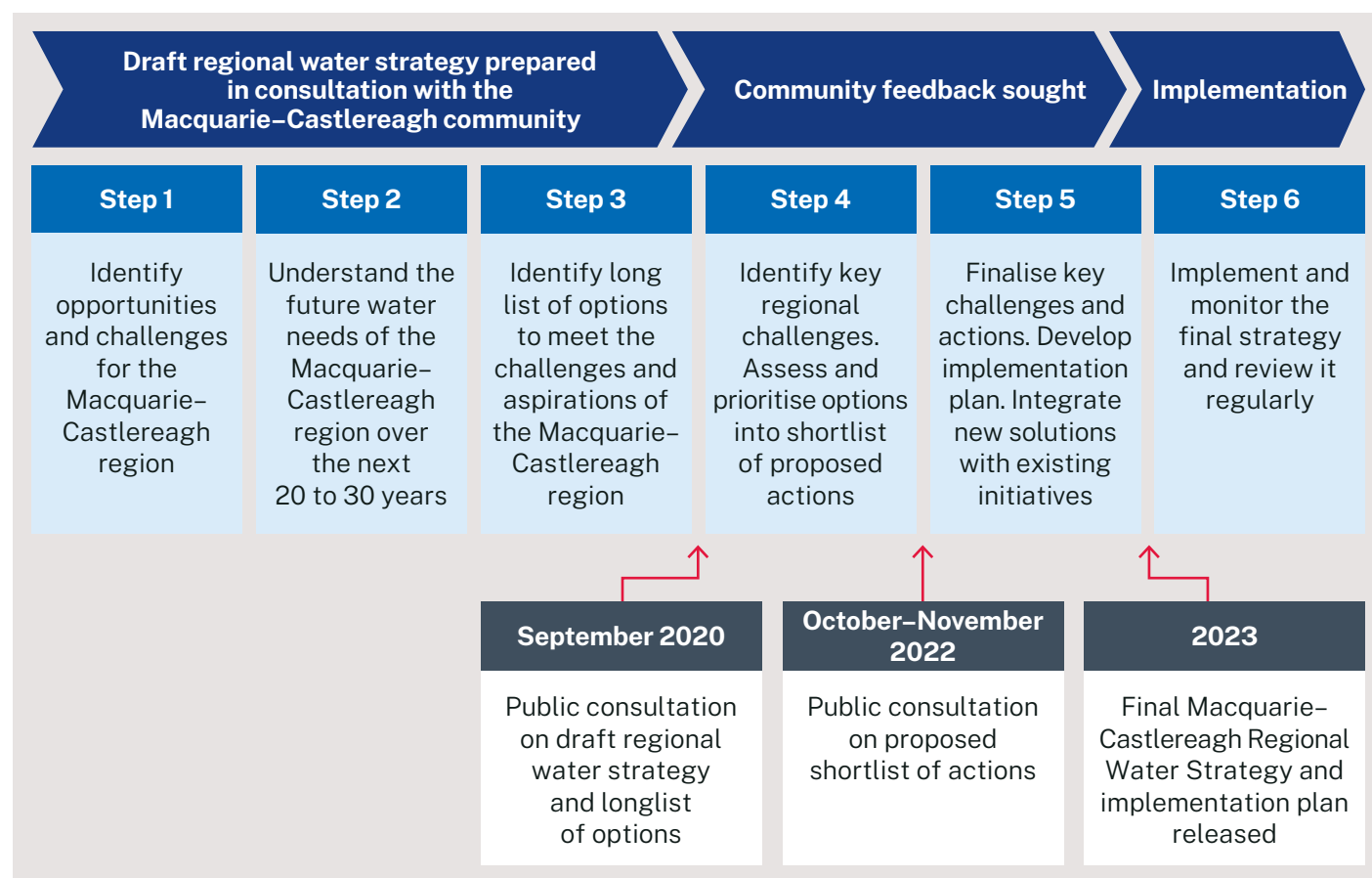
6. Available at [www.nsw.gov.au/nsw-government/projects-and-initiatives/floodinginquiry](http://www.nsw.gov.au/nsw-government/projects-and-initiatives/floodinginquiry)



# Development of the Macquarie–Castlereagh Regional Water Strategy

The strategy has been developed using an evidence-based and risk-based approach informed by extensive community consultation at each step of the process. A 6-step approach has been used to prepare and implement regional water strategies as shown in Figure 4.

**Figure 4. Process for developing regional water strategies**



## What informed the Macquarie–Castlereagh Regional Water Strategy

We have used feedback from the community, and the most recent data taken from a wide range of sources, to inform the regional water strategy and ensure it is founded on a robust evidence base. This information has been used to help identify the challenges that need to be tackled first, and the measures that will best support the region over the next 20 years.

Information used to develop the strategy included:

- new climate data
- extensive community consultation across a broad range of interests
- economic, ecological and hydrological analyses
- a range of existing studies
- existing commitments and reforms.



# Climate data in the regional water strategies

The regional water strategies are underpinned by ground-breaking new climate data. Our new climate datasets and modelling give us a more sophisticated understanding of past and future climatic conditions. These improved datasets integrate recorded historical data with paleoclimate data<sup>7</sup> to inform a modelling tool that generates 10,000 years of synthetic climate data. This information provides a much better understanding of the natural climate variability under current climate conditions. When combined with climate change projections, it is easier to understand how this natural climate variability will be influenced by human-induced climate change. We used both scenarios to assess risks to future water availability in each region.

This updated climate information has been used to help develop the regional water strategy and compare the effectiveness of the actions. It will also support all water users in making more informed decisions and better plan and prepare for climate risks.<sup>8</sup>

The section *What the future climate could look like in the Macquarie–Castlereagh region* summarises the results from the analysis of the new climate data for the region. We will continue to use the best and latest evidence about the future climate to help develop solutions for water challenges in the region.

## Regional water strategy modelling and flood analysis

The hydrological models used in development of regional water strategies produce information that helps us understand a region's long-term water security. They provide information to help us understand the whole waterway system, including catchment inflows, water storage behaviour, river flows and how water is used across the landscape.

Understanding flooding involves different hydrological approaches that consider shorter term weather events and hydraulic flood models that require a detailed understanding of the shape of the floodplain and the features that influence flood behaviour. These models are purpose built to support both an understanding of existing flood risk and how this may change with changes in climate, development and landscape.

7. Data reconstructed from before instrumental records began, using sources such as tree rings, cave deposits and coral growth. The data set can be found at: [datasets.seed.nsw.gov.au/dataset/water-modelling-stochastic-climate-data-macquarie](https://datasets.seed.nsw.gov.au/dataset/water-modelling-stochastic-climate-data-macquarie)

8. More information about these new climate datasets and how they are being used in our river system models is in the *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies)

## Extensive community consultation

Developing an effective and lasting regional water strategy requires input from Aboriginal people, landholders, community members, local councils, and industry and environment groups. We would like to acknowledge and thank all these groups and individuals for the time and effort they have given to providing input into the strategy.

We sought feedback on the Draft Macquarie–Castlereagh Regional Water Strategy through 2 public exhibition periods and a range of targeted engagement sessions (Figure 5). Community feedback was critical in shaping the final regional water strategy and implementation plan.<sup>9</sup>

Key insights we heard are shown in Table 1.

**Figure 5. Stakeholder engagement that informed the strategy**

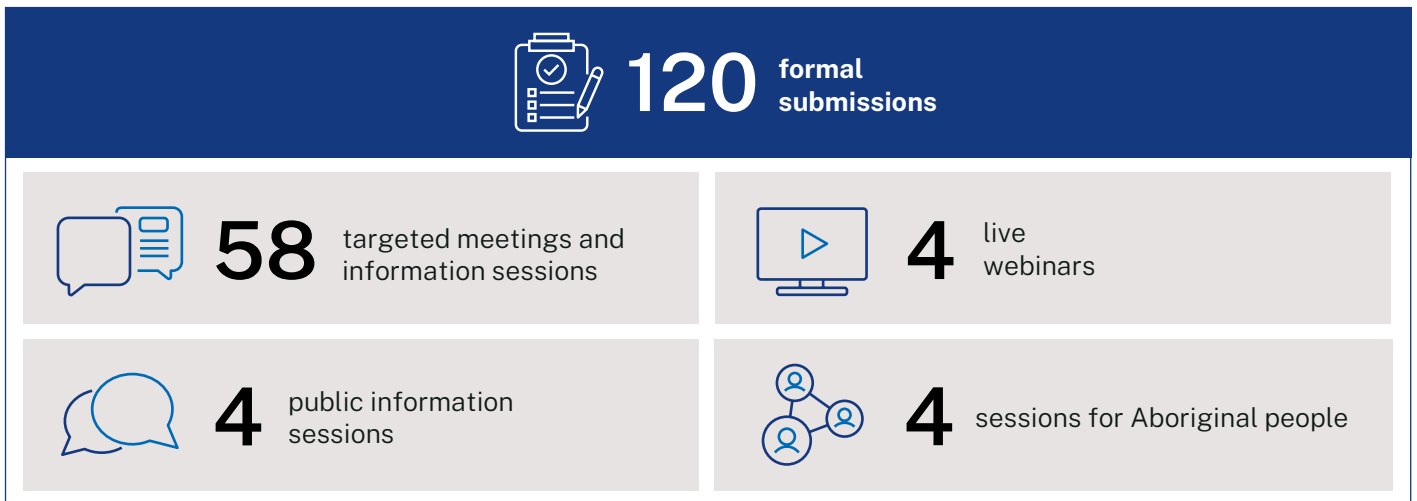


Image courtesy of iStock. Bogan River, Nyngan.

9. Information on community feedback that informed this strategy is available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy)



**Table 1. Summary of community feedback received during consultation on the Draft Macquarie–Castlereagh Regional Water Strategy and consultation paper**

Feedback theme	Feedback summary
<p><b>Need for long-term action</b></p>	<ul style="list-style-type: none"> <li>• We heard support for developing a long-term water strategy for the region. Multiple stakeholders requested that we continue to collaborate with the community and various levels of government during the implementation of the strategy and its actions.</li> <li>• Community feedback was supportive of long-term actions to improve ecological resilience, industry sustainability and Aboriginal water rights.</li> </ul>
<p><b>Water security for regional cities and towns</b></p>	<ul style="list-style-type: none"> <li>• While there was recognition that water security for Orange and Bathurst needs focused attention, there were mixed views on the best long-term option to secure water for these cities. <ul style="list-style-type: none"> <li>– <b>Critical human water needs definition:</b> Concerns were raised around the operation of Council-owned dams during the last drought and why businesses within towns were considered ‘critical human water needs’ and a higher priority than businesses outside of towns.</li> <li>– <b>Making better use of existing water:</b> There was strong support for water conservation and efficiency measures. There was also support for innovative water supply options, including purified recycled water and stormwater harvesting, as long as the programs do not impact on the environment or downstream water users.</li> <li>– <b>Infrastructure options:</b> While some suggested that new infrastructure in the region could secure water for the upper Macquarie, community members urged government to adequately consider downstream impacts of options being considered in the upper catchment.</li> </ul> </li> </ul>
<p><b>Water needs in the region’s west</b></p>	<ul style="list-style-type: none"> <li>• In the west of the catchment most of the feedback focussed on: <ul style="list-style-type: none"> <li>– support for additional <b>off-river storages</b></li> <li>– mixed views about raising the <b>full supply level of Burrendong Dam</b>. Some stakeholders suggested it needed to be prioritised for implementation while others were concerned that storing more water in the flood mitigation zone could erode planned environmental water provisions</li> <li>– concern from landholders on the <b>regulated effluent creeks</b> that changing the way they are operated would reduce water availability and impact on ecosystems relying on water in the creeks</li> <li>– general support for using <b>groundwater</b> more sustainably and improving knowledge about groundwater systems, with suggestions that the strategy needs a greater focus on groundwater, given its importance in parts of the region</li> <li>– concern about implementing the <b>NSW Floodplain Harvesting Program</b> in its current form</li> <li>– concern that the <b>drought of record</b> needs updating and that water allocations should consider the updated information.</li> </ul> </li> </ul>
<p><b>Clear and transparent information</b></p>	<ul style="list-style-type: none"> <li>• The need for <b>clear and transparent information</b> so that the community can understand how and why decisions will be made.</li> </ul>

# Economic, environmental and hydrological analyses

Robust assessments have been used to select the actions in the regional water strategy, including:

- hydrologic analysis of options that have the potential to change the supply, demand or allocation of water
- cost-benefit and cost-effectiveness economic analyses through rapid and detailed assessments
- assessment of environmental impacts, based on expert opinion, and detailed environmental watering requirements, based on hydrologic modelling
- qualitative assessments based on feedback from experts, Aboriginal people and the community.

The various analyses in the regional water strategies are based on the best available information at the time. As with all types of analyses, a range of assumptions are made. Significant changes to the critical assumptions used in the strategy may trigger the need to review or amend the strategy.

Critical assumptions adopted within the analyses include:

- **town water supply risks** focused on surface water availability for the towns supplied by Burrendong and Windamere dams and do not include consideration of existing alternative supply sources such as groundwater. A new river system model was built for the upper Macquarie catchment to inform development of this strategy and allowed assessment of town water security risks for Bathurst, Orange and Oberon that incorporated all town water supply sources
- **population changes** have been included in accordance with the medium population growth forecasts in the NSW Government's Common Planning Assumptions.<sup>10</sup> High population growth forecasts were also used as a sensitivity analysis for assessing the water security risks of some towns
- **water use and industry mix in the region** were assumed to be constant over the 40 years examined. Significant changes in the nature of the crops produced, or the industry mix in the Macquarie–Castlereagh region, will change the amount of water used and may require a review of the strategy.

Climate variability outside the bounds of the datasets used to inform this strategy may also trigger a review of the Macquarie–Castlereagh Regional Water Strategy.

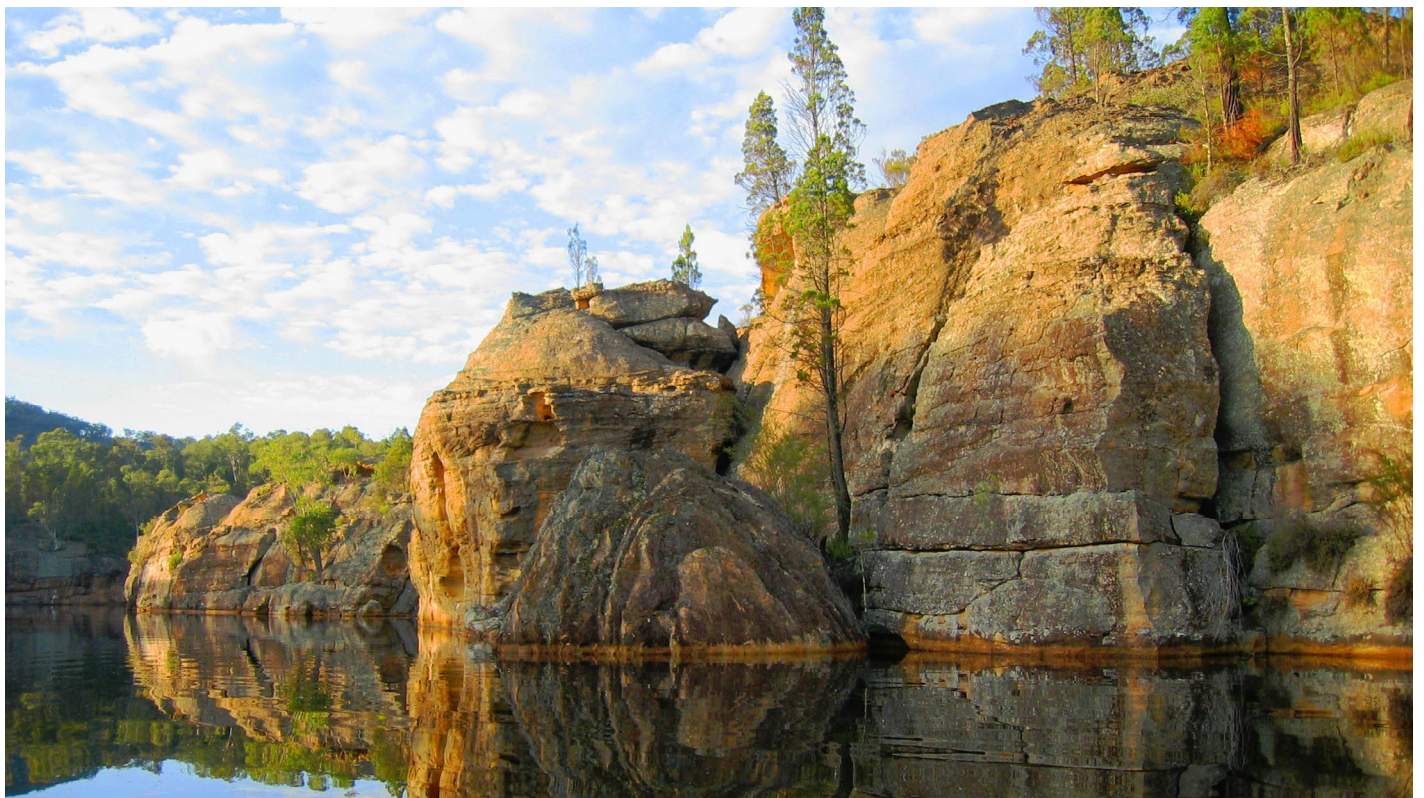


Image courtesy of Destination NSW. Dunns Swamp in Wollemi National Park, near Rylstone.

10. More information is available at: [www.treasury.nsw.gov.au/information-public-entities/nsw-common-planning-assumptions](http://www.treasury.nsw.gov.au/information-public-entities/nsw-common-planning-assumptions)



## Existing studies

A significant amount of work has been undertaken to understand the risks affecting water resource management in regional NSW.<sup>11</sup> In the Macquarie–Castlereagh region, this has included catchment studies, water security reports and existing water allocation and drought planning, as well as regional development, infrastructure and environmental strategies prepared by NSW Government departments and agencies. The following studies were critical for informing the Macquarie–Castlereagh Regional Water Strategy:

- WaterNSW’s 20 Year Infrastructure Options Study for Rural Valleys
- Independent Review of the Northern Basin First Flush Assessment<sup>12</sup>
- the *Independent Assessment of Social and Economic Conditions in the Murray–Darling Basin*, commissioned by the Australian Government<sup>13</sup>
- the Department of Planning and Environment’s Macquarie–Castlereagh Long-Term Water Plan<sup>14</sup>
- the Australian Competition and Consumer Commission’s inquiry into markets for tradeable water rights in the Murray–Darling Basin.<sup>15</sup>

The strategy has also been guided by NSW’s commitments under the Murray–Darling Basin Plan.

## Building on existing commitments and reforms

The NSW Government is preparing regions for the future. Some statewide water initiatives include:

- improving water and sewage services for Aboriginal communities
- improving compliance and transparency around water use and access
- implementing robust metering laws to ensure the vast majority of water taken in NSW is accurately measured and monitored.<sup>16</sup>

In 2020, the Department of Planning and Environment commenced implementation of all the environmental water reforms that arose from the Water Reform Taskforce, which was set up following the Independent Investigation into NSW Water Management and Compliance<sup>17</sup> report.

Regional water strategies improve water security and reliability in our regions by building on existing actions being taken by governments.

11. More information is in the *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies)

12. Available at: [www.industry.nsw.gov.au/water/allocations-availability/northern-basin-first-flush-assessment](http://www.industry.nsw.gov.au/water/allocations-availability/northern-basin-first-flush-assessment)

13. Available at: [www.mdba.gov.au/publications-and-data/publications/independent-assessment-social-and-economic-conditions-basin](http://www.mdba.gov.au/publications-and-data/publications/independent-assessment-social-and-economic-conditions-basin)

14. Macquarie–Castlereagh Long-Term Water Plan: [www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/macquarie-castlereagh](http://www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/macquarie-castlereagh)

15. Available at: [www.accc.gov.au/about-us/publications/murray-darling-basin-water-markets-inquiry-final-report](http://www.accc.gov.au/about-us/publications/murray-darling-basin-water-markets-inquiry-final-report)

16. The NSW Government and the Australian Government have committed \$23.6 million and \$12.5 million respectively to the metering program to ensure that meters are upgraded effectively. This funding includes rebates for water users who switch to telemetry-based systems.

17. Available at: [water.dpie.nsw.gov.au/about-us/how-water-is-managed/independent-review-of-water-management-and-compliance](http://water.dpie.nsw.gov.au/about-us/how-water-is-managed/independent-review-of-water-management-and-compliance)



Image courtesy of Quentin Jones, Department of Planning and Environment. Telegraph Hotel, Bank Street Molong.



# The Macquarie– Castlereagh region



Image courtesy of Peter Robey, Department of Planning and Environment,  
Vineyard, Dubbo.

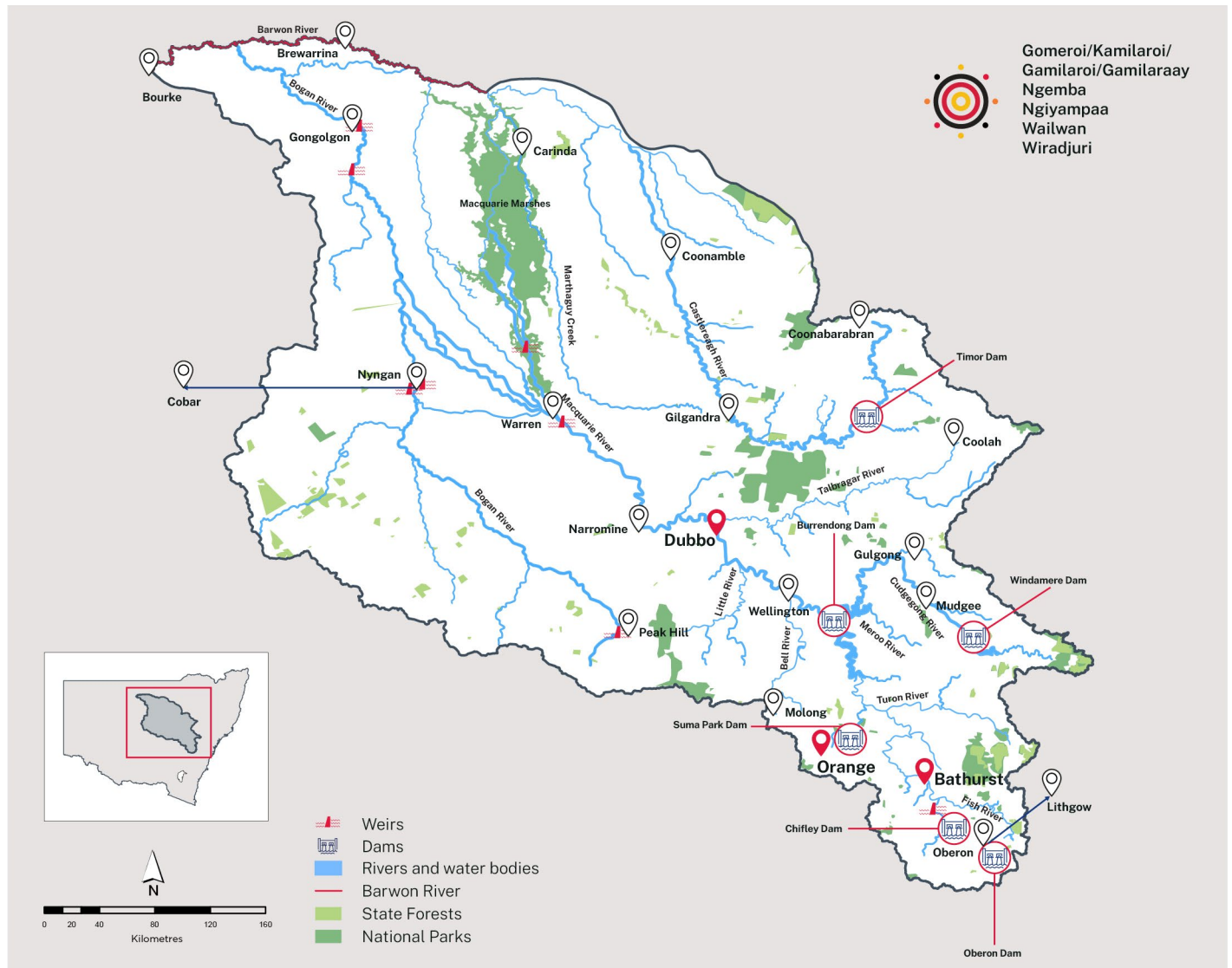


**Figure 6. Snapshot of the Macquarie–Castlereagh region**





**Figure 7. Map of the Macquarie–Castlereagh region**



The Macquarie–Castlereagh region is located within the traditional lands of the Gomeroi/Kamilaroi/Gamilaroi/Gamilaraay, Ngemba, Ngiyampaa, Wailwan and Wiradjuri nations who have lived in the region for over 60,000 years. Water is the lifeblood of Aboriginal people. It allows kinship, connection, stories, songlines, healing through medicine, and food. Healthy waterways and groundwater systems are critical to Aboriginal communities for culture, health and wellbeing. The lands and water of the Macquarie–Castlereagh contain places of deep significance to Aboriginal people that are central to their spiritual and religious belief systems.

The Macquarie–Castlereagh region covers an area of around 92,000 km<sup>2</sup> and varies from the steep terrain of the Great Dividing Range in the east to open plains in the west. The region covers the catchments of the Macquarie, Castlereagh and Bogan rivers that drain to the northwest and join the Barwon–Darling River. Significant groundwater resources in the region include the Great Artesian Basin, fractured rock aquifers and shallow alluvial aquifers.

The region is home to more than 200,000 people, with more than half of the population living in the centres of Dubbo, Bathurst and Orange. These regional centres – and other towns such as Coonamble, Mudgee, Coonabarabran, Wellington, Narromine and Nyngan – provide important services and employment for surrounding communities. Cobar, while located in the adjoining Western region, draws water from the Macquarie and Bogan catchments.

Agriculture, food processing and mining are major contributors to the region’s economy, along with tourism, health and education services, and the transport, freight and logistics industry.

## Environmental significance of the Macquarie–Castlereagh region

The Macquarie–Castlereagh’s expansive river systems, floodplains, wetlands and aquifers underpin the health of the natural environment, support threatened and endangered plants and animals, and are an integral part of the broader Murray–Darling Basin. Some areas in the Macquarie Valley have also been listed as part of the Lowland Darling Endangered Ecological Community under the *NSW Fisheries Management Act 1994*, recognising the ecological value and significance of all native fish and aquatic invertebrates in these systems.

As well as contributing to the wellbeing of the community and liveability of the region, these environmental assets provide recreation and tourism opportunities, support the economy and provide important ecosystem services such as water purification, managing flood risks and nutrient cycling.

### The Macquarie Marshes – an internationally recognised environmental asset

The region is home to the Macquarie Marshes, one of the largest remaining inland semi-permanent wetlands in south-eastern Australia, despite their extent having reduced by up to 50% since the mid-1900s.<sup>18</sup> The Marshes form the heart of the traditional country of the Wailwan people, who valued them as an important Aboriginal settlement because of their rich and reliable resources and iconic cultural values. The Marshes continue to be important for the Wailwan and other Aboriginal people.

The Macquarie Marshes, a non-terminal wetland, are situated in the lower reaches of the Wambuul / Macquarie River catchment. The Marshes commence at Marebone Weir north of Warren and extend for 120 km until the many watercourses form into a single defined channel near Carinda.

Approximately 19,000 ha of the Macquarie Marshes is listed as internationally significant under the Convention of Wetlands of International Importance (Ramsar). It supports threatened species, endangered ecological communities and species of conservation concern. This includes iconic water birds, fish, aquatic animals and vegetation communities. The Marshes contain the largest river red gum woodland in the northern Murray–Darling Basin (approximately 40,000 ha) and extensive areas of coolabah and black box woodland. As well as being a nationally significant breeding site for waterbirds, the Marshes are an important refuge for wildlife during dry times.<sup>19</sup>

Conserving the Macquarie Marshes is a strategic priority stated in the long-term water plan for the region.<sup>20</sup> To maintain them into the future, the wetlands need a mix of regular inundation – for vegetation such as reedbeds and water couch meadows – as well as inundation provided by only the largest floods.

18. Kingsford R.T and Thomas R.F 1995, *The Macquarie Marshes in arid Australia and their waterbirds: a 50-year history of their decline*, *Environmental Management*, 19, 867-78.

19. Department of Environment, Climate Change and Water NSW 2010, *Macquarie Marshes – Adaptive Environmental Management Plan*, retrieved 19 September 2023 from [www.environment.nsw.gov.au/research-and-publications/publications-search/macquarie-marshes-adaptive-environmental-management-plan](http://www.environment.nsw.gov.au/research-and-publications/publications-search/macquarie-marshes-adaptive-environmental-management-plan)

20. Department of Planning, Industry and Environment 2020, *Macquarie–Castlereagh Long-Term Water Plan Part A: Macquarie–Castlereagh catchment*, retrieved 19 September 2023 from [www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/macquarie-castlereagh](http://www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/macquarie-castlereagh)



## Addressing environmental challenges facing the Macquarie–Castlereagh region

Changes in water use and land use across the region have impacted the health of native aquatic species populations and their ecosystems. Barriers to fish passage, changes to water flow, degradation of in-stream habitat and riparian vegetation, development of water infrastructure, poor land management practices and introduced fish species, have put many native fish species under pressure by reducing water quality and limiting their ability to carry out lifecycle migration.

The potential for longer and more severe droughts will increase the risk of ecosystem damage and decline in connectivity. Managing these risks will need coordinated and cooperative action across all parts of the community, as well as a better understanding of how potential future climate scenarios might impact on different parts of the environment.

A range of water reforms, including the dedication of water to the environment and connectivity improvement measures, have sought to stop further decline and improve the condition and resilience of these environmental assets. However, parts of the catchment are still in poor condition and climate change will increase the risk for many species and ecosystems.

Through strategic planning the NSW Government aims to build on these reforms and enhance the natural environment. Strategic actions include improving knowledge of the region's environment and its water needs, introducing measures to support flows at a catchment level, supporting better cultural involvement in water, and improving the long-term outcomes of water for the environment. The Macquarie–Castlereagh Regional Water Strategy sets out a suite of actions that will be delivered by the NSW Government to address the region's water-related environmental challenges.



Image courtesy of Nicola Brookhouse, Department of Planning and Environment. Magpie Geese, Macquarie Marshes.

# Water use in the region

## Surface water

The Macquarie–Castlereagh region has 4 main river systems: the Castlereagh, Macquarie, Cudgegong and Bogan (see Figure 7). Many of the region’s water needs are supported by these river systems, including the major dams listed in Table 2.

- **Castlereagh River system:** The towns of Coonabarabran, Gilgandra, Binnaway, Mendooran, Gulargambone and Coonamble are within the Castlereagh River catchment. The river system is unregulated and water availability is often variable with periods of high flows and no flows. Water extracted from the Castlereagh River catchment is used primarily for stock watering, dryland agriculture and town water supply, as well as supplementing rainfall for fodder and cereal crops (Table 3). Many water users rely largely on groundwater to sustain their water needs between flood events.
- **Cudgegong River system:** The Cudgegong River becomes a regulated river at Windamere Dam, which controls the flows along the Cudgegong River and supports the towns of Mudgee and Gulgong. The Cudgegong River flows into Burrendong Dam.
- **Macquarie River system:** Water from the Wambuul / Macquarie River supports a large percentage of the region’s population and various industries.

The Wambuul / Macquarie River and its tributaries above Burrendong Dam supply water to the growing regional centres of Bathurst and Orange, several smaller towns, town-based businesses, and rural landholders and farms (Table 3).

Burrendong Dam is the main water storage in the region and is located upstream of Wellington. It regulates a 500 km section of the Wambuul / Macquarie River, and water released from the dam is used to supply towns and irrigated agriculture. Nyngan and Cobar and nearby mines also rely on water from Burrendong Dam. Cobar is located outside the region but is supplied water from the Wambuul / Macquarie River via Nyngan and the Albert Priest Channel – an unlined open channel that links the regulated Wambuul / Macquarie River near Warren to the Bogan River.

Water for the environment is also supplied from Burrendong Dam to meet the needs of the Macquarie Marshes and other environmental assets in the mid to lower end of the river system.

The lower Wambuul / Macquarie River, downstream of the Macquarie Marshes, is unregulated. Most of the unregulated entitlement is used for the irrigation of crops including vegetables, fodder, seed crops and cotton.

- **Bogan River system:** The Bogan River starts near Peak Hill and flows generally north-north west past Nyngan. The river supports a range of communities and landholders and is important for delivering water from the Macquarie catchment to the Barwon–Darling River. The system receives water from the Wambuul / Macquarie River via the Gunningbar, Belaringar and Duck creeks, and the Albert Priest Channel.



**Table 2. Major water infrastructure in the Macquarie–Castlereagh region**

	<b>Burrendong Dam</b>	<b>Windamere Dam</b>	<b>Oberon Dam</b>	<b>Chifley Dam</b>	<b>Suma Park Dam/ Spring Creek Dam/ Gosling Creek Dam</b>
<b>River/ creek</b>	Wambuul / Macquarie River	Cudgegong River	Fish River	Campbells River	Summer Hill Creek/ Spring Creek/ Gosling Creek
<b>Storage</b>	1,678,000 ML  489,000 ML of this capacity is only used on a temporary basis due to its function as a flood mitigation measure	368,120 ML	45,000 ML	30,800 ML	Suma Park Dam – 17,290 ML  Spring Creek Dam – 4,680 ML  Gosling Creek Dam – 400 ML
<b>Operating authority</b>	WaterNSW	WaterNSW	WaterNSW	Bathurst Regional Council	Orange City Council
<b>Purpose</b>	Town water supply, stock and domestic, irrigation, industrial and environmental flows	Town water supply, stock and domestic, irrigation, industrial and environmental flows	Town water supply, stock and domestic, commercial activities	Town water supply, stock and domestic and environmental flows	Town water supply, stock and domestic and environmental flows
<b>Towns supplied</b>	Dubbo, Wellington, Warren, Nyngan and Cobar	Mudgee	Oberon, Lithgow and Upper Blue Mountains	Bathurst	Orange

**Table 3. Regulated and unregulated river licences in the Macquarie–Castlereagh region**

Regulated Macquarie and Cudgegong rivers			Unregulated Macquarie–Bogan and Castlereagh rivers		
Entitlement	Proportion of shares compared to total share pool (%)		Entitlement	Proportion of shares compared to total share pool (%)	
	Macquarie	Cudgegong		Macquarie–Bogan	Castlereagh
Domestic and stock	<1%	2%	Domestic and stock	<1%	<1%
Town water	2%	9%	Town water*	18%	8%
High security	2%	18%	Unregulated (general)	41%	76%
General security	88%	67%	Unregulated (regulated supply)	25%	–
Supplementary	7%	4%	High flow	16%	15%

Source: *Water Sharing Plan for the Macquarie and Cudgegong Regulated River Water Source 2016*; *Water Sharing Plan for the Macquarie and Bogan Unregulated River Water Sources 2012* and *Water Sharing Plan for the Castlereagh Unregulated Water Sources 2011*.

\*Note: The figure comprises several licence categories.



Image courtesy of Peter Robey, Department of Planning and Environment. Field irrigation, Dubbo.



# Groundwater

Groundwater sources across the Macquarie–Castlereagh region include:

- Bell, Castlereagh, Cudgegong, Macquarie and Talbragar alluvial groundwater sources
- the Great Artesian Basin, which underlies the northern part of the Macquarie River catchment downstream of Warren
- the Orange Basalt, Oxley Basin and the Lachlan Fold Belt fractured rock groundwater water sources.

Groundwater is an important source for stock, domestic, irrigation, industrial, town needs and groundwater-dependent ecosystems (Table 4); however, it is not equally available across the region. Some towns such as Narromine, Gulgong, Dunedoo and Coonamble rely on groundwater for their town water needs. Warren and Gilgandra use groundwater as their primary drinking water source. In places such as Cobar and Nyngan, access to groundwater is limited due to low availability and quality.

In more extreme dry times, there is a greater reliance on groundwater, when water users and towns such as Coonabarabran and Dubbo use it as an alternate supply of water.

**Table 4. Alluvial groundwater licences in the Macquarie–Castlereagh region**

Entitlement	Proportion of shares compared to total pool (%)					
	Bell Alluvial	Castlereagh Alluvial	Cudgegong Alluvial	Lower Macquarie Zones 1 – 6	Talbragar Alluvial	Upper Macquarie Alluvial
Domestic and stock	<1%	13%	<1%	2%	1%	1%
Town water	2%	–	22%	4%	11%	14%
Aquifer	98%	87%	13%	94%	88%	85%
Aquifer (high security)	–	–	65%	–	–	–

Source: *Water Sharing Plan for the Macquarie Alluvial Groundwater Sources 2020*.

Note: While most extraction occurs in the alluvial aquifers, they overlie porous and fractured rock groundwater sources that have additional shares that are not included in this table. Water sharing plans not shown in the table include *NSW Great Artesian Basin Groundwater Sources 2020*, *NSW Great Artesian Basin Shallow Groundwater Sources 2020*, *NSW Murray–Darling Basin Fractured Rock Groundwater Sources 2020* and *NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*.



Image courtesy of Destination NSW. Windamere Dam, Mudgee.



# What the future climate could look like in the Macquarie– Castlereagh region



Image courtesy of iStock. Bathurst, NSW.



## Climate data and modelling used to develop the strategy

We have used 3 climate datasets to understand the key regional challenges and to assess the effectiveness of actions under different climate change scenarios:

- **historical data:** about 130 years of observed rainfall, temperature and evaporation records collected by the Australian Bureau of Meteorology
- **long-term climate variability risk data (stochastic data):** 10,000 years of stochastically-generated climate data developed using paleoclimatic information by the University of Adelaide
- **dry climate change scenario:** modified version of the long-term climate variability data, scaled up or down using the NSW and Australian Regional Climate Modelling (NARCLiM) climate projections. These scaling factors compare the baseline period of 1990–2009 with climate projections for the periods 2020–2039 and 2060–2079. These scaling factors have been applied to every climate timeseries used in the modelling.

Combined, these 3 datasets provide us with a range of plausible climate futures that cover a range of wet and dry sequences.<sup>21</sup>

### Why we have used the dry ‘worst-case’ future climate scenario

The regional water strategies planned for climate change by using a dry ‘worst-case’ climate change scenario. The dry future climate change scenario<sup>22</sup> is the SRES A2, which represents a high carbon emissions scenario and therefore results in higher projected climate change impacts on the region.<sup>23</sup> This is not a forecast of how climate change is expected to eventuate, but it is one possible future outcome.

This scenario assumes that governments around the world will not take any action to reduce carbon emissions. This scenario may not occur because many governments, companies and people around the world are already acting on climate change. Using this ‘worst-case’ scenario helps to plan strategically and focus on the key challenges facing a region. It also helps to understand how different options might work in a very dry climate in the future.

Considering the worst-case climate scenario together with current climatic conditions is appropriate for this type of strategic-level assessment. It allows us to assess the full range of risks to the water system. We will need to complete more refined assessments of climate change risk when we implement many of the regional water strategy actions. These additional assessments will be based on both the actions’ planning horizons and the latest climate science.

This recognises that policy and operational decisions with short-term planning horizons should be based on shorter-term climate scenarios and risk management. When making long-term infrastructure and investment decisions, we will need to consider how the climate may change decades into the future. These longer-term climate scenarios may be more extreme than the shorter-term climate scenario.

Our climate science is continuously improving. The regional water strategies are an important first step to better understand the region’s climate and the potential vulnerability of our towns, communities, industries and the environment to a more variable and changing climate. We know that the future climate is uncertain, and work is progressing to further enhance understanding of the region’s climate and how it affects our vital water resources, including groundwater.

21. For further details about the new climate data and modelling, refer to [water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/climate-data-and-modelling](http://water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/climate-data-and-modelling)

22. The scenario uses the regionally downscaled factors from the NARCLiM 1.0 Project to adjust the long-term past climate scenario rainfall and evapotranspiration data. Further information on the NARCLiM 1.0 Project is available on the NSW Government, AdaptNSW website: [www.climatechange.environment.nsw.gov.au/climate-projections-used-adaptnsw](http://www.climatechange.environment.nsw.gov.au/climate-projections-used-adaptnsw)

23. The SRES A2 assumes a 2°C warming over the regional water strategy planning horizon.



# Climate snapshot

## The Macquarie–Castlereagh region has a naturally variable climate

The Macquarie–Castlereagh region has a highly variable climate, ranging from temperate conditions around Orange to semi-arid conditions on the alluvial plains north of Warren. Average, maximum and minimum temperatures in the region have been increasing over the length of the observed historical record and, over the last 30 years, there have been more hot days and consecutive days above 38°C each year.<sup>24</sup>

Across the region, annual rainfall decreases from east (over 1,200 mm) to west (around 300 mm), while evaporation and temperature increases – meaning there is more evaporation where there is less rain. Annual evaporation ranges from ~1,250 mm to ~1,500 mm.

Like many other inland catchments across northern NSW, the Macquarie–Castlereagh region can experience multiple consecutive years dominated by either wet or dry conditions. Over the past 130 years the region has undergone several transitions between wet and dry periods:

- the 1900s to 1940s was a comparatively dry period and most of the recorded short droughts (1–5 years) and decadal droughts (10 years) occurred in this period
- the 1950s to 1990s was a comparatively wet period
- since the Millennium Drought, the observed record suggests a return to a dry period, however the past decade has illustrated the extreme climate variability that can be experienced, with Burrendong Dam going from flood operations in 2016, to almost empty during the 2017–2020 drought, and back to flood operations again in 2021–2022.

## Our latest data suggests that a future climate could be even more variable

We don't know for sure what the future climate will be like. It may be similar to the past or it might be drier than previously seen.

The NSW Government's new climate data has improved understanding of the natural variability of the state's climate, beyond the observed historical records. This includes a more realistic picture of the frequency and severity of past wet and dry periods in the Macquarie–Castlereagh region.

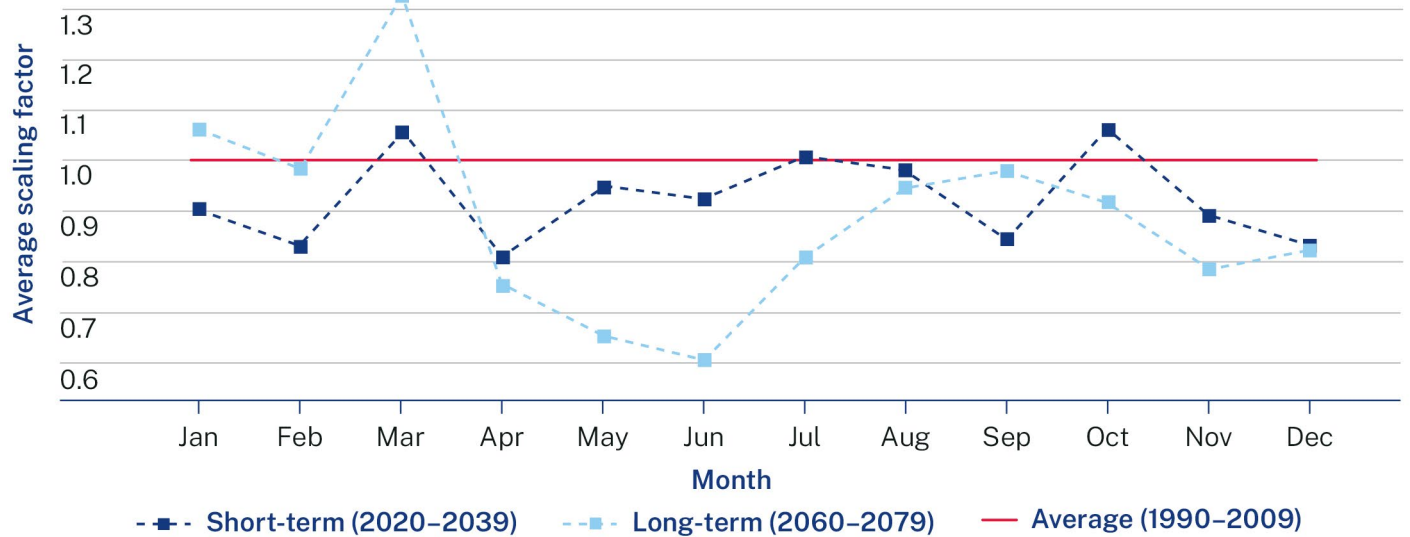
The new data suggests that there have been more extreme dry and wet conditions in the long-term past than have been seen in the last 130 years. If the region's future climate is like its past climate – before observed records began – we could experience more variability in rainfall, particularly during summer and winter, more variability in catchment inflows and potentially more extreme droughts.

Our analysis of climate change projections shows us that under the worst-case dry climate change scenario, if no action is taken, by 2070 there could be:

- a reduction in average annual rainfall by up to 12% and shifts in seasonal patterns that cause an overall decrease in spring rainfall and an increase in autumn rainfall (Figure 8)
- a 2–3% probability of conditions similar to the 2017–2020 drought, meaning that a drought of this severity and length may go from a 1 in 1,000-year event to a 1 in 50-year event
- increasing potential for droughts that persist for more than 10 years, similar to the 1932–1942 drought
- a significant decrease (up to 50%) in inflows in the region and increasing potential of Burrendong Dam falling below critical levels. This would significantly increase water security risks for water users below Burrendong Dam, particularly Dubbo, Wellington, Nyngan and Cobar.

24. Regional Weather and Climate Guide 2019, *A climate guide for agriculture – Central West, NSW*.

**Figure 8. Projected impacts of a dry climate change scenario on average monthly rainfall in the Macquarie–Castlereagh region\***



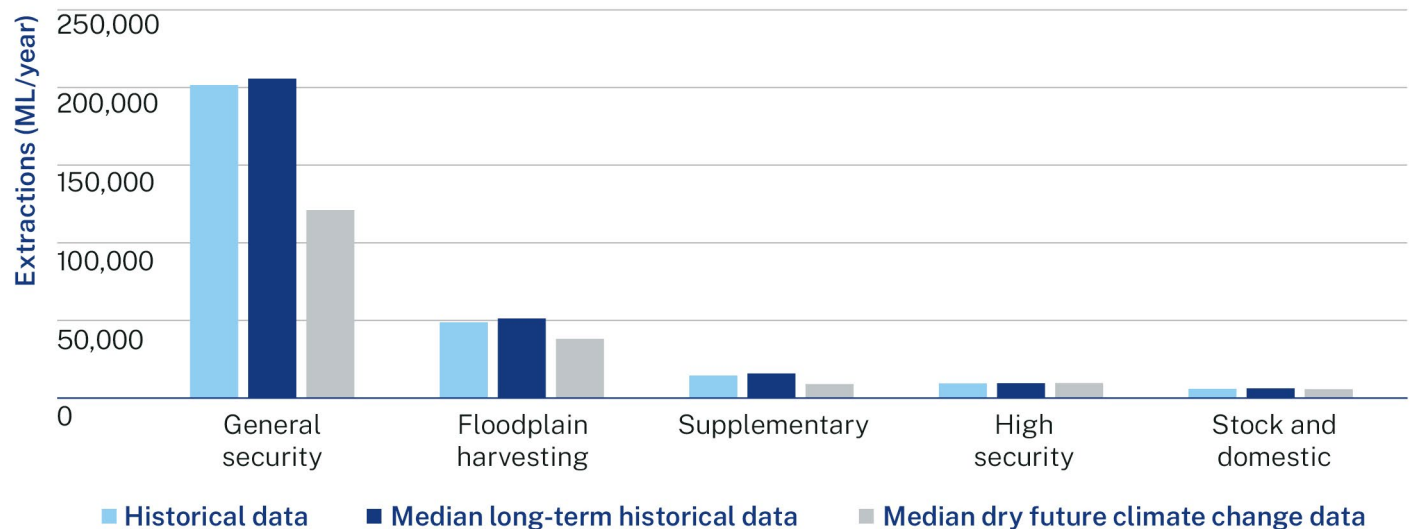
\*Short-term (2020–2039) and Long-term (2060–2079) projections are compared to baseline data from 1990–2009.

Source: Department of Planning, Industry and Environment–Water 2020, catchment climate data

The potential impacts of decreased inflows on water licences in the regulated Wambuil / Macquarie River show that there could be a 40% reduction in water availability for general security licences and supplementary licences over the coming 40 years (Figure 9). For the irrigated agriculture industry, this would represent a 45% reduction in profit. It would also impact the ability of water managers to provide water for the environment.

Climate analysis released by the Bureau of Meteorology and CSIRO in November 2022 has already shown a shift towards drier conditions across Australia’s south-east, with more frequent years of below average rainfall, especially for the cool season months of April to October. This drying trend is the most sustained large-scale change in observed rainfall since widespread observations became available in the late 1880s.<sup>25</sup>

**Figure 9. Possible impacts on average annual diversions for Macquarie–Castlereagh regulated rivers water access licences and floodplain harvesting**



Source: Department of Planning, Industry and Environment–Water 2020, hydrological modelling

25. The State of the Climate report can be found at: [www.csiro.au/en/research/environmental-impacts/climate-change/state-of-the-climate](http://www.csiro.au/en/research/environmental-impacts/climate-change/state-of-the-climate)



# The challenges facing the Macquarie– Castlereagh region

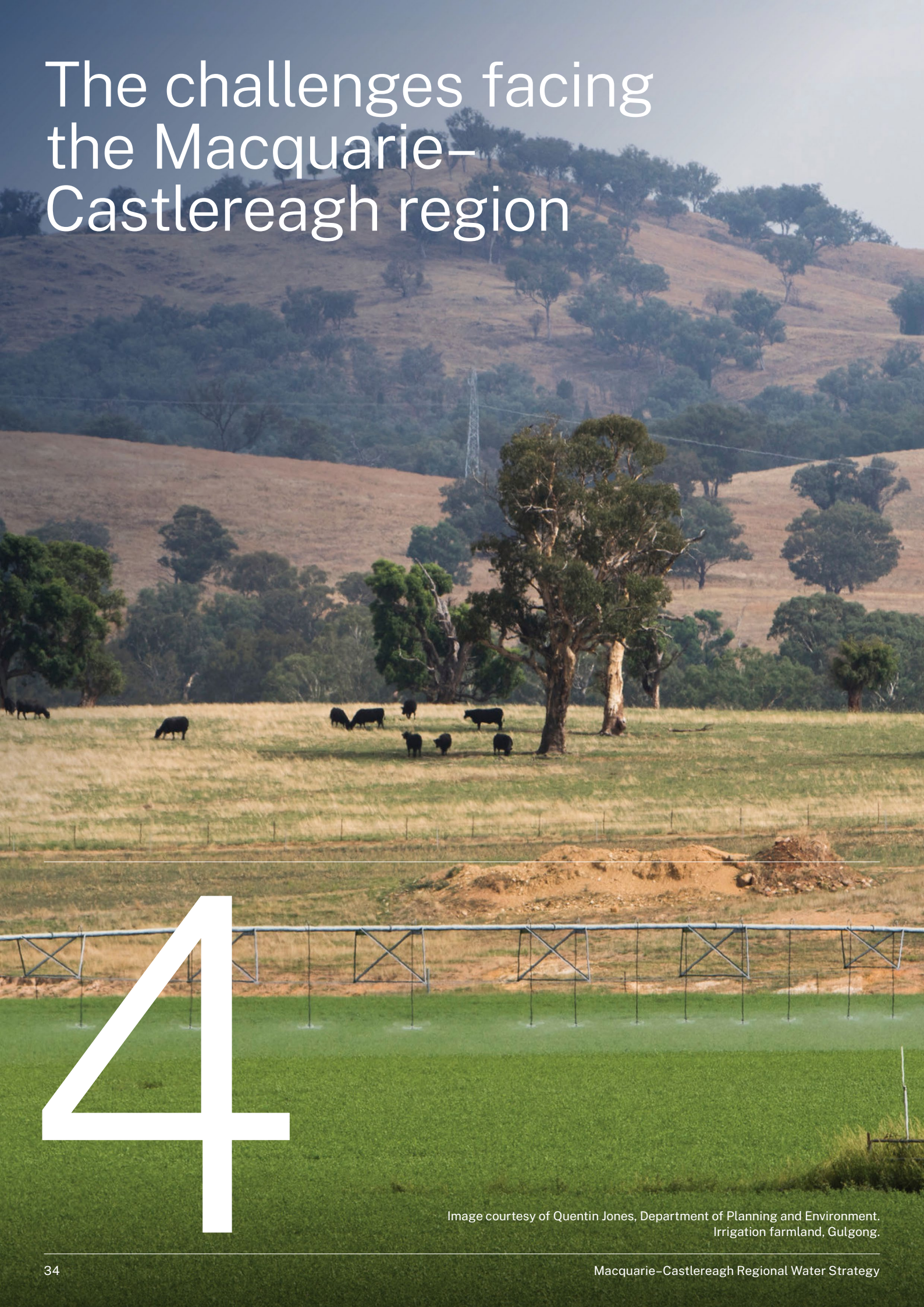


Image courtesy of Quentin Jones, Department of Planning and Environment.  
Irrigation farmland, Gulgong.



Like all regions across Australia, the Macquarie–Castlereagh region faces a more variable and changing climate. We need to transition to a scenario where we do more with less water, make smarter decisions about water use and management – armed with better knowledge and information – and protect important water needs.

We have identified 5 key challenges that are immediate priorities for the region:

- Reducing water supply risks for regional cities and rural and remote towns
- Supplying water to high priority needs in the west of the catchment and connected valleys
- Maintaining and improving river, floodplain and wetland health
- Addressing barriers to Aboriginal people's water rights
- Supporting a growing regional economy in a future of potentially reduced water availability.

Addressing these challenges will help us meet the vision and objectives we have set for the Macquarie–Castlereagh Regional Water Strategy.



Image courtesy of Department of Primary Industries. Macquarie River, NSW.





# Challenge: Reducing water supply risks for regional cities and rural and remote towns

Dams that supply regional cities like Bathurst and Orange can go from full to near empty in less than 4 years, and towns that rely on groundwater face uncertainty about water availability during drought. Even with recent investments in water, there are still immediate water security risks for regional cities in the Macquarie Valley. If there are no changes to infrastructure, policy, or demand management practices, future droughts could have severe consequences for cities and towns in the region.

## Water security risks remain for growing regional cities despite recent investments

Bathurst, Orange and Dubbo are large and growing regional cities in the Macquarie Valley. Each city provides important health, education and retail services for residents and surrounding communities. In 2020, their local government areas jointly contributed a gross regional product of \$9.9 billion, driven by mining, agriculture, forestry and tourism.<sup>26</sup>

Bathurst, Orange and Dubbo account for around half of the region's population, with 38,000, 41,000 and 39,000 residents, respectively.<sup>27</sup> The population of all 3 cities is projected to grow over the next 20 years. Bathurst is expected to experience the largest increase of 34%.<sup>28</sup> Orange and Dubbo are projected to increase by 19% and 22%, respectively.<sup>29</sup>

Bathurst, Orange and Dubbo councils supply water to their residents. The water supplies for the region's cities also underpin the water security of surrounding smaller towns, communities and rural residents during times of drought.<sup>30</sup>

26. REMPLAN 2021, *Central West Industries Gross Regional Product and REMPLAN 2021*, Orana Industries Gross Regional Product.

27. Department of Planning and Environment, *Common Planning Assumptions*, 2022, available from [pp.planningportal.nsw.gov.au/populations](http://pp.planningportal.nsw.gov.au/populations)

28. Department of Planning and Environment, *Common Planning Assumptions*, 2022, available from [pp.planningportal.nsw.gov.au/populations](http://pp.planningportal.nsw.gov.au/populations)

29. Department of Planning and Environment, *Common Planning Assumptions*, 2022, available from [pp.planningportal.nsw.gov.au/populations](http://pp.planningportal.nsw.gov.au/populations)

30. Molong Creek Dam ran out of water in the latest drought but the recently completed pipeline from Orange provided emergency water for Molong. Since then, Cabonne Council has successfully supplemented its water supply system with groundwater bores. Cadia mine relies on the treated wastewater from Orange.

## Understanding the economic and social cost of severe water restrictions

During public consultation, stakeholders stressed the importance of urban water and how it underpins businesses in regional centres, as well as the economy and prosperity of the broader region.

The 2017–2020 drought was the worst on record for Bathurst and residents were placed on Level 4 water restrictions for an extended period.

Following the drought, Bathurst Regional Council assessed what the economic impacts would have been if Level 5 and Level 6 water restrictions had been applied, or if the city had run out of water.

Bathurst's Level 4 restriction is the last level that impacts residential consumption only. Additional restrictions beyond that level will mean that significant parts of the economy would be affected. The analysis revealed that Level 6 restrictions would have resulted in a 40% decline in economic output and employment. If the system had failed, economic output and employment would have reduced by 90%.

Each city is improving the security of their water supplies. However, our analysis shows that further investment is needed to ensure Bathurst and Orange retain the security of their water supplies as their dams could go from full to nearly empty in less than 4 years, or sooner if climate change causes drier conditions. Table 5 shows the probability of Orange, Bathurst and Dubbo experiencing restrictions or shortfalls in water supplies under different

climate scenarios if there are no changes to policy, infrastructure or demand management.

A key challenge for all levels of government is to ensure that growth in the region is sustainable. This includes ensuring access to reliable and secure water supplies, while retaining and enhancing the character of the environment, towns and cities and the surrounding region.

## Water security investments for Dubbo, Orange and Bathurst

Actions to improve urban water security for Dubbo, Orange and Bathurst are underway. These include:

- **Dubbo** – Expansion of borefields: Works to enhance access to groundwater by bores northwest of the town and for pipelines from new bore fields.
- **Orange** – Phase 2 of the Stormwater Harvesting Scheme: Orange City Council is seeking approval to expand the Blackmans Swamp Creek Stormwater Harvesting Scheme with Phase 2 being an offline wetland in east Orange, upstream of the existing harvest weir (Phase 1). If approved, this could provide 36 ML of air space for filling with harvested stormwater.
- **Bathurst** – Stormwater harvesting and Winburndale Pipeline projects: Bathurst Regional Council is constructing 2 storage ponds (36 ML and 8 ML) to capture stormwater runoff and a replacement pipeline from Winburndale Dam to Bathurst.



**Table 5. Probability of major towns experiencing shortfalls under different climate scenarios**

Town	Historical climate	Dry future climate change scenario
<b>Percent of time in severe water restrictions*</b>		
<b>Orange</b>	3.3% (1 in 30 years)	14.7% (1 in 7 years)
<b>Bathurst</b>	1.8% (1 in 60 years)	7.6% (1 in 13 years)
<b>Dubbo</b>	0.2% (1 in 500 years)	2.7% (1 in 40 years)
<b>Frequency of failure**</b>		
<b>Orange</b>	1.9% (1 in 50 years)	11.8% (1 in 8 years)
<b>Bathurst</b>	1.7% (1 in 60 years)	6.3% (1 in 16 years)
<b>Dubbo</b>	0.0% (No simulated occurrences)	1.2% (1 in 80 years)

Note: Climate projections are based on 10,000-year data sets.

\*Severe water restrictions are defined differently for each council and depends on their restriction regime and water supply sources:

- Orange: Level 5 restrictions, which represents 62% of unrestricted demand, or worse
- Bathurst: Level 4 restrictions, which represents 67% of unrestricted demand, or worse
- Dubbo: Level 2 restrictions, which represent 70% of unrestricted demand, or worse.

\*\*Failure is defined differently for each local government and depends on their restriction regime and water supply sources:

- Orange: where water demands cannot be met under Level 6 restrictions for Orange, which represents 60% of unrestricted demand
- Bathurst: where water demands cannot be met under Level 5 restrictions for Bathurst, which represents 52% of unrestricted demand
- Dubbo: when water demands cannot be met under Level 3 restrictions for Dubbo, which represents 50% of unrestricted demand.

## Assessing town water security risks

Historically, the Department of Planning and Environment–Water has provided guidance to local water utilities on assessing, and adapting to, the impact of changing climatic patterns on the secure yield of their town water supplies. The guidelines for the secure yield assessment focus on using about the last 100 years of observed historical data and applying a 2°C warming scenario. This is to help understand the level of storage and water needed, so that local water utilities can manage their water supplies through droughts that occur in the forward planning horizon (typically 30–50 years).

The new data underpinning the regional water strategies includes consideration of paleoclimate and climate change impacts to develop scenarios of plausible extreme climate events. These scenarios allow town water supply systems to be tested for droughts and scenarios beyond those that have occurred in the last 100 years. It can also help us to understand the level of risk that could be faced by towns in the future over a longer-term planning horizon.

For towns like Bathurst, both the secure yield and regional water strategy assessment have demonstrated that additional action is needed now, and over the medium and long-term, to support the city’s water needs.

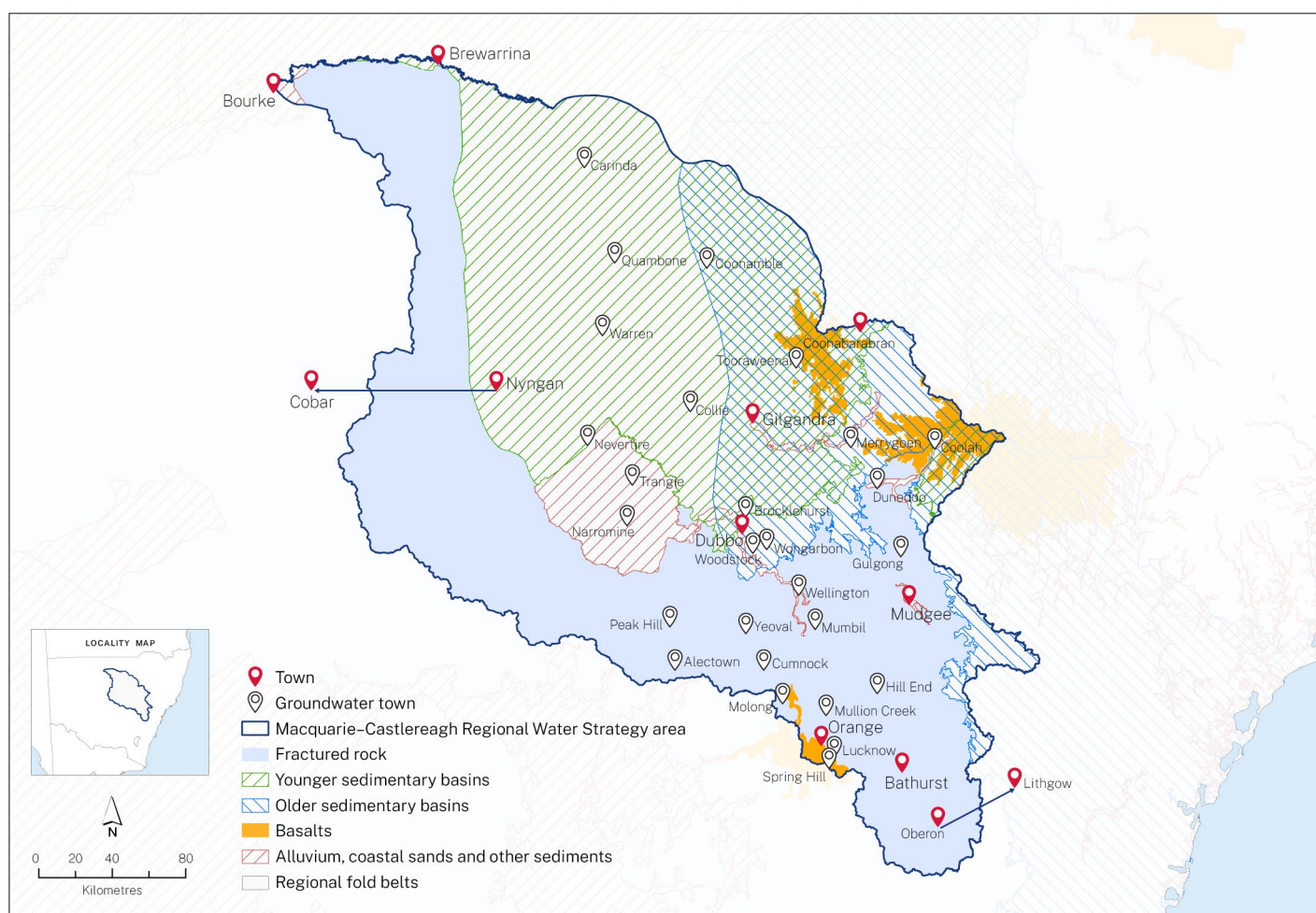
## There is uncertainty about groundwater security in severe drought

Groundwater is an important water supply for towns in the region.<sup>31</sup> All towns in the Castlereagh Valley depend on groundwater for their drinking water supply (Figure 10). The only exception is Coonabarabran, which relies partially on Timor Dam and uses groundwater as an alternate supply of water in drought. In the Macquarie Valley, groundwater is the primary supply for the towns of Warren and Narromine and is an important backup source for Dubbo and Wellington. In other places, such as Nyngan and Cobar, there are limitations to accessing groundwater as local aquifers typically have low productivity and high salinity.

Where there is a high density of irrigation bores, the local groundwater level can decline during the pumping season. This makes it harder to extract the same amount of water from nearby bores, including those used for town water. Increased reliance on groundwater resources for irrigation and livestock during drought can make local water level decline worse, and impact town water access and use at critical times.

Several towns, including Gilgandra and Narromine, had difficulty accessing groundwater for essential needs during the 2017–2020 drought, despite town water supply licences having a higher level of priority than other groundwater licences. There is uncertainty in the Castlereagh Valley about the ability of alluvial groundwater systems to withstand higher demands during severe droughts, which presents risks to future town water security.

**Figure 10. Regional towns and cities in the Macquarie–Castlereagh region that use groundwater**



31. There is 13,872 ML of groundwater entitlement held by local water utilities across the Macquarie–Castlereagh region. Groundwater is drawn from the Macquarie, Bell, Talbragar, Castlereagh and Cudgegong alluvial groundwater sources, the Great Artesian Basin and Oxley Basins, the Orange Basalt and the Lachlan Fold Belt. Appendix C of the NSW Government’s Draft Guide to Groundwater Resources in NSW contains details on the characteristics of these groundwater sources and can be accessed at: [www.water.nsw.gov.au/plans-and-programs/nsw-groundwater-strategy](http://www.water.nsw.gov.au/plans-and-programs/nsw-groundwater-strategy)



The water quality of the aquifers used for town water supply in the region is generally suitable for this purpose, although there are risks to drinking water supplies, such as diffuse and point-source pollution. In recent years, specific industrial contaminants such as PFAS<sup>32</sup> have affected many groundwater sources in NSW, including around Dubbo.

Access to groundwater will become increasingly important within the context of declining surface water availability under a potentially drier climate. Under a drying climate the amount of water seeping into the ground and replenishing groundwater could reduce, making it harder to meet current demand.

It also means that if other users continue to turn to groundwater in extreme droughts, there may be increased risks for towns that rely solely on this resource.

Towns and local water utilities have limited access to data on the availability, quality and extraction of groundwater sources, and the potential effects of climate change on them. This makes it difficult to make effective risk-based decisions, particularly during drought periods. Councils need more information on anticipated future demands, groundwater recharge rates, and how groundwater is managed in the region to ensure it remains a reliable and safe water supply.

## What we heard



Councils have said there is uncertainty about how long town water bores will be able to sustain towns during droughts, and whether emergency provisions may be needed to ensure groundwater supplies are available for towns during extreme events. There is also broader community concern about declining groundwater levels and the impacts on aquifers due to an increased reliance on groundwater during drought.

There was strong support for improving knowledge about groundwater systems and ensuring it is shared so that these resources can be more sustainably managed in the future. There were also requests for more consultation with stakeholders and landholders when considering investment in groundwater for town water supplies.

32. PFAS is an acronym for per- and poly-fluoroalkyl substances. PFAS are toxic chemicals that are used in industrial and household products that resist heat, oil, stains and water.

## Oberon faces ongoing water quality and supply challenges

Oberon relies on water from Oberon Dam (part of the Fish River Water Supply Scheme), which is operated by WaterNSW and located a short distance from the township. Despite its proximity to the 45 GL dam, the town of Oberon has drought security concerns that are made worse by relying solely on a single source of water.

Water quality has also been a consistent concern for Oberon. High levels of minerals in the water, along with infrastructure and technical capacity limitations, have contributed to water quality challenges in Oberon.

Raw water supplied to Oberon's water treatment plant sometimes contains high concentrations of manganese, particularly when the dam's water level is low. The manganese in the treated water is safe to drink, but causes aesthetic issues, including discolouration of the water and staining of laundry. Oberon Council has reviewed operational procedures and optimised treatment operations, and now reliable manganese removal is undertaken at the plant. In 2022, Oberon Council conducted a scour and flush program to clean the reticulation system of solids including manganese deposits that accumulated during the period of poor control.

Continual cleaning of the reticulation system and ongoing capacity to manage water quality issues will need to be a priority for Oberon in coming years. An upgrade to the Oberon Water Treatment Plant requiring significant capital expenditure may be needed if water of a suitable standard is not supplied from Oberon Dam.



Image courtesy of Destination NSW. Lake Oberon, Oberon.





# Challenge: Supplying water to high priority needs in the west of the catchment and connected valleys

Delivering water long distances is challenging during dry periods and creates economic, social and environmental risks. A more variable and potentially drier climate will make it even more difficult to meet high priority needs in the west of the catchment, especially during drought.

## The region's west has high priority water needs

There are a range of priority<sup>33</sup> water needs in the west of the catchment (Figure 11), including:

- **the internationally recognised Macquarie Marshes**, with its extensive river red gum woodlands, water couch marsh and the largest common reed beds in the northern Basin
- **the towns of Nyngan and Cobar**, where water is supplied from approximately 200 km upstream in the Wambuul / Macquarie River from Burrendong Dam. This water is first diverted to Gunningbar Creek at the Warren offtake, before being transferred to Nyngan via the 60 km Albert Priest Channel. Water is then transferred from Nyngan to Cobar via a pipeline
- **mines near Cobar and Nyngan**, including the Endeavour Mining metallic mines, Peak Gold, CSA Mine and Tritton Copper Operations, hold high security licences and source water from the Nyngan–Cobar water supply systems and Gunningbar Creek
- **landholders on rivers and creeks** who receive replenishment flows from the regulated Wambuul / Macquarie River or rely on unregulated flows for stock and domestic needs.

As well as these high priority needs, there are also productive irrigated cropping and livestock operations in the west of the catchment, and further needs to address in the connected valleys. The Macquarie–Castlereagh catchment flows into the Barwon and Darling–Baaka rivers during median to high flows, supporting communities, industries and the environment further downstream.

33. A range of factors influence how water is allocated in regulated river systems, including the priorities for sharing water under the *Water Management Act 2000* and water for the environment. In terms of licensed entitlements in regulated rivers, the order of priority is: 1. local water utility, major utility and domestic and stock water supply (high priority needs). 2. high security 3. conveyance (the water needed to deliver ordered water). 4. general security. 5. supplementary.





## Large volumes of water are needed to deliver supplies during dry periods

The Wambuul / Macquarie River, from its headwaters to its junction with the Barwon River, is over 960 km long. The regulated section of the river below Burrendong Dam is around 500 km long. A large portion of the water released from Burrendong Dam to users in the catchment's west evaporates along the way. It also seeps into the dry riverbed, contributing to critical ecosystem functions and processes in the lower end of the valley.

The length of the river presents challenges in delivering water to the end of the system in dry periods. In extreme drought conditions, there are no tributary flows to help run the river. This creates economic and social risks for towns, communities and industries, and has significant impacts on aquatic ecology.

In the 2017–2020 drought, supplying water from Burrendong Dam to Nyngan and Cobar and nearby mines became especially difficult. At this time, approximately 27 GL of water needed to be released from Burrendong Dam to deliver 1 GL of water to Nyngan and Cobar.<sup>34</sup>

The 2017–2020 drought was the first time in 50 years the regulated Wambuul / Macquarie River was shortened to Warren to save water for critical human needs. This occurred from September 2019 to January 2020, and had significant impacts on downstream communities and environments. Regulated releases down Gunningbar Creek for Tritton Mine ceased in December 2019 until mid-February 2020, to extend supplies to major towns on the Wambuul / Macquarie River.

As a result, Tritton Mine now has a connection directly into Cobar Water Board's water supply. If the drought had continued, supply of water below Dubbo would have become impossible.

Our new climate datasets and risk modelling shows that droughts like the 2017–2020 could occur more frequently and go for longer than previously thought. Burrendong Dam could sit at or below levels that trigger drought operations measures more often in a dry future climate change scenario (Table 6). This would make it harder to deliver water to the environment and water users on the regulated effluent creeks, Nyngan and Cobar, and at the mines connected to those water systems.

Water carting is not a viable back up option for Nyngan and Cobar. In the last drought, water carting to meet emergency needs only would have required trains, costing approximately \$1 million a day. In addition, 70% of the total economic output in the Cobar and Bogan local government areas – and one-third of direct employment – is linked to mining, which requires a constant supply of water to operate. Failure to supply water to the mines would have major consequences for the local economy.

34. In drought it takes 15 GL to get water into Warren Weir and another 12 GL to top up Nyngan Weir down the Albert Priest Channel.

**Table 6. Probability of Burrendong Dam’s storage falling to low levels at least once in a year under different climate scenarios**

Storage volume		Probability of occurring (% time, in days)			Drought operation measures <sup>35</sup> used at each level in the 2017–20 drought
Total storage capacity* (1,188 GL)	Active storage capacity** (1,154 GL)	Historical climate data	Long-term historical climate data	Dry future climate scenario	
Below 304 GL (25% of total storage)	Below 270 GL (~23% of active storage)	36	35	60	Drought Stage 3 <sup>36</sup> – Severe drought was introduced. Measures included zero general security allocations and restrictions to account carryover.
Below 160 GL (13% of total storage)	Below 126 GL (~11% of active storage)	10	11	31	Drought Stage 4 – Critical drought introduced at approx. 110 GL total storage capacity. Measures included suspension of access to all remaining water in general security accounts and environmental water provisions in the water sharing plan. Town and domestic and stock allocations reduced to 80% and high security 70%.
Below 95 GL (8% of total storage)	Below 61 GL (~5% of active storage)	1	1	9	Warren Weir was raised to extend supplies for critical water needs upstream. All regulated flows downstream of Warren Weir ceased.
Below 70 GL (6% of total storage)	Below 36 GL (~3% of active storage)	0.2	0.2	3	Flows to Gunningbar Creek (which supplies Tritton Mine) ceased when Burrendong Dam was at approx. 67 GL of total storage.  The lowest level the dam reached was 51 GL (4% of total storage/1.47% of active storage) in February 2020.

\*Total storage capacity includes the dead storage volume of 33.7 GL.

\*\*Active storage capacity is total storage capacity minus the dead storage volume of 34 GL. WaterNSW uses this value when reporting regional NSW dam levels on [www.waterrsw.com.au/supply/regional-nsw/dam-levels](http://www.waterrsw.com.au/supply/regional-nsw/dam-levels)

35. The NSW Extreme Events policy establishes the principles for managing water resources within the NSW Murray–Darling Basin during an extreme event. The policy framework establishes a staged approach and provides a range of measures for water managers to deploy as conditions deteriorate. Further information on the drought stages is available from [www.dpie.nsw.gov.au/water/allocations-availability/drought-and-floods](http://www.dpie.nsw.gov.au/water/allocations-availability/drought-and-floods)

36. For additional details about the measures implemented in the Macquarie Valley during the 2017–2020 drought see [www.water.nsw.gov.au/allocations-availability/drought-and-floods/drought-recovery/2017-20-drought](http://www.water.nsw.gov.au/allocations-availability/drought-and-floods/drought-recovery/2017-20-drought)



## Improving connectivity to the Barwon–Darling

There are ecological, industry and community needs – including critical human and critical environmental needs – in the Barwon–Darling system that rely on surface water flowing in from northern Basin tributaries. In the Macquarie–Castlereagh catchment these tributaries include:

- Castlereagh River, which meets the Wambuul / Macquarie River upstream of where the Macquarie meets the Barwon River
- Wambuul / Macquarie River, which meets the Barwon River upstream of Brewarrina
- Bogan River, which flows northwest past Nyngan to meet the Barwon River upstream of Bourke.

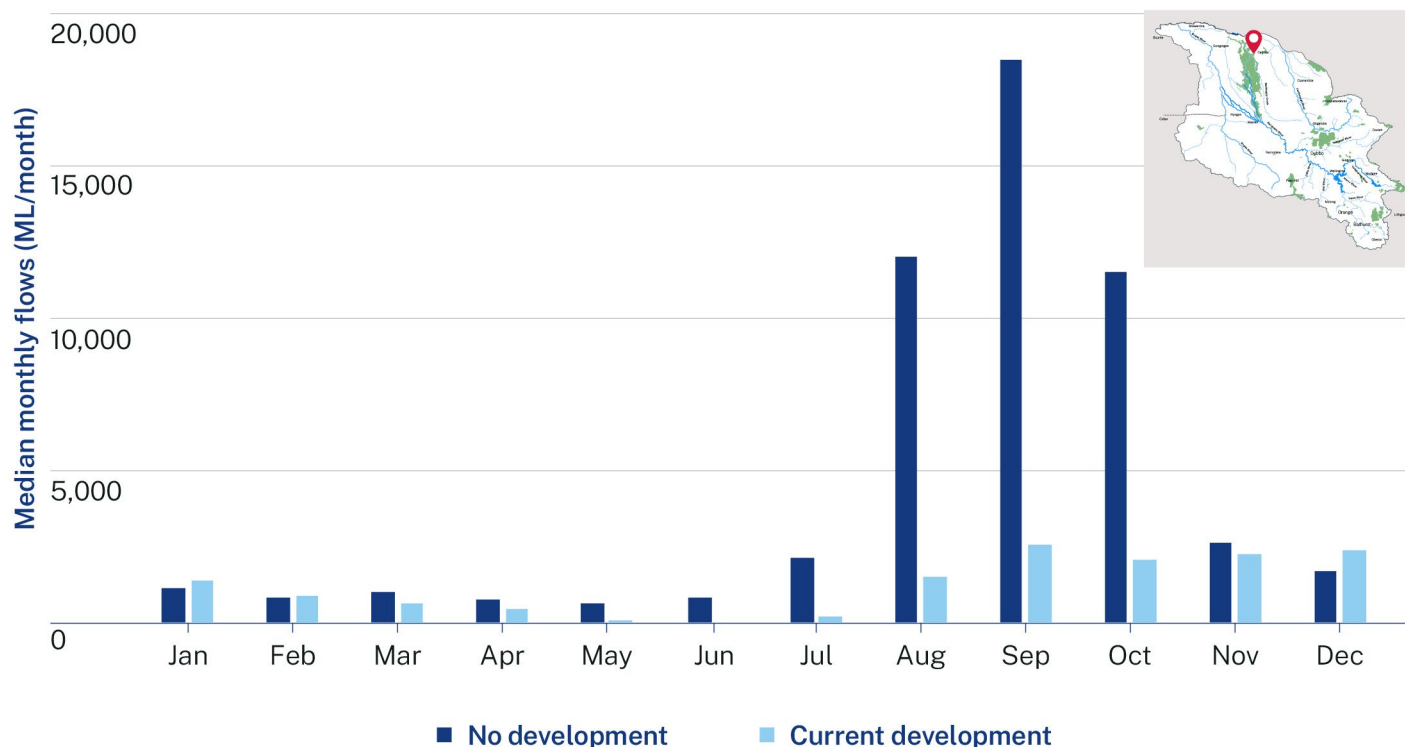
On average, approximately 42% of the total volume of mid-catchment flows in the Wambuul / Macquarie, Castlereagh and Bogan rivers flow downstream to the Barwon–Darling.<sup>37</sup> This makes up about 17.3% of the water in the Barwon–Darling.<sup>38</sup>

Flows into the Barwon–Darling typically occur during periods of median and high flows, with minor connection opportunities during dry years. The Macquarie Marshes can absorb flows before they reach the 80 km stretch of the lower Wambuul / Macquarie River channel downstream and connect to the Barwon River.

Our analysis suggests that large flows at the end of the Wambuul / Macquarie River that would often occur during winter and spring have decreased in response to river regulation, irrigation development and water use in tributary rivers and creeks (Figure 12). There is also irrigation use below the Bell River Bridge streamflow gauge (used in Figure 12) that further reduces connectivity to the Barwon–Darling River.

Enabling water to flow across connected systems at important times is critical to the fair sharing of water and protecting critical downstream needs.

**Figure 12. Modelled median monthly flow in the Wambuul / Macquarie River at Bells Bridge at Carinda (Stream gauge 421012) for the period 1892–2020**



37. This is the proportion of the long-term average modelled mid-system flow from the Macquarie–Bogan catchment into the Barwon–Darling system. Further information is available in the report *Stocktake of northern Basin connectivity rules – analysis of implementation and effectiveness* available at [www.industry.nsw.gov.au/water/environmental-water-hub/outcomes](http://www.industry.nsw.gov.au/water/environmental-water-hub/outcomes)

38. Murray–Darling Basin Authority 2011, Water resource assessments for without-development and baseline conditions. Supporting information for the preparation of proposed Basin Plan Technical report 2010/20 Version 2 November 2011, Table 10, page 25. The modelled flow contribution figures are based on the without development figures in Table 10.



# Challenge: Maintaining and improving river, floodplain and wetland health

The Macquarie, Bogan and Castlereagh catchments support diverse river, wetland and floodplain ecosystems. Infrastructure development, changes in water use and poor land management practices have impacted the health of these ecosystems. A range of water reforms, including the dedication of water to the environment, have sought to stop further decline and improve the condition and resilience of these environmental assets. However, parts of the catchment are still in poor condition and climate change will increase the risk for many species and ecosystems.

Maintaining healthy rivers, floodplains and wetlands is critical for supporting the communities of the Macquarie–Castlereagh region. The region's aquatic habitats form an important part of shared biodiversity resources, have cultural value for local Aboriginal communities and support the economy, liveability and community wellbeing in the region. Aquatic habitats also provide important ecosystem services such as water purification, carbon sequestration, flood risk mitigation and nutrient cycling.

A variety of flows in rivers and creeks at different times of the year support the lifecycles of native fish, animals and plants by providing cues for movement, growth and reproduction. Recharge of groundwater sources also supports groundwater-dependent ecosystems.

## Reductions in large flows are impacting ecosystems

River flows in the Macquarie–Castlereagh region have changed over time.<sup>39</sup> The degree of change varies depending on the location within the catchment; however, the frequency of large fresh and overbank flows has decreased throughout the region's regulated rivers and in areas downstream of regulated flows.

For example, the number of large fresh and overbank flows at Warren Weir and into the Macquarie Marshes has likely halved since development in the catchment (Figures 13 and 14). These larger flows have potentially been reduced to smaller flows and contribute to a slight increase in the number of small fresh events. However, this increase in small freshes is not equivalent to the reduction in larger flows, indicating potential impacts to overall flow events in the valley. Overbank flows in Warren are limited, as the Burrendong Dam Flood Mitigation Zone is used to reduce impacts on infrastructure and land access.

The reduction in large freshes and overbank flows has contributed to reduced connectivity between river channels and floodplains.<sup>40</sup> In the regulated Wambuil / Macquarie River, this has led to a decline in the condition and extent of river red gum and coolabah-black box communities and a reduction in the number of breeding events for colonial waterbirds.<sup>41</sup>

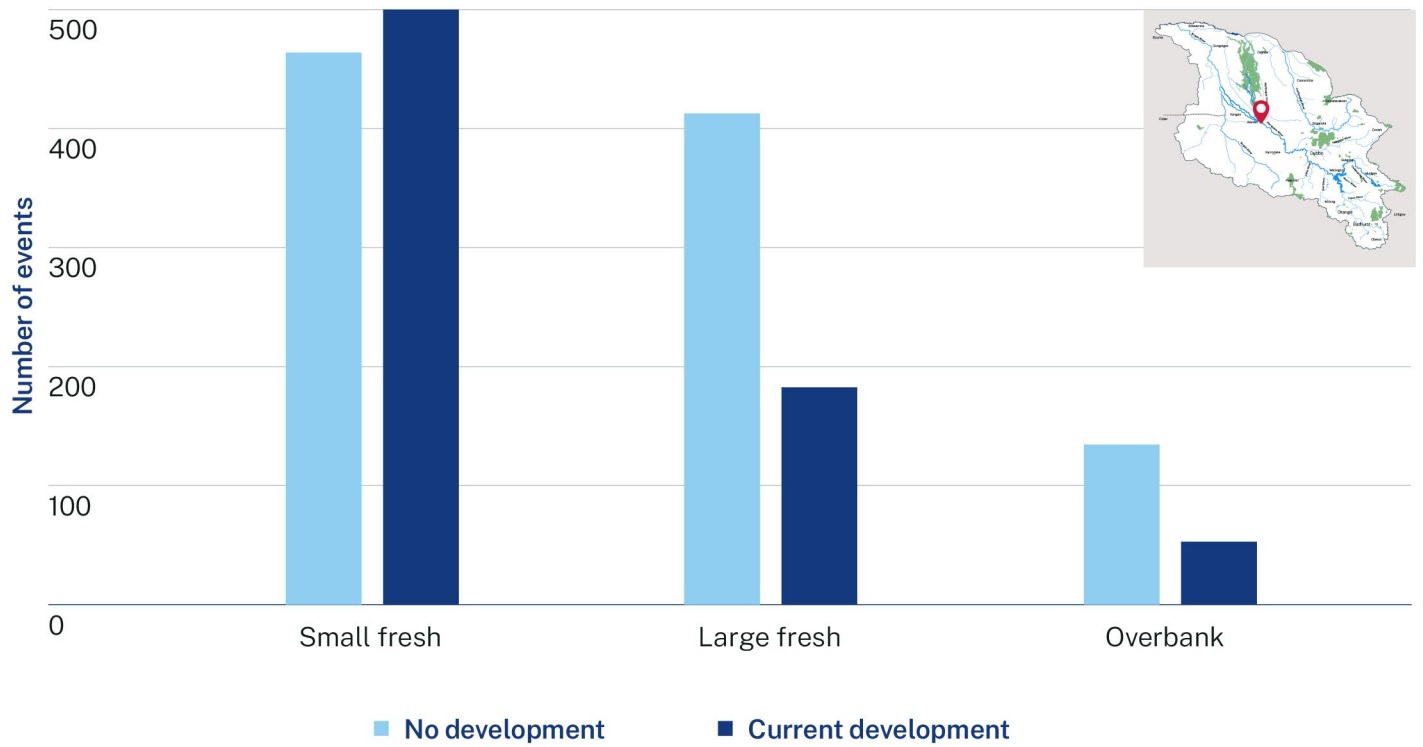
39. Kingsford, R.T 2000, *Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia*. *Austral Ecology*, 25(2), pp.109–127

40. Kingsford, R.T 2000, *Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia*. *Austral Ecology*, 25(2), pp.109–127

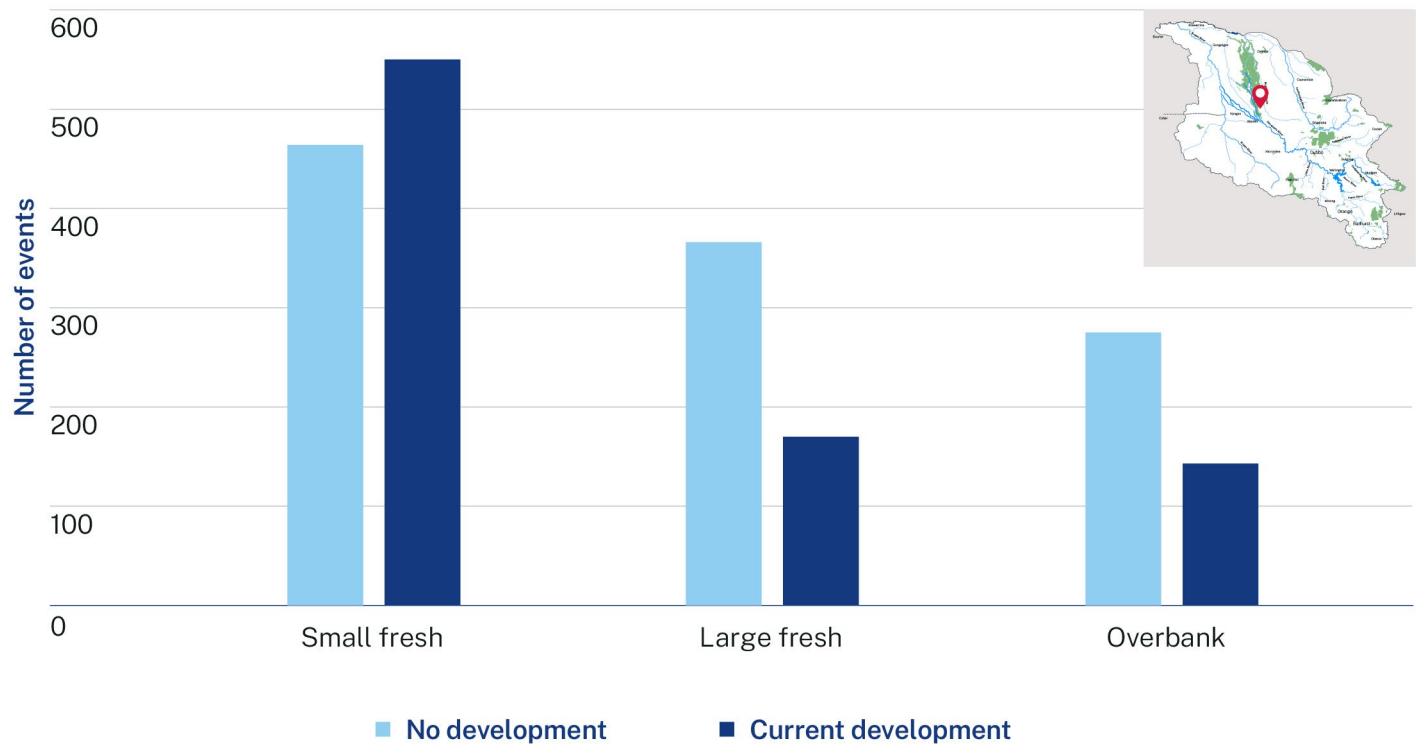
41. Department of Planning, Industry and Environment 2020, *Macquarie–Castlereagh Long-Term Water Plan–Part A: Macquarie–Castlereagh catchment*: [www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/macquarie-castlereagh](http://www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/macquarie-castlereagh)



**Figure 13. Modelled frequency of flow events in the Wambuul / Macquarie River at Warren Weir (Stream gauge 421004) for the period 1892–2020**



**Figure 14. Modelled frequency of flow events in the Wambuul / Macquarie River at Marebone Weir and Break (Stream gauge 421088 and 421090) for the period 1892 to 2020**



## Constraints limit the ability of environmental water managers to reinstate large flows

Government water reforms over the past 2 decades have recovered water for the environment in the Macquarie catchment to support the health of its ecological assets and ecosystem functions. The regulated Macquarie system includes the largest environmental water portfolio in the northern Basin,<sup>42</sup> equating to approximately 25% of the total licensed entitlement in the regulated valley. This portfolio includes approximately 160 GL of environmental water allowance that can be actively managed in the regulated rivers, as well as 175 GL of general security licence entitlement and 10 GL of supplementary licence entitlement.

The NSW Environmental Water Manager<sup>43</sup> delivers water for the environment to the Cudgegong and Wambuul / Macquarie river channels, the Macquarie Marshes and the Wambuul / Macquarie River downstream of the Macquarie Marshes, with potential for deliveries to the unregulated distributary systems of the lower Crooked and Marra creeks. In consultation with the Macquarie Cudgegong Environmental Water Advisory Group,<sup>44</sup> the NSW Environmental Water Manager uses both preventative and responsive strategies to manage the needs of aquatic ecosystems. Watering events target a range of outcomes – from building resilience and promoting ecological restoration when water is abundant, to minimising losses or damage by maintaining drought refuges when water is scarce.

At times the ability of the Environmental Water Manager to use these entitlements and reinstate some of the large and overbank flows is constrained. In non-flood times, Burrendong Dam is operated so that releases do not exceed the channel capacity upstream of the Macquarie Marshes. This is done to maintain system efficiency and to avoid flooding of cropping land and essential service assets.

## Extended dry periods place environmental assets at risk

In-stream pools and floodplain lagoons provide important refuges and habitats for waterbirds and native fish in dry periods. Refugia are critical to the survival of many aquatic species during dry spells and act as source populations for subsequent recolonisation and population growth. Extended periods of no or very low flow put in-stream refugia at risk.

During the 2017–2020 drought, flows to the regulated Wambuul / Macquarie River were cut off below Warren and access to water held in general security accounts was suspended (including environmental water accounts). Water allocations were also reduced to high-priority licence holders to reserve remaining storage volumes as long as possible for critical human needs. While use of the Environmental Water Allowance was suspended in the Millennium Drought, 2019 was the first time that water held in general security environmental accounts could not be released from Burrendong Dam. This meant that water recovered for the environment was not available to help meet critical environmental needs at this stage of the drought.

Extending water supplies for critical human needs also placed pressure on platypus populations in the east of the catchment near Bathurst during the 2017–2020 drought.

A potential dry future climate change scenario could increase the likelihood of extreme dry periods, as well as the possibility of more frequent and extended cease-to-flow periods that dry out drought refuges and heighten risks to iconic water dependent animals, native fish and mammals. It could also lead to a shift in seasonality of rainfall from spring to autumn, with implications for a range of plant and animal species that currently rely upon springtime flows.

42. For further information, see [www.environment.nsw.gov.au/topics/water/water-for-the-environment/about-water-for-the-environment/current-water-holdings](http://www.environment.nsw.gov.au/topics/water/water-for-the-environment/about-water-for-the-environment/current-water-holdings)

43. The NSW Environmental Water Manager also delivers water held by the Commonwealth Environmental Water Office for environmental management.

44. The Environmental Water Advisory Group includes a range of interested groups including representatives from the Aboriginal community, NSW Local Land Services, Cudgegong Valley Water Users, NSW Department of Primary Industries, Nature Conservation Council/Inland Rivers Network, Macquarie Effluent Creeks Association, Macquarie Marshes Environmental Landholders Association, Macquarie River Food and Fibre, Environment, Energy and Science, Water NSW, and the Commonwealth Environmental Water Office (observer status).



## Water infrastructure, land management and pest species impact aquatic health and fish movement

The Macquarie–Castlereagh catchment supports 19 native fish species, including 7 threatened or vulnerable species, as well as platypus populations. The health of fish communities, particularly in the upper unregulated reaches of the Macquarie–Castlereagh catchment, is poor.<sup>45</sup> In addition to modified flows, other threats to native aquatic species, including fish, are:

- **physical structures and infrastructure** such as dams, weirs and road crossings restrict the ability for fish to move and find food and habitat. There are 238 major in-stream structures in the Macquarie River Valley, with 7 of these being high priority for remediation. Fish passage and native fish recovery programs can help address these challenges
- **poor land management** has reduced the amount and quality of riparian vegetation in the region. This is particularly threatening for native fish as it takes away habitat opportunities and shade, as well as removing a source of food, nutrient and carbon input
- **pest fish species** are common throughout most of the catchment. The Macquarie Marshes has been identified as a carp breeding hot spot during some years<sup>46</sup>
- **algae blooms** are common in Burrendong and Windamere dams. This impacts the quality of the water for town and household use, the amenity of the rivers, and increases the stress on aquatic species. Algal blooms also limit the ability to manage cold water pollution
- **cold water pollution** is caused by the release of cold water from dams and weirs, which can change the temperature of the water and pose a threat to the survival of fish populations. Cold water pollution damages riverine ecological function, particularly in summer when biological cues such as fish spawning are disrupted. Cold water pollution can result in native fish failing to breed, breeding later in the season, fish eggs failing to hatch, or young dying or developing more slowly – making them more susceptible to disease and predation. Cold water released from Burrendong Dam can persist for up to 325 km downstream to Warren Weir,<sup>47, 48</sup> and up to 90 km downstream of Windamere Dam
- **hypoxic blackwater events** can occur when the flows in the river restart after excessive dry periods. High levels of bare ground and a potential build-up of organic material (leaves, sticks) can mean that rain occurring after extended dry periods results in poor quality water running off the catchment. This poor quality water runs into the river channel and floodplain, depleting dissolved oxygen and impacting aquatic animals. In recent years hypoxic blackwater events have contributed to fish deaths in the Wambuul / Macquarie River, Cudgegong River and Burrendong Dam.

Log jams from accumulated debris and tree logs floating down rivers can block and even divert river flows and increase erosion. During the development of the strategy stakeholders told us that an 800 m long willow log jam had formed below Warren adjacent to the Bulla Bulla anabranch. Community members said that this accumulation of logs and debris is causing bank erosion, creating a barrier for fish movement in low flows and needs to be remediated as a priority.

45. Department of Primary Industries 2015, *Fish and Flows in the Northern Basin: responses of fish to changes in flow in the Northern Murray–Darling Basin – Valley Scale Report*. Final report prepared for the Murray–Darling Basin Authority, Department of Primary Industries, Tamworth.

46. Gilligan, D., Hartwell, D. and McGregor, C 2009, *Identification of ‘hot-spots’ of carp reproduction in the Murray–Darling Basin*. American Fisheries Society Conference, 30 August -3 September 2009, Nashville, USA.

47. Lugg and Copeland 2014, *Review of cold water pollution in the Murray–Darling Basin and the impacts on fish communities*.

48. Burrendong and Windamere dams were ranked by Preece (2004) [referenced in Water quality technical report for Macquarie Castlereagh surface water resource plan area (SW11)] as having severe and minor cold water impacts respectively.



# Challenge: Addressing barriers to Aboriginal people's water rights

Historical dispossession of land, the effects of colonisation and water management processes continue to impact Aboriginal people's access to water and their ability to care for Country. There is a need to restore lost access to water, and to change the way we engage with Aboriginal people so that we can all benefit from traditional knowledge in managing water resources.

## Aboriginal people have lost access to water and Country

The lands and waters of the Macquarie–Castlereagh region have been occupied by the Wiradjuri, Gomeroi/Kamilaroi/Gamilaroi/Gamilaraay, Ngemba, Wailwan and Ngiyapamaa nations for over 60,000 years. They have always been closely linked to rivers, groundwater, billabongs and wetlands, and this relationship is essential to culture, community and connection to Country. As the traditional custodians of this natural resource, Aboriginal people have rights and a moral obligation to care for water under their law (lore) and customs. These obligations extend across communities throughout the catchment and the connected surface water and groundwater systems.

Fences and locked gates on public land can prevent Aboriginal people from accessing water, carrying out cultural practices and using traditional knowledge and science to care for and manage waterways. Access to waterways is essential for fulfilling cultural obligations and passing down knowledge to the next generation.

There are already steps being taken by governments to address this. For example, the National Parks and Wildlife Services is developing a new model for Aboriginal joint management of the NSW national parks estate. It is anticipated the new model will provide for the potential handback of title to all NSW national parks – covering nearly 10% of the state – over a 15- to 20-year period, subject to the land being leased back (long term and for nominal rent) to the NSW Government for its continued use and management as national park.

In addition, access to water entitlements now requires Aboriginal people to buy entitlements from the fully allocated market. From consultation undertaken regionally and for the NSW Water Strategy, there is strong community support for Aboriginal water rights. The small amount of water in Aboriginal ownership has frequently been identified as a key area for improvement.

The NSW Government has agreed in principle to the intent of the Closing the Gap inland water target as a national aggregate of 3% of total water entitlements. These would be held by Aboriginal organisations on the basis that it is consistent with the objective of increasing Aboriginal water access and ownership under Priority 2 of the NSW Water Strategy.



## Better incorporation of Aboriginal traditional knowledge and values into water management

In the past, water management decisions in the Macquarie–Castlereagh region have not been comprehensively informed by Aboriginal people’s history, knowledge and experiences, which are based on many thousands of years of living on Country. Aboriginal people have had limited involvement in water consultation processes due to:

- the consultation timeframes and processes not allowing the time needed for Aboriginal cultural governance processes, which erodes trust
- a complex set of state and federal laws and systems around water management that is often not explained in a plain English or visually
- limited resources and support for Aboriginal groups to drive their engagement in water management. Often, Aboriginal people and individual members of the public need to give up personal time and resources to have a say in water consultation processes.

For many years, government has committed to models around committees and advisory bodies that are not made up of local Aboriginal people with cultural connection to, or authority to speak about, their Country. Efforts are already underway to include and enhance Aboriginal representation in environmental water management, such as the Environmental Water Advisory Groups and new regional Aboriginal water committees. NSW also has a strategy to enhance Aboriginal people’s involvement in environmental water decision making.

Culturally appropriate engagement approaches that focus on Aboriginal people in their own nation area/region can help get the right people involved or appointed to seats at the table where decisions about water are being made. We heard that genuine consultation with Aboriginal people through such a process can be an important step in addressing past disparities, earning trust and encouraging participation in water management by Aboriginal communities.

NSW is addressing these challenges by investing \$15 million over 3 years to 2025 to develop an Aboriginal Water Strategy that will identify a program of measures to deliver on First Nations’ water rights and interests in water management. It is being informed by direct engagement and co-design with Aboriginal people and communities.

## Improving water availability to important cultural locations

Delivering water to water-dependent culturally important sites is a priority identified by Aboriginal communities across the Macquarie–Castlereagh catchment. We have heard there are opportunities for a greater focus on improving water related projects around Jinchilla Gardens and Beemunnel Reserve.

Beemunnel Reserve Aboriginal Place, a designated Aboriginal site on Ewenmar Creek, holds significant cultural and spiritual value for the local Wailwan people of the Warren area. The landscape of the Beemunnel Reserve, including Ewenmar (Beemunnel) Creek, the flood-free ground beside it and the natural vegetation was used by the Wailwan people for economic, cultural and ceremonial purposes. It contains tangible evidence of traditional use, including burials and scarred trees.

During consultation stakeholders raised that water flows through Beemunnel Reserve have changed due to upstream diversion and infrastructure works at the connection to the Wambuul / Macquarie River at Redenville break (see Figure 11). Increasing flows at important times will help with the wellbeing of the community and allow for connection to Country and culture.

We heard from the community that there is support for securing flows for water-dependent cultural sites such as the Beemunnel Reserve Aboriginal Place. However, Aboriginal people would like this to be expanded to provide better access to water entitlements that allow local Aboriginal communities to have an active role in making decisions about how and when this place, and other culturally important sites, receive water.

*“We’ve always been on this creek, as far back as I can remember.*

*It had regular flow when we were growing up, it was very seldom dry. We’d fish and swim and we used to drink it...never harmed us...we drank it all the time. We’d catch yellowbelly, cod, catfish and bream. That changed when they built the dam [Burrendong] in the 60s” George Riley<sup>49</sup>*

49. This quote has been sourced from a brochure titled Beemunnel Heritage Trail available from [www.warren.nsw.gov.au/discover/things-to-see-and-do](http://www.warren.nsw.gov.au/discover/things-to-see-and-do)



# Challenge: Supporting a growing regional economy in a future of potentially reduced water availability

Agriculture and mining are major water-reliant industries in the Macquarie–Castlereagh region and will continue to be important economic contributors in the future. The tourist economy is also significant in the region’s east and includes well-known food and wine destinations. Climate change could reduce water availability for these existing industries, leading to adverse economic and social impacts. In addition, there is significant potential for future development in high value industries; however, a shortage of reliable water supplies may hinder this growth.

## Water-reliant industries are important to the regional economy

Agriculture (including cotton, grains, and horticulture), food processing and mining are major contributors to the region’s economy, along with tourism, health and education services, and the transport, freight and logistics industry (Figure 15).

The Macquarie–Castlereagh region can be broadly divided into 3 economic zones:

- the upland (eastern extent) around Orange, Bathurst and Mudgee
- the midland (central) around Dubbo and Wellington
- the lowland (western extent) around Narromine, Warren and Nyngan.

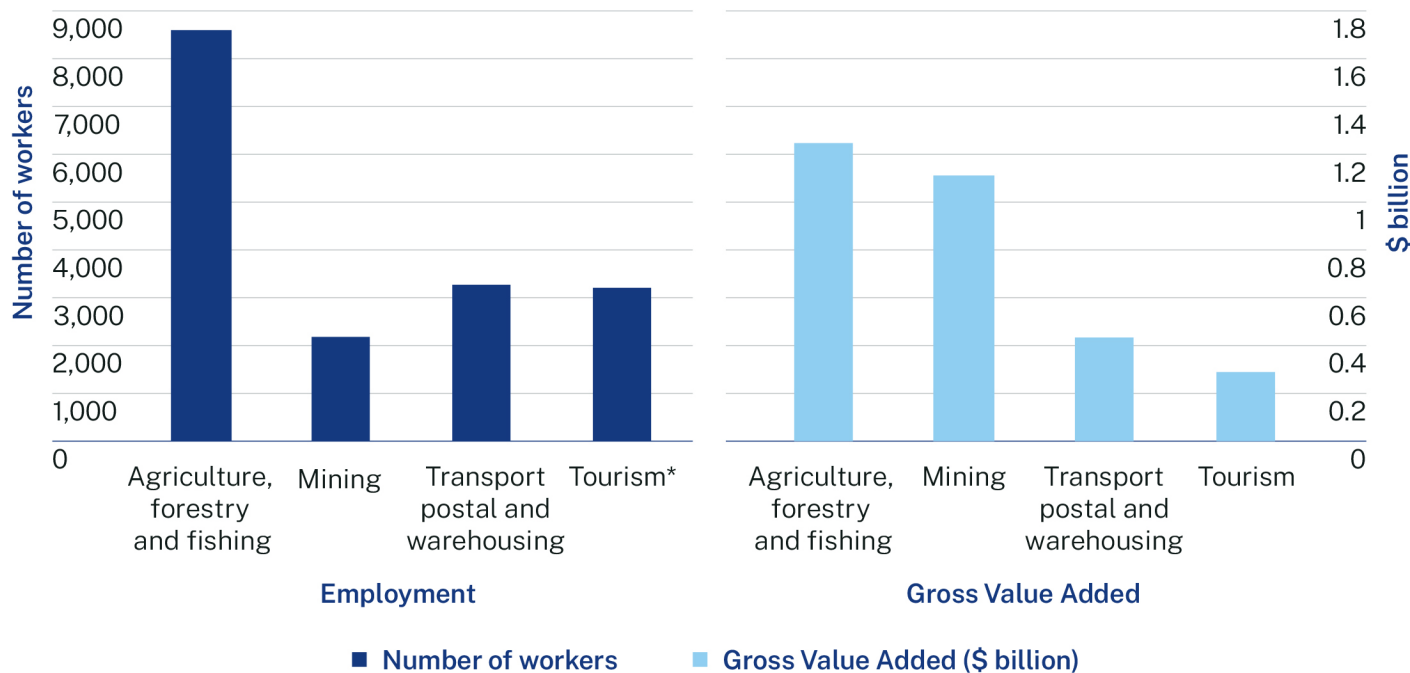
The upland and midland zones are dominated by irrigated agriculture and permanent plantings such as apples, citrus, cherries, stone fruit and viticulture, along with some vegetable production. People from across Australia travel to the region to enjoy the wineries and fresh produce. This area also supports wool production and livestock grazing.

Irrigation, dryland agriculture and mining dominate the economy in the lowland areas in the region’s west. Nearly 70% of the irrigated area is cotton grown near Narromine, Trangie and Warren. Major mines operate in the west of the region and are dependent on reliable water supplies from the Wambuul / Macquarie River.

The Macquarie Marshes in the region’s west supports cattle grazing, some dryland cropping and irrigation cropping, as well as a limited amount of eco-tourism.



**Figure 15. Employment and economic outputs of key industries in the Macquarie–Castlereagh region**



Source: REMPLAN Economy: custom data 2019

\*Tourism is not a defined industry category.

The level of economic activity in the region is closely related to water availability. Agricultural production, and most licensed environmental water, relies on general security water licences. These licences have a lower reliability than high security water access licences or local water utility licences. General security licences make up 87% of all available surface water licences in the regulated Wambuil / Macquarie and Cudgong river valleys. These licences receive 64% of their water allocation on average by the end of each year<sup>50</sup> and typically receive low water allocations during drought (Figure 16).

Many farm businesses have adapted to the region’s highly variable climate and water availability. Many producers grow annual or seasonal crops and have invested in technology and improved management practices, including the adoption of no-till and conservation farming methods. The cotton industry has improved whole-farm irrigation efficiency so much that growers now produce twice as much cotton using the same amount of water compared to 25 years ago.

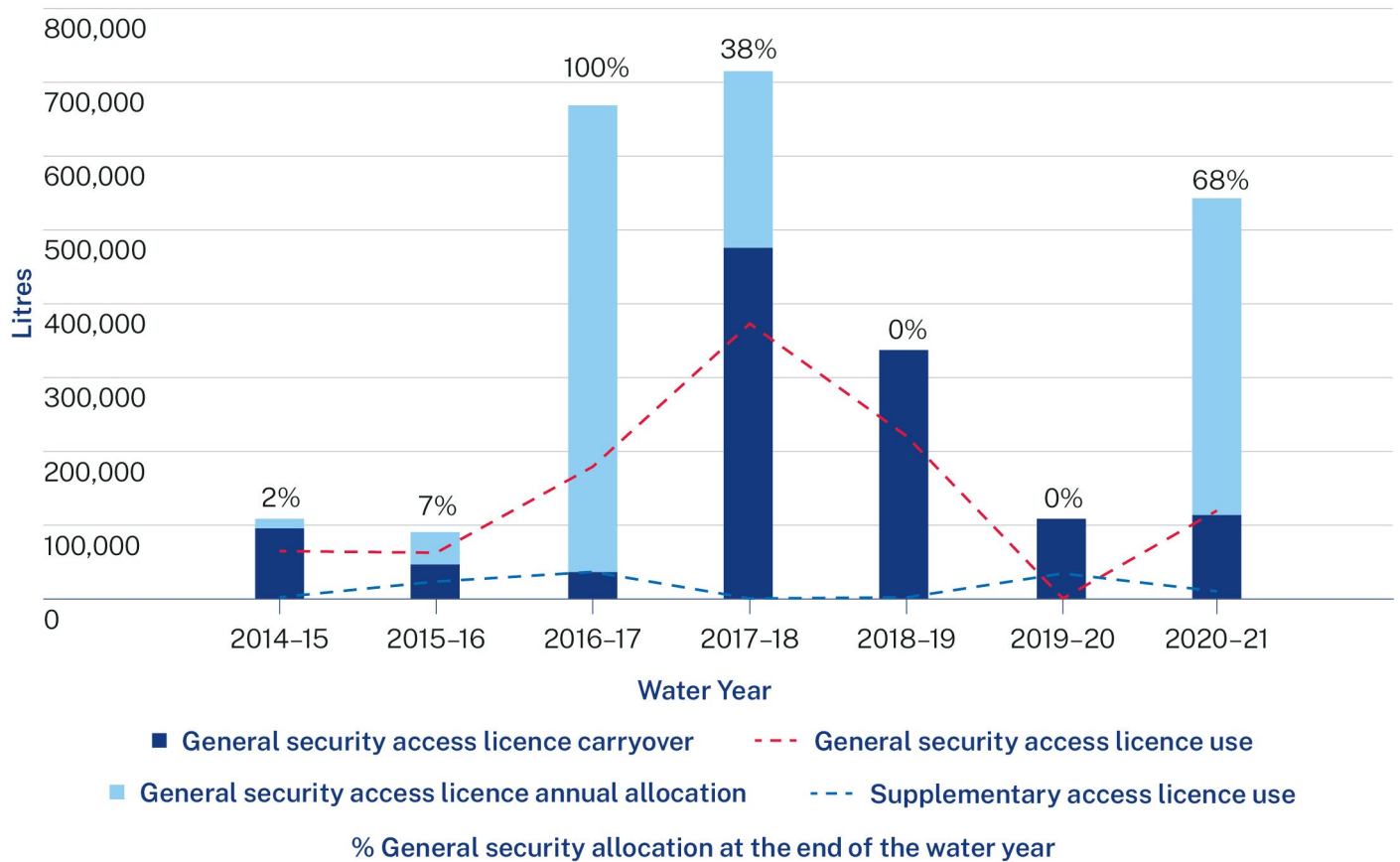
Even with all these adaptations, severe droughts place great pressure on the viability of farm businesses and the resilience of the broader regional economy. The gross domestic product of the Far West–Orana region of NSW, which includes most of the Macquarie–Castlereagh region, declined by approximately 12% in the 2017–2020 drought. This is reflected in lower employment, reduced capital utilisation and productivity losses.<sup>51</sup>

Regional centres such as Orange, Bathurst, Mudgee and Dubbo have experienced growth in professional services since 2020, which may reduce the economic impact of future droughts.

50. Department of Planning and Environment–Water data

51. Wittwer, G. 2020, *Estimating the Regional Economic Impacts of the 2017 to 2019 Drought on NSW and the Rest of Australia* (COPS Working Paper No. G297, March). Available at [www.copsmodels.com/ftp/workpapr/g-297.pdf](http://www.copsmodels.com/ftp/workpapr/g-297.pdf)

**Figure 16. General security and supplementary water availability and use in the Wambuul / Macquarie and Cudgegong regulated rivers from 2014 to 2021**



Note: The general security access licence annual allocation shown in this figure (light blue area of column and percentage) is the highest final allocation for the water year. The general security access licence carryover shown in the figure is the start of the water year carryover balance. Data in the figure excludes the general security Environmental Water Allowance of 160 GL but includes Held Environmental Water.

Source: Department of Planning and Environment – Water Group, General Purpose Water Accounting reports, available at [www.dpie.nsw.gov.au/water/allocations-availability/water-accounting/nsw-general-purpose-water-accounting-reports](http://www.dpie.nsw.gov.au/water/allocations-availability/water-accounting/nsw-general-purpose-water-accounting-reports)

## Less reliable surface water could impact the regional economy

Our new analysis suggests that under a dry future climate change scenario, there could be a significant decrease in average inflows into the region’s rural water storages (Table 7). This could result in general security licences and supplementary licences having access to 23% less water when compared to the long-term historical climate projection.

If practices do not change, there could be a 45% reduction in profit generated by irrigated annual agriculture under a dry future climate change scenario.

As well as industries reliant on the regulated river systems, a more variable or changing climate would also impact many of the region’s mixed farming and grazing enterprises along unregulated rivers and creeks.



**Table 7. Burrendong Dam minimum inflow sequences and the probability of these sequences occurring again under different climate scenarios**

Burrendong Dam minimum inflow sequence	Total inflow volume (ML)	When did it occur in the observed historical record?	Probability of it occurring in the long-term climate scenario (stochastic)	Probability of it occurring in a climate change scenario (stochastic and NARClIM)
<b>36-month</b>	225,316	2017–2020	~0.1%	~2–3%
<b>5-year</b>	1,037,194	1937–1942	~1%	~15–20%
<b>10-year</b>	3,135,971	1932–1942	~1%	~20–25%

## New high value industries need reliable water supplies

There is significant potential for growth in new and high value industries, stimulated by private sector and government investment. These include:

- NSW’s first **Renewable Energy Zone** near Dubbo and Wellington, which at its peak is expected to support around 5,000 construction jobs and bring up to \$10 billion in private investment into the region by 2030<sup>52</sup>
- **pumped hydro** – with the phasing out of ageing coal fired power stations, pumped hydro energy projects could feed into the energy transmission network. There is a potential pumped hydro site in the Central West<sup>53</sup>
- **specialised agriculture** – the region is strategically located between the major domestic markets of Melbourne, Brisbane, Adelaide and Sydney, and is close to the supply of raw agricultural materials. This means there are opportunities to add value to the agricultural sector through secondary food processing, packaging and associated industries
- **critical minerals processing** – the region could become a major global supplier of critical minerals needed for information and renewable energy technology, such as personal electronic devices, electronic vehicles, renewable energy generation and advanced manufacturing.

To support growing or emerging industries in the region, innovative ways to provide water are needed to ensure these industries can operate in times of reduced water availability. This is because:

- there is only a relatively small volume of high security surface water entitlement in the entire Macquarie–Castlereagh region and it is fully committed to towns and existing industries
- groundwater sources with high-quality water are fully committed and highly utilised (Figure 17). It is also often difficult to establish new bores due to the potential impacts on existing bores. This means that, even if groundwater entitlements can be purchased, they cannot necessarily extract where it is needed
- the expansion and development of new mines or expansion of existing permanent horticulture and viticulture plantings around Narromine, Dubbo, Mudgee and Orange is already constrained by the lack of high security water supply, or by difficulties in supplying high security water to downstream locations.

Despite these challenges, there are opportunities in the Macquarie–Castlereagh region that may not be available in other inland regions in NSW. There are entitlements in the fractured and porous rock groundwater sources that extend beyond the Macquarie–Castlereagh region, which have lower yields and poor water quality but may still be useful for industries that do not require high quality water. Power stations adjacent to the upper Macquarie region near Lithgow are transitioning from coal and there is a possibility some of their water entitlements could be redeployed. These opportunities will inform assessments of where certain industries could be strategically located in the region.

52. [www.energyco.nsw.gov.au/renewable-energy-zones/centralwest-orana-renewable-energy-zone](http://www.energyco.nsw.gov.au/renewable-energy-zones/centralwest-orana-renewable-energy-zone)

53. The roadmap is available at: [www.energy.nsw.gov.au/renewables/clean-energy-initiatives/hydro-energy-and-storage](http://www.energy.nsw.gov.au/renewables/clean-energy-initiatives/hydro-energy-and-storage).

Figure 17. Average level of use and commitment of high yielding aquifers in the Macquarie–Castlereagh region





# A plan to secure water for the Macquarie– Castlereagh region

# 5

Image courtesy of Department of Planning and Environment.  
Castlereagh River, Gilgandra.



The vision for the Macquarie–Castlereagh region is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous region. To achieve this, the region needs to be positioned so the right amount of water of the right quality is delivered in the right way for people, Aboriginal communities, towns, industries and the environment.

To address the 5 challenges in the Macquarie–Castlereagh region, actions have been prioritised that aim to:

- Ensure safe and reliable water supplies for growing regional cities and towns
- Reduce water security risks in the region’s west
- Support industry and community climate adaptation
- Improve the health and resilience of natural systems.

Together, these actions can improve the region’s readiness to adapt to a more variable climate and support the decisions we may need to make to ensure healthy, reliable and resilient water resources for the region’s future.

The regional priorities do not override the priorities around water sharing in the *Water Management Act 2000*. Instead, they identify the range of actions that need to be progressed in the region over the coming decades. Each priority contributes to all of the objectives of the regional water strategies. The actions are not listed in any priority order.

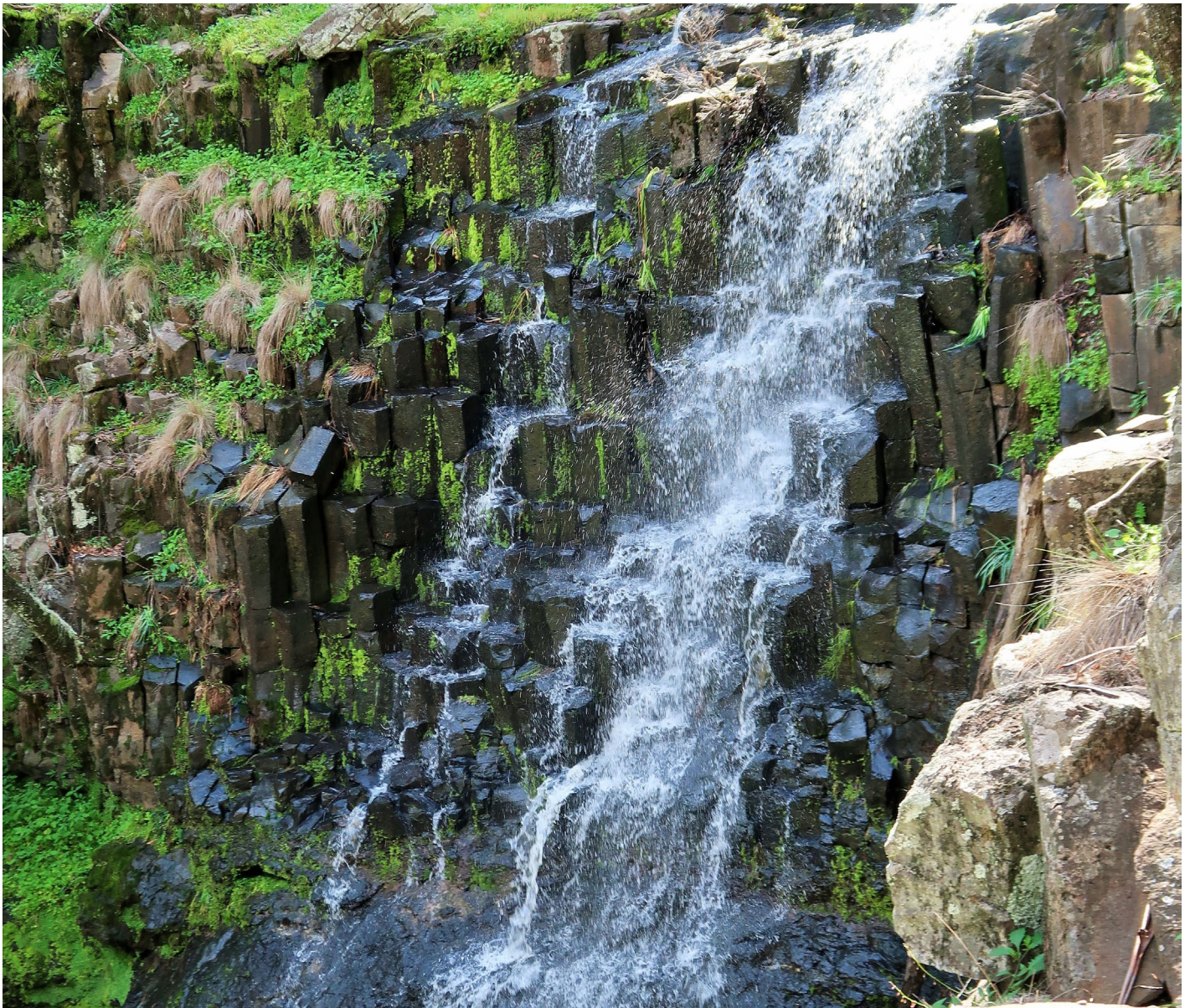


Image courtesy of Nicola Brookhouse, Department of Planning and Environment. Coolah Tops National Park, Bald Hills Creek Falls.



**Figure 18. Macquarie–Castlereagh Regional Water Strategy: overview of strategy vision, objectives, water security challenges and priorities**

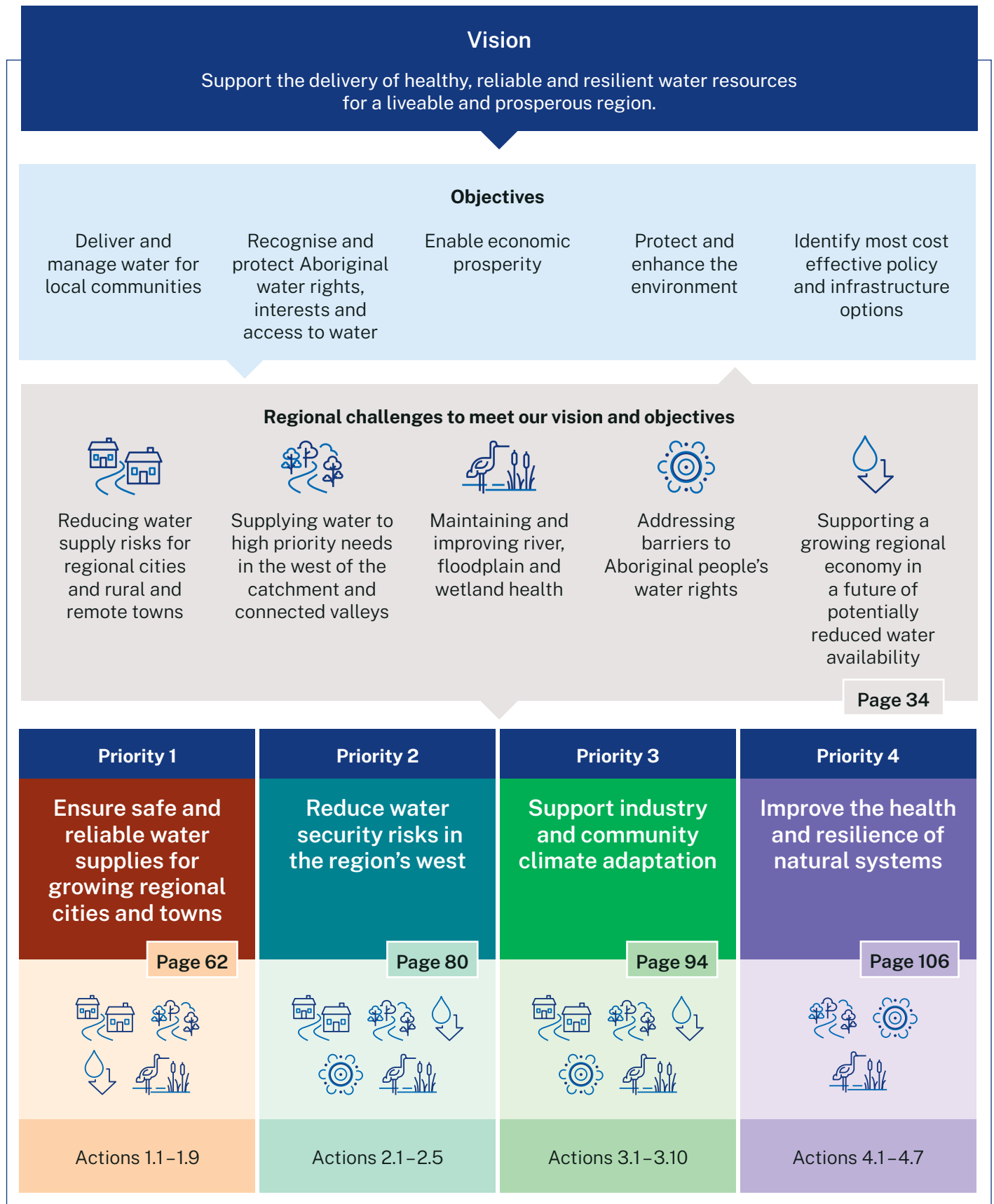


Figure 19. Summary of Macquarie–Castlereagh Regional Water Strategy actions





# Priority 1

## Ensure safe and reliable water supplies for growing regional cities and towns

Even with recent investments in water security, regional cities and towns in the Macquarie–Castlereagh region will face increasing risks to the security of their water supplies over the coming decades.

For many towns and communities across the Macquarie–Castlereagh region, having reliable and sustainable access to groundwater is essential.

The actions in this priority help make existing water go further, prepare for future extremes and secure water supplies for the region’s cities and towns. This will support the resilience of growing towns and their surrounding communities in a future with a more variable or potentially drier climate.

### Our starting point

#### Supporting town water security

Over recent years investments have been made to help secure water supplies for towns across the Macquarie–Castlereagh region, and to support critical needs during drought periods. The NSW Government will continue to support local water utilities to reduce risks to water security.

Every local water utility faces unique challenges and risks. In the Macquarie–Castlereagh region, working through regulatory requirements, attracting and retaining skilled staff and the costs associated with implementing water security infrastructure solutions across a small and dispersed ratepayer base can make it challenging for local water utilities to operate.

During the 2017–2020 drought funding assistance was provided to local water utilities through critical drought initiative and emergency relief programs to ensure critical human needs continued to be met, whilst also improving future drought resilience.

The NSW Government is providing ongoing funding support to local water utilities to resolve priority water security, water quality and environment (sewerage) risks through the Safe and Secure Water Program.






The NSW Government has collaborated with local water utilities and the wider water sector on the Town Water Risk Reduction Program to develop and implement a new approach of working together that enables local water utilities to manage risks and priorities in town water systems more strategically and effectively.















The program recognises and leverages the wealth of expertise within councils and local water utilities and provides opportunities for these stakeholders to design and refine better solutions in collaboration with the department.

#### Groundwater resources

The NSW Groundwater Strategy aims to guide sustainable groundwater management across NSW. In addition, the NSW Government has published a report on how groundwater levels have been changing since monitoring began in the 1970s–80s across 29 alluvial groundwater systems.

**Figure 20. Actions for Priority 1: Ensure safe and reliable water supplies for growing regional cities and towns**

Legend				
				
Reducing water supply risks for regional cities and rural and remote towns	Supplying water to high priority needs in the west of the catchment and connected valleys	Maintaining and improving river, floodplain and wetland health	Addressing barriers to Aboriginal people's water rights	Supporting a growing regional economy in a future of potentially reduced water availability

Action	Summary	Challenges addressed
Action 1.1	Move towards an enduring level of supply to support regional cities and towns	
Action 1.2	Establish a coordination approach involving all levels of government for implementing actions under Priority 1	 
Action 1.3	Develop measures for managing extreme events in the upper Macquarie catchment	  
Action 1.4	Maintain a strong focus on urban water conservation and efficiency	
Action 1.5	Invest in innovative water management options	 
Action 1.6	Plan for the best long-term augmentation solution for the upper Macquarie	
Action 1.7	Reduce uncertainty in groundwater security for the region's towns	 
Action 1.8	Support skills, capacity building and water quality in Oberon and other local water utilities	
Action 1.9	Provide additional water from the Wambuul / Macquarie River for Orange	



## Action 1.1: Move towards an enduring level of supply to support regional cities and towns

The current approach to managing water security for regional cities and towns relies on defining an 'acceptable risk' of running out of water. Existing NSW Government guidelines suggest town water supplies should meet a minimum level of service that roughly correlates to town water supplies being able to withstand a drought that has the probability of occurring 1 in 1,000 years. This level of risk may not be appropriate for large towns where there are no last resort options, such as water carting, in extreme droughts.

Metropolitan water utilities such as Sydney Water and the Hunter Water have shifted their focus away from an 'acceptable level of risk', recognising that running out of water is a risk that neither the communities they

supply nor government will tolerate, regardless of the probability of it happening. Instead, they have moved to the concept of 'enduring supply' to inform their long-term water supply planning.

The enduring supply concept involves determining the amount of water needed to meet the minimum needs of the community during periods of prolonged and extreme drought, irrespective of how long the drought lasts.

Determining this level of supply is informed by:

- the minimum amount of water needed for the cities or towns to keep running
- how long residents and businesses are willing to endure severe water restrictions
- the willingness of communities to pay for increased water security.

This action will develop guidance for local water utilities to use the enduring supply approach.

### What we heard



During public consultation on this strategy, we heard that the enduring level of supply approach must ensure environmental, social and cultural requirements are included in the assessment, as well as potential climate change impacts.

We also heard that the approach should be applicable to all towns, and that community engagement and input is considered critical.



Image courtesy of John Spencer, Department of Planning and Environment. The End Festival 2017, Hill End Historic Site.

## Drought and flood risk mitigation planning: roles and responsibilities

Local councils and various state agencies have responsibility for drought and flood preparedness and planning.

### Drought mitigation planning

- Under the Regulatory and Assurance Framework for Local Water Utilities, local water utilities (LWUs) must demonstrate that their local strategic water planning addresses water security, including drought planning. The Department of Planning and Environment–Water provides guidance and support for local councils to undertake this strategic planning.

### Flood mitigation planning

- The Department of Planning and Environment–Environment and Heritage Group is primarily responsible for providing flood risk management advice to government, and supporting local councils to undertake their flood risk management planning responsibilities for urban communities. This is undertaken in line with the NSW Flood Prone Land Policy, the NSW Flood Risk Management Manual and its supporting toolkit, and the Floodplain Management Program.<sup>54</sup>
- The Department of Planning and Environment–Water is responsible for the development, review and replacement of rural floodplain management plans under the *Water Management Act 2000*. Rural floodplain management plans developed under the *Water Management Act 2000* coordinate development on declared floodplains by establishing management zones and setting clear and consistent rules and assessment criteria for each management zone. They also identify and protect flood-dependent ecological and cultural assets and identify risks to life and property from the effects of flooding.
- The NSW Reconstruction Authority is currently developing a State disaster mitigation plan and supporting local councils to undertake local and regional disaster planning. The State disaster mitigation plan will:
  - identify potential strategies and actions for reducing the impact of disasters
  - assess and consider the impacts of climate change on disasters
  - determine priority projects for regions to mitigate the impact of disasters.

The State disaster mitigation plan will also set priorities for the plan, disaster adaptation plans and strategic plans under the *Environmental Planning and Assessment Act 1979*.

### Other disaster planning and response roles

- Under the *State Emergency and Rescue Management Act 1989* and *NSW State Emergency Service Act 1989*, the NSW State Emergency Service is the emergency management lead agency.
- Under the *NSW Reconstruction Authority Act 2022*, the NSW Reconstruction Authority is responsible for reconstruction and recovery following disasters and other emergencies, including:
  - facilitating, coordinating and directing the recovery, planning and rebuilding of affected communities, including repairing and rebuilding land and infrastructure and other development
  - balancing constraints to enable a focused, timely and expedited recovery of affected communities.
- The Department of Planning and Environment–Water plays a support role during emergency incidents, including drought and flooding, by providing technical assistance and advice regarding emergency water security options or damaged local water infrastructure.
- Other state agencies administer various funding and support programs to assist councils with disaster planning (e.g. the Regional Drought Resilience Planning Program administered by Regional NSW).

54. Further information about the policy, manual and programs can be found at: [www.environment.nsw.gov.au/topics/water/floodplains/floodplain-management-program](http://www.environment.nsw.gov.au/topics/water/floodplains/floodplain-management-program)



## Action 1.2: Establish a coordination approach involving all levels of government for implementing actions under Priority 1

The aim of this action is to support the drought and flood resilience of local councils by improving the coordination of water management actions and planning processes across different levels of government. This action will, in partnership with local councils and local water utilities in the Macquarie–Castlereagh region, establish an enduring framework to coordinate the local council and town water-related actions under Priority 1 of the Macquarie–Castlereagh Regional Water Strategy in relation to water security, as well as flood mitigation planning.<sup>55</sup> Delivery of other actions in this strategy, such as Action 3.1: Invest in continuous improvement to surface and groundwater modelling, could benefit from this coordination approach.

There is also an opportunity for this coordination framework to allow relevant state agencies to better collaborate with local councils on flood planning and preparedness. This approach is not intended to be an operational emergency event response mechanism but will support existing disaster planning and recovery arrangements by strengthening the partnership approach between local councils and state agencies.

Progressing this action will allow councils in the Macquarie–Castlereagh region to raise drought, flood planning and regulatory issues so that they can be resolved in a consistent and coordinated manner. The approach is not intended to be an operational emergency response mechanism but will support existing disaster planning and recovery arrangements.

The coordination framework will:

- facilitate the consideration of regional issues and approaches to drought and flood mitigation planning
- inform regional and state level disaster planning being led by the NSW Government (e.g. the consideration of input to flood mitigation infrastructure investigations).

The coordination framework will be developed in collaboration with councils in the Macquarie–Castlereagh region, Central NSW Joint Organisation of Councils, and relevant state agencies with responsibilities for drought preparedness and response, and flood mitigation planning.

### What we heard



Throughout the development of the Macquarie–Castlereagh Regional Water Strategy, councils and joint organisations have told us that there needs to be a continued, coordinated focus on supporting and implementing water security measures and drought preparedness for towns. We have heard this needs to be an approach that involves all levels of government and stakeholders, including the environment. The approach to this framework also needs to have clear and transparent communication about decision-making.

<sup>55</sup>. Consideration will be given to the capacity of local councils and local water utilities to contribute to such a coordination approach.

## Action 1.3: Develop measures for managing extreme events in the upper Macquarie catchment

The NSW Extreme Events Policy<sup>56</sup> applies to all NSW surface water and groundwater sources within the Murray–Darling Basin. This policy outlines the principles for how to manage the sharing of water in extreme events, including drought and periods of severe water shortage.

Each major river valley, including the Macquarie–Castlereagh, and groundwater water resource plan area, has an Incident Response Guide based on the Extreme Events Policy. This guides the types of actions and how water releases from dams or access to groundwater may change as drought conditions deteriorate.

Most of the measures in surface water Incident Response Guides focus on the regulated rivers that are controlled by large state-owned dams – such as Burrendong and Windamere – in the Macquarie Valley.

However, there are a number of locally significant dams that are owned and operated by local councils to support town water needs in the upper Macquarie. These include Bathurst’s Chifley and Winburndale dams, and Orange’s Suma Park Dam. The operating rules of the dams require daily flows of water to be released for water dependent ecosystems and basic landholder rights.

During the 2017–2020 drought the daily flows from Council-owned dams were amended to prolong water for the large regional cities of Bathurst and Orange and surrounding towns. We heard from councils that the process for making these amendments was long and cumbersome, resulting in a depletion of the remaining water available for towns and impacting on their water security. We heard from landholders downstream of the dams that reductions in the flow releases impacted the environment and placed stress on stock and domestic users.

There needs to be greater clarity and transparency around how the operation of these dams may need to change to share water under an extreme event in accordance with the priorities of the *Water Management Act 2000*.

### Water sharing in extreme events

When formulating plans to share water, the NSW Government must take all reasonable steps to prioritise the protection of water sources and their dependent ecosystems. During extreme events, such as prolonged droughts or a serious water quality event, water for critical human needs become the highest priority for water sharing under the *Water Management Act 2000*.

The framework provided by the NSW Extreme Events Policy includes a staged approach and provides a range of measures for water managers to extend remaining supplies for critical needs as conditions deteriorate. As an extreme drought is prolonged, water managers will progressively introduce more stringent restrictions on access to water by different water users. The Department of Planning and Environment website has a summary of the types of actions that the department may take as the drought becomes more critical.<sup>57</sup>

56. [www.water.nsw.gov.au/about-us/how-we-work/legislation-and-policies/extreme-events-policy](http://www.water.nsw.gov.au/about-us/how-we-work/legislation-and-policies/extreme-events-policy)

57. [www.dpie.nsw.gov.au/water/allocations-availability/drought-and-floods](http://www.dpie.nsw.gov.au/water/allocations-availability/drought-and-floods)





There was significant interest in this action during consultation on the strategy. Comments included:

- there needs to be a shared understanding of critical human water needs, the critical needs of the environment during a drought and an improved understanding of basic landholder rights requirements. A number of submissions raised concerns that, during the last drought, businesses within towns were considered ‘critical human water needs’ and a higher priority than domestic basic landholder rights outside of towns
- watering green spaces within towns should not be prioritised over basic landholder rights
- we need to provide greater certainty and transparent rules around when water allocations may be reduced to avoid changing water access mid-growing season. Business decisions are made based on the best information available at the beginning of the cropping season. When changes to water access are made partway through a growing season it creates significant financial impacts on businesses
- councils noted it is difficult to manage environmental flows from council-operated dams as downstream water users take water that is released. Suggestions raised to address this issue include providing additional gauging stations, consideration of active management to protect environmental water flows between the council-owned dam and town water supply offtake, and reviewing triggers to restrict irrigation access
- guidance documents and operating rules need to be consistent with the *NSW Water Management Act 2000* and include how these systems will be operated to share water in its order of priority.

### How we have responded

This action has been amended to make it clear that understanding critical human water needs, the critical needs of the environment during a drought and an improved understanding of basic landholder rights requirements is an essential piece of work when developing the guidelines. This work will need to be developed in consultation with local communities and councils.

This action will improve clarity and transparency about:

- how and when water releases from town dams in the upper Macquarie catchment could change during drought
- how water will be shared in accordance with the priorities in the *NSW Water Management Act 2000* under an extreme event, such as drought
- the triggers for when irrigation access in unregulated rivers may need to change during droughts
- the communication and engagement protocols associated with developing the guidelines, as well as informing impacted landholders and the community about the changes.

Elements of this work may be incorporated into the Macquarie–Bogan Unregulated Water Sharing Plan, which covers these town water supply catchments and is being reviewed in 2024. Protocols and guidance documents may be prepared to help towns and water users to understand and apply the rules.

To begin with, this action will focus on Bathurst and Orange and determine:

- critical human water needs and critical environmental needs downstream of each town water supply dam
- clear triggers for suspending irrigation access below dams
- cooperative arrangements between council and irrigators to enable more accurate releases from dams, in particular Chifley Dam and Suma Park Dam
- the timing for introduction of temporary river flow access rules for town water supplies to enable water supply for critical human needs
- communication protocols.

This work may need to be supplemented by plans that define how water demands are balanced between commercial and social needs within towns during extreme dry periods.

## Action 1.4: Maintain a strong focus on urban water conservation and efficiency

Local water utilities are responsible for implementing water conservation and efficiency measures in towns. For large centres like Orange, initiatives to reduce water consumption in their communities were vital for sustaining essential town water supplies throughout recent extended droughts.

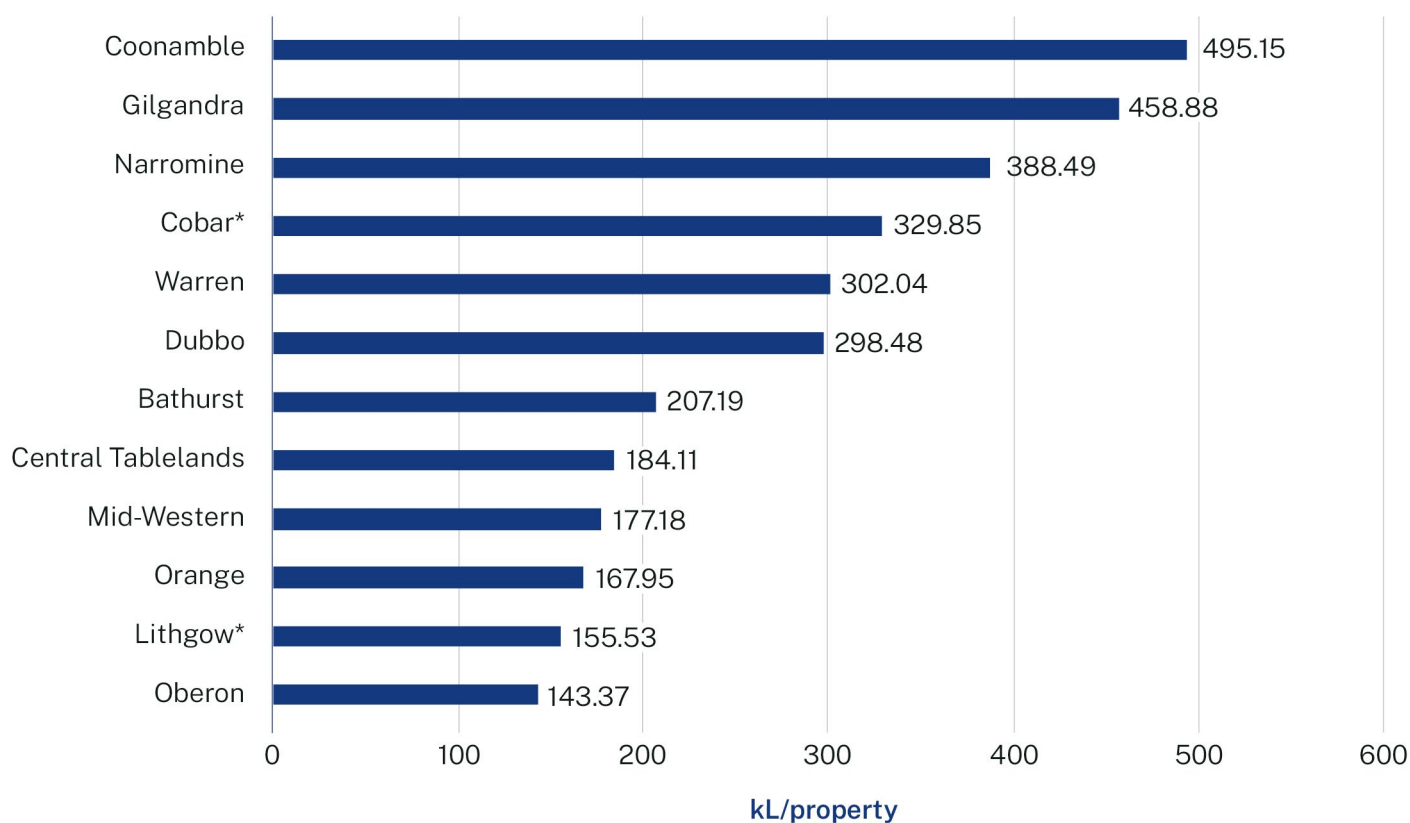
While demand management is well underway in many of the region's towns, opportunities for demand management and water efficiency measures remain (see Figure 21). A continued focus on the efficiency measures such as those listed below will be required across the entire region to make existing supplies go further:

- water restrictions to limit town water use during dry periods and prolong water supplies
- installation of rainwater tanks and greywater systems on houses and commercial buildings, and encouraging water-efficient appliances
- reducing leakage from pipes
- smart metering and pricing.

There is strong community, business and government support for doing more with less water and focusing on urban water conservation in the region. Water conservation measures are considered more cost-effective and to have less environmental impacts than new large-scale infrastructure projects.

This action will support councils to implement the NSW Government's statewide Water Efficiency Framework. The framework focuses on building water efficiency capacity, gaining a greater understanding of water use, improving the evaluation of water efficiency initiatives, and increasing private sector involvement in water conservation and efficiency.

**Figure 21. Average annual residential water (potable) supplied to towns across the Macquarie–Castlereagh region (2013–2021)<sup>58</sup>**



\*These towns do not lie within the Macquarie–Castlereagh region but receive water from the Macquarie–Castlereagh region catchment.

58. Data for other NSW towns is available at: [www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data](http://www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data)



## NSW Water Efficiency Program

The NSW Water Efficiency Program for urban areas is collaborating with key stakeholders to increase investment in water system efficiency, water conservation and demand management. This aims to delay the timing and reduce the scale of investment in new supply infrastructure.

### Regional Leakage Reduction Program

A key aspect of the Water Efficiency Program is addressing network leakage and water loss. The need to focus on local water utilities' network leakage and water losses became apparent during the drought and has been reinforced during consultation with councils and the wider sector as part of the Town Water Risk Reduction Program.

Coonamble and Warrumbungle councils in the Macquarie–Castlereagh region are participating in the regional leakage reduction program. The Central West Joint Organisation is also overseeing a joint leakage reduction initiative across its member councils in the upper Macquarie region, including Orange, Bathurst and Oberon.

The initiative will audit member councils' water loss management approaches, and provide tailored assistance to improve approaches through co-funding infrastructure upgrades and training.

### Aboriginal Communities Water and Sewerage Program

This program provides ongoing leak repair and education projects to promote water-wise behaviour and demand management measures within Aboriginal communities.

### Smart Approved WaterMark – Smart Water Advice Program

The NSW Government and Smart Approved WaterMark are partnering with local water utilities and councils to provide subsidised subscriptions to the Smart Water Advice Program. Subscribers to Smart Water Advice receive water efficiency tips and advice, interactive tools and information to share with their communities.

### Local water utility performance data

The NSW Government provides and maintains a public web-based database for NSW regional water utilities to annually report their current water supply and sewerage data.<sup>59</sup> Performance monitoring and benchmarking are required under the National Water Initiative and provide assurance to the NSW Government that the requirements of the *Water Management Act 2000* are being met (i.e. each local water utility is performing satisfactorily).



Image courtesy of Destination NSW. Streetscape, Dubbo.

59. Department of Planning and Environment, *Water Utilities Performance Data*, available at: [www.dpie.nsw.gov.au/water/local-water-utilities/local-water-utility-performance](http://www.dpie.nsw.gov.au/water/local-water-utilities/local-water-utility-performance)

## Action 1.5: Invest in innovative water management options

Diversifying urban water supplies will be critical to the long-term resilience of the region's communities. With fully committed groundwater sources and less surface water available under a potentially drier climate, water supply options such as stormwater harvesting, re-use of water and managed aquifer recharge will become increasingly important in the coming decades. Investing in water treatment and reuse initiatives will help to reduce reliance on potable water in dams and rivers.

There is strong support from the community, industry and towns for the development and adoption of these water supplies, however regulatory challenges exist.

### Stormwater harvesting

Stormwater is runoff from rain that falls on hard surfaces such as roofs, roads, footpaths and car parks. This runoff flows from property drains into street drains owned by local councils. It then flows into much larger channels and pipes that run to waterways.

A greater effort has been taken in recent years to collect, clean and re-use urban stormwater. Stormwater harvesting can relieve pressures on the wastewater system. However, the development and assessment processes for stormwater harvesting projects need to consider environmental impacts.

Orange City Council has implemented stormwater harvesting schemes in recent years and, if expanded, treated stormwater has the potential to supply over 25% of Orange's water demand.<sup>60</sup> Orange City Council is seeking planning approvals to progress with stage 2 of the Blackmans Swamp Creek Stormwater Harvesting Scheme (known as the East Orange Harvesting Wetland). We heard during consultation on this strategy that the stormwater harvesting schemes need to consider and mitigate impacts on downstream water needs.

Bathurst Regional Council is also constructing a \$20 million 2-stage water harvesting scheme. The volume of water provided back into the system is 1,100 to 1,500 ML/year in stage 1 and 1,800 to 2,350 ML/year in stage 2.<sup>61</sup> Bathurst Regional Council is beginning investigations for a second water harvesting scheme.

Our analysis suggests that additional stormwater harvesting schemes in Bathurst and Orange will reduce each city's time spent in severe water restrictions and reduce the pressure on their primary water supplies.<sup>62</sup> However, stormwater harvesting schemes alone will not go far enough to adequately reduce water security risks for the region's major cities, and these schemes need to be progressed as part of a broader package of actions.

This action will develop a policy framework to enable stormwater harvesting to occur to support growth in major urban centres and reduce the impact of stormwater runoff.

### Stormwater harvesting in Orange

In August 2008, Orange was in the midst of a critical water shortage because of the Millennium Drought. Water storages had dropped below 26.7%.<sup>63</sup> At the time, inflows to storages on the outskirts of town were not enough to meet demand and few alternative supplies were available.

Urban stormwater harvesting was identified as one solution to meet this shortfall. Blackmans Swamp Creek and Ploughmans Creek stormwater harvesting schemes now operate in urban creek catchments in Orange. These schemes capture a portion of the high creek flows during storm events and transfer them into the nearby Suma Park Dam, where the water is then treated according to the Australian Drinking Water Guidelines.

This alternative water supply has improved the city's resilience to drought. The schemes have the potential to provide 10% of the town's water supply,<sup>64</sup> and an average of 1,350 ML/year of additional water into Orange's raw water supply.<sup>65</sup> The scheme involves triggers for when the harvesting scheme operates in order to provide reasonable access to water for users downstream of the scheme.

60. Orange City Council 2019, *Stormwater Harvesting*, [www.orange.nsw.gov.au/water/stormwater/](http://www.orange.nsw.gov.au/water/stormwater/)

61. The yield is based on the average of the 3 years of the worst drought on record (2017–2019).

62. See Attachment 2 in the *Macquarie–Castlereagh: Shortlisted Actions–Consultation Paper* available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/public-exhibition/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/public-exhibition/macquarie-castlereagh-regional-water-strategy)

63. Cooperative Research Centre for Water Sensitive Cities (CRCWSC) 2018, *Case Study–Orange Stormwater to Potable: Building urban water supply diversity*, p.11, Available at: [watersensitivecities.org.au/solutions/case-studies/orange-stormwater-to-potable/](http://watersensitivecities.org.au/solutions/case-studies/orange-stormwater-to-potable/)

64. Cooperative Research Centre for Water Sensitive Cities (CRCWSC) 2018, *Case Study–Orange Stormwater to Potable: Building urban water supply diversity*, p.11, Available at: [watersensitivecities.org.au/solutions/case-studies/orange-stormwater-to-potable/](http://watersensitivecities.org.au/solutions/case-studies/orange-stormwater-to-potable/)

65. Cooperative Research Centre for Water Sensitive Cities (CRCWSC) 2018, *Case Study–Orange Stormwater to Potable: Building urban water supply diversity*, p.11, Available at: [watersensitivecities.org.au/solutions/case-studies/orange-stormwater-to-potable/](http://watersensitivecities.org.au/solutions/case-studies/orange-stormwater-to-potable/)



## Advanced water treatment and purified recycled water facilities

Advanced treatment of water has significant potential in reducing water security risks for regional cities. It could also provide a means for towns to grow without increasing their drought risk.

Advanced treatment and reuse of water is technically feasible and has been implemented in different locations around the world. However, there are barriers to implementation in NSW, including regulatory processes and standards, community acceptance and costs.

NSW is progressing regulatory reform, guidelines and community acceptance campaigns to make the development and use of recycled water easier.<sup>66</sup> Addressing these limitations at the state and local levels includes working with local water utilities to identify policy and regulatory barriers to recycled water use, which will also inform development of a policy framework for purified recycled water regulation.

We heard from councils that increased use of advanced treated water for drinking or industrial use is feasible, with rapidly improving technologies:

- **Bathurst** – Bathurst’s wastewater is currently treated and returned to the Wambuul / Macquarie River. The amount discharged to the river represents over half of total current average water demand. Advance treatment and purification could allow this water to be used for a range of residential, commercial and industrial purposes. Alternatively, it could be less rigorously treated and used to supply only that part of Bathurst’s demand associated with parks and gardens or industries that can use lower quality water.

- **Orange** – Orange City Council supplies wastewater to Cadia Mine. There are opportunities to treat and use this water for multiple purposes; however, the treatment process needs to be demonstrated and tested first. Council states that investing in a demonstration plant for purified recycled water can help provide the data and testing on advanced water treatment facilities in inland regions. It would also provide an opportunity to engage with customers on the technology and the range of beneficial uses for purified recycled water. Any demonstration plant will not form part of Orange’s drinking water supply but would be providing improved water quality back to Cadia Valley Operations for process use under the existing Section 60 approval.<sup>67</sup> Any future decision to include purified recycled water would be subject to community consultation and require stringent government approvals.
- **Dubbo** – Close to 100% of Dubbo’s effluent is recycled to irrigate crops. Other recycling options are also being investigated, such as using recycled water on parks.

An important part of progressing this option is gaining community acceptance and support. The primary barrier to progressing some forms of recycled water use at a local level is community hesitancy. During consultation there was a strong desire for government to fast-track community engagement programs on purified recycled water, and if possible, consider it as a short to medium term action rather than a longer-term aspiration.

66. [www.dpie.nsw.gov.au/water/plans-and-programs/nsw-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/nsw-water-strategy)

67. Under Section 60 of the Local Government Act 1993, local water utilities are required to obtain Ministerial approval for the construction or modification of water or sewage treatment works.

## Managed aquifer recharge

Managed aquifer recharge – also known as groundwater replenishment, water banking or artificial recharge – is the purposeful replenishment of aquifers for environmental benefit or future use. A range of sources can be used to recharge aquifers, including stormwater, treated wastewater, industrial water, dam water or water directly from the river. Potential benefits from managed aquifer recharge include:

- minimising evaporation, compared to storing water aboveground
- increasing the reliability of groundwater sources for ecosystems and water users
- reducing pressure on surface water supplies during drought, which could improve environmental outcomes for riverine environments.

During consultation, there was support for investigating managed aquifer recharge, which was considered to have potential to enhance water security. However, potential environmental impacts on the aquifers and surface water systems would need to be assessed and understood, as well as any possible changes to water sharing processes and plans.

Studies have indicated that the alluvial aquifers in the Macquarie–Castlereagh region have potential to be used for managed aquifer recharge.<sup>68</sup> Initial assessments show that a pilot in the Dubbo region could be feasible. Dubbo Regional Council has indicated that a desirable capacity for the managed aquifer recharge scheme would be 1,500–2,000 ML/year. During the final quarter of each water year (April to June), the council could assess its likely surplus urban water entitlement and pump to an aquifer.

Progressing the development of a managed aquifer recharge policy and regulatory framework is a priority. As it is a new way of managing and storing water in NSW, extensive stakeholder consultation will be needed, especially as existing users could be affected. Equally, no decision on introducing managed aquifer recharge into potable systems will be made without extensive community consultation and development of stringent water quality standards.



Image courtesy of Destination NSW. Morning mist passing through a paddock in Lue, near Mudgee.

68. Gonzalez, D., Dillon, P., Page, D. and Vanderzalm, J 2020, *The potential for water banking in Australia's Murray–Darling basin to increase drought resilience*. *Water*, 12(10), p.2936.



## Action 1.6: Plan for the best long-term augmentation solution for the upper Macquarie

As regional centres and towns in the upper Macquarie grow in the coming decades, so will water demand. Reducing water demand and investing in stormwater harvesting schemes can improve urban water security for Bathurst and Orange, but these actions alone may not prevent each town from running out of water in a severe drought. Additional investment will be needed to maintain the security of water supplies.

The Macquarie–Castlereagh Regional Water Strategy aims to adapt as the region's circumstances, climate and population changes over the next 20–30 years. Adaptive strategies typically do not rely on a single solution but identify a range of feasible solutions. This can allow decision makers to choose the most appropriate options to implement, based on the information, technology and conditions at the time.

A range of long-term options will need to be investigated further to understand the best package of options that can support ongoing town water security in the upper Macquarie catchment. The preferred options will require more detailed investigations and community consultation. While we have identified a range of options in this strategy, additional options may be identified as information and evidence evolves over time. This includes any related actions arising from the Fish River–Wywandy Sub-Regional Water Strategy that is currently under development. These would be compared against each other if found to be viable.

Infrastructure options that could support medium to long-term water security for towns in the upper Macquarie include:

- supply water to upper Macquarie towns from the Fish River or Coxs River catchment
- supply water to Bathurst and/or Orange from the Lachlan Valley
- new infrastructure in the upper Macquarie, which could include a new Ulmarrah Dam at Dixon Long Point
- new infrastructure to provide a piped supply of water from Burrendong Dam if the full supply level is raised (see Action 2.4).

Note: These options are not listed in any prioritised order.

## Supply water to upper Macquarie towns from the Fish River or Coxs River catchment

The Coxs River catchment and Fish River Water Supply Scheme straddle the border between the Macquarie–Castlereagh region and the Sydney catchment. There are a range of rivers, creeks, groundwater sources, weirs and dams in this system. The water from the rivers, dams and groundwater sources in this border area supplies water customers in the Greater Sydney Metropolitan area, power generation, mines, and the townships of Oberon, Lithgow and surrounding villages.

This option proposes to investigate augmenting Bathurst and Orange's water supplies with water from the Fish River Scheme or the Coxs River catchment. This could include assessing water availability from Duckmaloi Creek. The water could be delivered via the Fish River or pipelines. Our initial analysis shows that an annual water entitlement of 4.6 GL from the Fish River Scheme could reduce Bathurst's risk of water supply shortfalls.<sup>69</sup>

The challenge in the short term is securing this water from existing licence holders. Over the longer term, water from the Fish River Scheme and the Coxs River near Lithgow could become available as coal-fired power stations close down and water that is currently dedicated to these power generation companies is redeployed. While the Wallerawang Power Station near Lithgow has shut down and the Mt Piper Power Station is currently scheduled to close by 2040, it is not clear whether, or when, this freed up water will become available. If it becomes available, there will be competing demands for it, as it could also be used to reduce the water security risks for towns in the Blue Mountains or Lithgow, support economic growth and new industries in the Lithgow region or be held by Aboriginal people for cultural and economic purposes.

Progressing this action will involve further assessment of whether and when water may become available, design of infrastructure, the impacts on customer pricing, and the benefits or trade-offs of using the water for other needs. The financial costs associated with paying for water from the Fish River Scheme may be significant for water users. This option will need to ensure there are no adverse impacts on water security for Oberon or Sydney's Blue Mountains area.<sup>70</sup>

69. See Attachment 2 in the *Macquarie–Castlereagh: Shortlisted Actions – Consultation Paper* available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/public-exhibition/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/public-exhibition/macquarie-castlereagh-regional-water-strategy)

70. The Greater Sydney Water Strategy has identified a portfolio of actions that are being progressed to support Sydney's water security.

## What we heard



There was general support for supplying water to upper Macquarie towns from the Fish River or Coxs River catchment with some suggesting it should be a priority for implementation. However, progressing this option for the benefit of towns in the upper Macquarie should not come at the cost of reducing water security for Oberon or towns in the Upper Blue Mountains.

### Supply water to Bathurst and/or Orange from the Lachlan Valley

The eastern part of the Lachlan Valley includes a range of state-owned and council-owned water storages that support the water needs of towns, industry and the environment in the Lachlan Valley.

There is already a pipeline connection from Orange into the Lachlan Valley, and there is an opportunity

to consider whether water from the Lachlan Valley could help reduce future water security risks for Bathurst and Orange. Impacts on the Lachlan Valley of these options will also need to be considered.

The viability of this option for Orange and Bathurst will depend on how effective this option is in reducing Bathurst's and Orange's water security risks compared to other options presented in this strategy.

A Sub-Regional Town Water Strategy is being developed by Orange City Council, Cabonne Shire Council and Central Tablelands Water to cover their areas of operation in the upper Macquarie Valley. Existing and proposed pipeline links between the towns of Manildra, Orange and Molong (and adjacent areas) will be assessed. Linking these existing town water supply schemes can provide shared benefits and improve the drought resilience of the individual town water supply schemes.

## What we heard



We received mixed feedback on supplying water to Bathurst and/or Orange from the Lachlan Valley with some views that Wyangala Dam should function as a regional water source and that inter-regional pipeline connections should be progressed as a priority. Other views were that water transfer between catchments should be avoided or only used in emergency situations.



## New infrastructure in the upper Macquarie catchment, such as a dam at Dixons Long Point (Ulmarrah Dam)

Additional infrastructure in the upper Macquarie could help support the water needs of Orange and Bathurst and surrounding communities.

A dam on the Wambuul / Macquarie River at Dixon's Long Point (Ulmarrah Dam) was proposed by several stakeholders in submissions on the Draft Macquarie–Castlereagh Regional Water Strategy. Our analysis suggests a dam of 20–30 GL capacity could meet

Orange's long-term water needs. However, given the large cost and downstream impacts associated with a dam,<sup>71</sup> the other options in this action may be more cost-effective for reducing Orange's water security risks in the short to medium term.

There is merit in further investigating new infrastructure in the upper Macquarie and comparing it against alternative options. Potential impacts on the reliability of water for downstream needs, and the cultural and environmental impacts of new infrastructure, would need to be addressed.

### What we heard



There was strong support for and strong concern about building new infrastructure in the upper Macquarie. Support for a new dam in the catchment centred around helping to secure water for the towns and communities in the upper Macquarie. Concerns related to potential impacts on the reliability of water for downstream needs and the cultural and environmental impacts of a new dam.

We heard from councils that if the option to increase the full supply level of Burrendong Dam (Action 2.4) is progressed, then it should consider how some of the additional water stored in Burrendong Dam could be used to support upper Macquarie towns through a pipeline.



Image courtesy of John Spencer, Department of Planning and Environment. Post Office residence, Hill End Historic Site.

71. See Attachment 2 in the *Macquarie–Castlereagh: Shortlisted Actions – Consultation Paper* available from: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy)

## Action 1.7: Reduce uncertainty in groundwater security for the region's towns

Most towns in the Castlereagh catchment, including those in Warrumbungle Shire Council, and some towns in the mid Macquarie, such as Narromine and Warren, rely primarily on groundwater for water supply. Towns such as Dubbo rely more heavily on groundwater during droughts.

The NSW Government collects data on groundwater levels at a regional scale; however, this information is often not sufficient to show local impacts on groundwater or to support council decision making. Because of the complexity of the aquifer systems, knowledge of the physical characteristics of these aquifers is still developing. To better understand short-term localised behaviour of aquifers, we need further data, modelling and investigations.

At the local level, the critical factor in supporting groundwater-dependent towns is to understand whether town water bore infrastructure can sustain town water supply during droughts. This includes ensuring there are:

- enough bores that are sufficiently deep and well-constructed so that bore yield is not affected by declines in the groundwater level during drought. It is important that these bores can sustain the needs of the local water utility over an extended period of time
- suitable water treatment facilities to support the long-term treatment and use of groundwater sources for towns
- enough monitoring bores to monitor local level changes in groundwater.

The site-specific nature of this issue means that local-level investigations are the best way to understand risks to water supply. The NSW Government may provide funding and support to councils to undertake these investigations through local level planning processes. Narromine Shire Council has commenced local level groundwater investigations.

At the strategic level, the NSW Government can provide clear guidance around how high priority groundwater needs such as town water supply will be managed in the Macquarie–Castlereagh region. This includes:

- determining how critical needs and high priority uses, such as local water utility licences, are prioritised when considering impacts on the aquifers and other users
- investing in science about the recharge rates of various groundwater sources
- exploring the option of granting temporary licences to access groundwater during drought
- reviewing the regulation of basic landholder rights (including stock and domestic) to assess whether new rules are required to better manage this type of water take when water restrictions are in force
- investigating the degree of connectedness and time lags between groundwater and surface water, and the influence that each has on the successful management of the other. In some sources there may be merit in exploring a joint trigger arrangement. This may be particularly useful in managing the Cudgegong Alluvial, which has high connectivity with the overlying river.

### What we heard



There was strong support for this action, and agreement that towns should have multiple sources of water supply.

Councils are seeking more streamlined groundwater approval processes. There was concern that local water utilities do not have the resources and skills to investigate and identify suitable groundwater sources.

Granting of temporary licences to access groundwater during drought received mixed feedback. Some stakeholders requested that further work is undertaken to ensure this does not lead to further declines in groundwater levels or impacts on groundwater dependent ecosystems and other water users.

We heard that actions resulting in an increased reliance on or use of groundwater would need to ensure the ongoing sustainability of the resource is not compromised, and that surface and groundwater dependent ecosystems are protected.



## Action 1.8: Support skills, capacity building and water quality in Oberon and other local water utilities

Attracting and retaining skilled staff to operate water treatment plants is a significant challenge for many small local water utilities across the region and NSW more broadly. This as an ongoing and widespread issue that can impact on the ability of council to maintain water and sewerage treatment operations and maintenance. During community consultation we heard support for improving the water quality for Oberon's town water supply.

Over the next 4 years there is an expected deficit of 1,476 water operators' qualifications in NSW and a shortfall of up to 21 trainers and assessors to deliver training in regional NSW. This limits the capability of local water utilities to operate and maintain water infrastructure.

The NSW Government is committed to supporting local water utilities to fill these skills gaps. This is a statewide priority and work has already begun to help address this. Under this action, the NSW Government will continue to work across the training and water sector to help address the skills and training gaps.

### What we heard



We heard that council staff need training in groundwater as most are focused on river water and water quality treatment.

This action will also provide ongoing support to Oberon to improve water quality for Oberon's citizens and businesses, and will involve:

- the NSW Government continuing to provide ongoing technical support and guidance to help manage water quality. In the short-term this may continue to focus on managing the reticulation system
- working with WaterNSW to improve the quality of raw water supplied to Oberon to reduce treatment difficulties
- exploring options to support the financial costs associated with sourcing water from the Fish River Water Supply Scheme.

### Town Water Risk Reduction Program

The NSW Government, in partnership with local water utilities and the wider water sector, is collaborating on the Town Water Risk Reduction Program. This program will develop and implement a new approach of working together that enables local water utilities to manage risks and priorities in town water systems more strategically and effectively.

The program is based on a new partnership approach, which recognises and leverages the wealth of expertise within councils and local water utilities and provides opportunities for these stakeholders to design and refine better solutions in collaboration with the department.

Phase 1 of the Program, which ended in December 2022, focussed on working to identify the most fundamental barriers within state and local government that prevent effective and strategic risk management, and to develop and implement long-term solutions to these barriers.

Phase 2 of the Program is:

- addressing critical skills shortages and boosting water operations training and employment opportunities in regional NSW for school leavers, Aboriginal and First Nations students and existing water operators, in partnership with Training Services NSW
- delivering a new program in partnership with NSW Health to help optimise the performance of high-risk water treatment infrastructure using innovative technology so that more regional towns have reliable, resilient and safe water services
- enabling local water utilities to accelerate responses to audits to improve local dam safety and address water quality risks, leveraging the systems and expertise of WaterNSW.

## Action 1.9: Provide additional water from the Wambuul / Macquarie River for Orange

Orange currently has a pipeline from the Wambuul / Macquarie River and a licence to take water from the river for town water supply. This is an important part of Orange's water supply system. Orange can take up to 1,286 ML/year,<sup>72</sup> but cannot take water when the river levels are lower than the cease-to-pump threshold of 108 ML/day.

This option would look at bolstering Orange's water security by increasing the annual limit on water taken under this licence, while still adhering to the cease-to-pump rules. An additional entitlement could be granted by the Minister under provisions in the legislation. Our analysis suggests that increasing the annual take limit would effectively decrease the time that Orange is under severe restrictions<sup>73</sup> and has the

potential to reduce the risk of Orange running out of water. However, these benefits deteriorate under a dry climate change scenario because this option relies on river flows which will become less reliable.

Our analysis also suggests that increasing the annual take limit does not impact storage levels in Burrendong Dam or the reliability of allocations from the dam to the Wambuul / Macquarie River water users.<sup>74</sup> This is because the amount of additional water proposed to be taken by Orange City Council under this option is small compared to the volumes of water in the river, and the amount of water used further downstream. This option would be subject to additional impact analysis, including consideration of how the increased water licence volumes would be sourced.

This option would be a short to medium-term solution for reducing Orange's water security risks.

### What we heard



We heard concerns about how this option would impact on downstream needs. We also heard that any additional water for Orange City Council from the Wambuul / Macquarie River should be purchased from the market.

72. Total transfer over any 3-year period not to exceed average 643 ML/year (i.e. maximum 1,929 ML total transfer over any 3-year period).

73. See Attachment 2 in the *Macquarie–Castlereagh: Shortlisted Actions – Consultation Paper* available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/public-exhibition/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/public-exhibition/macquarie-castlereagh-regional-water-strategy)

74. See Attachment 2 in the *Macquarie–Castlereagh: Shortlisted Actions – Consultation Paper* available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/public-exhibition/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/public-exhibition/macquarie-castlereagh-regional-water-strategy).



# Priority 2

## Reduce water security risks in the region's west

Water in the Macquarie catchment, downstream of Burrendong Dam, plays a critical role in supporting major economic activity in the region, towns, globally significant ecological assets and important Aboriginal cultural sites. A more variable or drier climate will mean more times when there is no water in the mid and lower reaches of Wambuul / Macquarie River. This will increase water security risks and make it more difficult to meet water needs downstream of Burrendong Dam.

Multiple actions will be required to reduce these risks. Ensuring there is enough water set aside for essential needs and delivering water efficiently during dry periods can help build resilience in the region.

There are opportunities to fast track and implement cost effective solutions in the mid and lower Macquarie–Castlereagh region while gathering further evidence needed to progress large, regionally significant projects.

This priority focuses on actions that:

- more efficiently deliver water to high priority needs and reduce town water security risks in the west of the Macquarie catchment
- improve the drought resilience of industry in the west of the Macquarie catchment
- ensure environmental assets are not impacted, including flows into the Ramsar listed Macquarie Marshes or the end of the Wambuul / Macquarie River.

Water also needs to be downstream of the valley at important times. It may not be possible to always meet all needs from river flows, since the Macquarie mainly connects with the Barwon–Darling during high-flow periods. It is important that when flows resume after a prolonged drought they are initially protected from commercial extraction to ensure that they can flow through the system.

### Our starting point

The actions in this strategy will build on:

- the NSW Government's response to managing limited water supplies, supporting rural communities and minimising ecological impacts during the last drought (2017–2020). Individual valley 'drought snapshots' have been prepared that include sections on 'lessons learnt' and changes that are being implemented in response
- the NSW Extreme Events Policy and valley-specific incident response guides, which help to manage extreme events in each of the major water sources in the NSW Murray–Darling Basin. The NSW Extreme Events Policy was updated after the drought in 2017–2020.

**Figure 22. Actions for Priority 2: Reduce water security risks in the region's west**

Legend				
				
Reducing water supply risks for regional cities and rural and remote towns	Supplying water to high priority needs in the west of the catchment and connected valleys	Maintaining and improving river, floodplain and wetland health	Addressing barriers to Aboriginal people's water rights	Supporting a growing regional economy in a future of potentially reduced water availability






Action number	Action name	Challenges addressed
Action 2.1	Investigate options to improve water delivery efficiency for high priority needs	
Action 2.2	Upgrade the Nyngan to Cobar Pipeline and associated infrastructure	
Action 2.3	Investigate how much water should be set aside in Burrendong Dam for dry periods	
Action 2.4	Continue to investigate regional water security solutions for the region's west	
Action 2.5	Fully implement the NSW Floodplain Harvesting Program	



Image courtesy of Ines Richter, Department of Planning and Environment. Burrendong Dam Spillway.



## Action 2.1: Investigate options to improve water delivery efficiency for high priority needs

Toward the end of the Wambuul / Macquarie River catchment there are high priority water needs that often use relatively small amounts of water but need water consistently. These needs include towns (Nyngan, Cobar), stock and domestic users, and ecological assets.

During extreme dry periods, a significant amount of water is needed to be released from Burrendong Dam to meet these small, but important water needs at the end of the system. It can take 27 GL of water released from the dam to get 1 GL at the end of the system.

More efficient ways to store and deliver water during extreme dry periods can support the drought resilience of the entire catchment. This action proposes to investigate several options to improve drought resilience and efficiency.

## Investigate an additional off-river storage in the west of the catchment

Water travels approximately 300 km from Burrendong Dam to supply Nyngan and Cobar via the Wambuul / Macquarie River, Gunningbar Creek and then the Albert Priest Channel. Bogan Shire Council's annual water demand is approximately 5,000 ML and future droughts may mean it will be more difficult to deliver water down these rivers and creeks to meet this demand.

Bogan Shire Council has constructed a 650 ML off-river storage that requires sealing to prevent leakage. Council also has plans for a second 550 ML storage.

This action proposes a third off-river storage in the western part of the Macquarie catchment to reduce the risk of towns and high priority water needs running out of surface water or being in water restrictions for extended periods of time. The third storage could be filled during wetter periods for use during dry periods.

Our analysis indicates that an additional off-river storage with a capacity of 3,000 ML could reduce the water security risks for Nyngan and increase the resilience of Nyngan, Cobar and nearby mines during droughts. The analysis also shows benefits for general security and high security licence holders in the regulated Wambuul / Macquarie River.<sup>75</sup>

Further detailed investigations will need to be undertaken to confirm a preferred site, geotechnical site suitability, potential environmental impacts and cost considerations.

## What we heard



During consultation we heard strong support for an additional off-river storage, and a range of suggestions for its location. We heard that an additional storage may provide local and regional drought security benefits if located near Warren, Narromine or Peak Hill. We also heard a strong desire that, if progressed, local businesses should be engaged to implement and build the off-river storage.

There were concerns that a new structure at Nyngan would impact upon environmental assets and other water users in the Macquarie region.

The dependence of Cobar on water from Nyngan also generated suggestions about the need to improve efficiency, and the option of replacing or lining the Albert Priest channel (see Action 2.4).

75. See Attachment 2 in the *Macquarie–Castlereagh: Shortlisted Actions – Consultation Paper* available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy)

## Investigate changing the operation of the regulated effluent creeks during dry periods

Gunningbar Creek, Crooked Creek and Duck Creek form part of a network of channels that branches off the main trunk of the Wambuul / Macquarie River near Warren (refer to Figure 11). They are often termed the effluent creeks. Gunningbar Creek receives regulated flows from the Wambuul / Macquarie River just upstream of Warren, and the Duck and Crooked creeks branch off from Gunningbar Creek shortly thereafter. Downstream of the 'Mumblebone' weir pool, flows along the Crooked Creek are essentially unregulated.

Naturally, all 3 creeks would have flowed about 15% of the time, however, as the flows are now largely regulated, it is rare for them to stop flowing (Figure 23). The change in water management to provide more permanently flowing creeks has implications for the social, economic and environmental aspects of these systems.

Agricultural businesses have used the effluent creek system for more than 100 years for livestock grazing, dryland cropping and, more recently, irrigated cotton. Most landholders along the creeks rely on them for stock and domestic water.

During dry periods, it takes approximately 30 GL of water from Burrendong Dam to meet 1 GL of demand. During the 2017–2020 drought, flows to Gunningbar Creek ceased when Burrendong Dam fell to approximately 5% of its total storage capacity (67 GL). This is equivalent to approximately 3% (33 GL) of its active/effective storage. Under a more variable or drier future climate there may be more instances when it will not be possible to supply river water to the creeks. Our climate data suggests droughts could be longer than previously anticipated, and water deliveries to these creeks from Burrendong Dam may need to cease earlier than during the 2017–2020 drought.

Supplying the stock and domestic needs on the effluent creeks through alternative means during dry periods could support the drought resilience of the landholders on the creeks. It also has the dual benefit of saving 1–3 GL of water per year on average over the long-term that could be used to bolster town water security, improve flow variability in the creeks at other ecologically beneficial times, or support the drought resilience of industries. Water savings are much higher during drought periods.



Image courtesy of Destination NSW. Bogan River, Nyngan.





During consultation the following concerns were raised by landholders on the effluent creeks:

- the 'regulated' status of the effluent creeks would be changed
- the environmental values of the effluent creek system are not sufficiently understood and recognised but are integral to the operation of the Macquarie Marshes that are located to the east and therefore should be afforded the same protections. Specifically, that water should not be taken off the creeks and provided to the Macquarie Marshes
- alternative water supplies operated in non-drought times would result in dry creeks more often, impacting the amenity of rivers and ability of landholders to manage stock
- there would be costs associated with fencing and alternative stock watering points
- the effluent creeks are important recreational areas for landholders and the communities from nearby towns of Warren, Nyngan and Brewarrina.

There was support from some stakeholders who noted there are opportunities to use water more efficiently and support the drought resilience of landholders. Savings from progressing this action could be used to keep water in the dam for town security. In non-drought years, normal flows to the effluent creeks should be supplied.

There were requests for the department to undertake environmental studies before progressing with this option, consider opportunities to trial this option in some creeks, and publish clear information on when the pipeline would operate, and how any water savings that could result from the option would be managed.

### How we have responded

In response to this feedback, the strategy has been amended to clarify that this action will focus on investigating the benefits of changing the operation of the creeks during dry periods when water is unlikely to be able to be delivered from Burrendong Dam to the end of the system. It would not intend to cease water deliveries to the creeks during 'average' periods or remove the regulated status of the creeks. Specific rules around when the changes could occur will need to be negotiated through water sharing plan changes in consultation with the community and following further investigation of this action through a business case. Understanding the ecological values of the creek system and environmental impacts of this action will be a part of the next stage of investigation.

The department has published further information on the technical analysis behind this action at [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy)

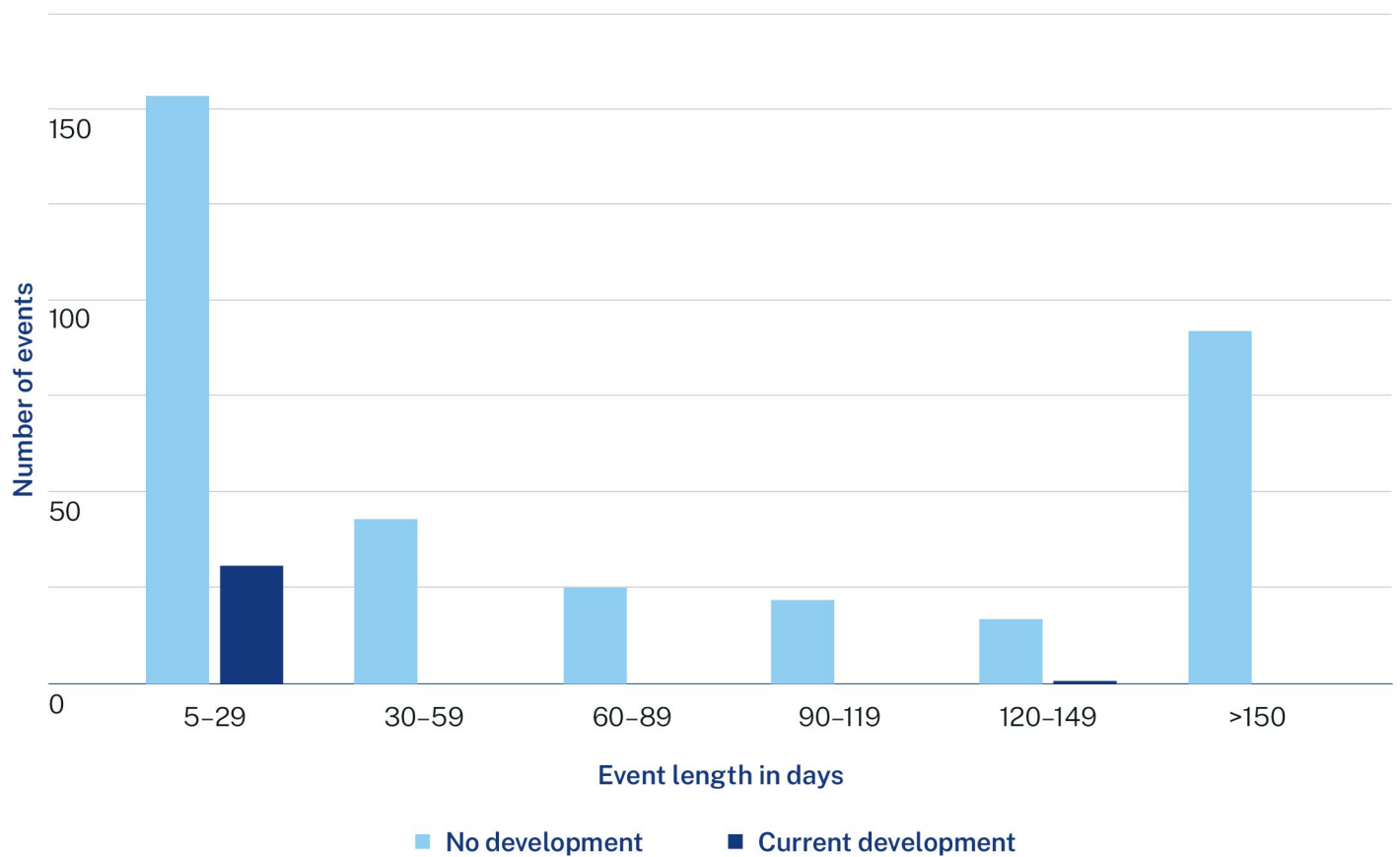
This action proposes to investigate whether changing the operation of Gunningbar Creek, Duck Creek and the upper part of Crooked Creek to a more variable regime with occasional periods of no flow during dry periods could help extend water supplies for the region during extreme droughts.

Progressing this action will involve consultation with community and stakeholders, and include:

- undertaking relevant environmental studies to assess the ecological values of the creek, the water required to maintain them and potential impacts of alternative supply of water in dry times
- undertaking feasibility studies for alternative water supply options

- confirming clear rules around when it is not possible to deliver water to the creeks from Burrendong Dam during dry periods
- identifying projects to support and rehabilitate the environment of the creeks (see Action 4.6)
- confirming funding and ongoing operation and maintenance of any new works
- identifying management actions, such as a riparian fencing program, as many properties have come to rely on the creeks as ‘fences’ for stock movement.

**Figure 23. Modelled effect of development on frequency of no-flow events in Gunningbar Creek**





## Action 2.2: Upgrade the Nyngan to Cobar Pipeline and associated infrastructure

The water for Cobar and its surrounding mines is sourced from the Wambool / Macquarie River and transferred to the town via the 130 km Nyngan to Cobar Pipeline. The pipeline is the only source of water to the community of Cobar, and it provides emergency supplies to the satellite towns of Canbelego, Hermidale, Mt Hope, Nymagee, Euabalong and Euabalong West. It is the sole source of water for 5 operational mines.

The existing pipeline and pumping stations are nearing the end of their design life, with the emergency backup system also at risk of failure. This presents a risk to water reliability for the township and mines in the area.

With NSW Government funding, Cobar Water Board replaced a 30 km section of the pipeline in 2018. This action will continue work to upgrade and replace the remaining 100 km pipeline and pumping infrastructure to ensure continued water security for the town of Cobar and the mines in the region. It will also increase water accessibility and reliability for agriculture and improve the use of technology such as pipeline monitoring. A final business case has been developed for the project.



Image courtesy of Ines Richter, Department of Planning and Environment. Gin Gin Weir, NSW.



## Action 2.3: Investigate how much water should be set aside in Burrendong Dam for dry periods

When allocating water to users in the Macquarie–Cudgegong Regulated River Water Source, the NSW Government first ensures, as far as practicable, that approximately 2 years of essential requirements can be met from Burrendong Dam before allocating to lower priority (general security) licence categories. This volume must include the amount of water required for town water supplies, high security licences, minimum dam releases, stock and domestic replenishment needs and water conveyancing volumes, which are based on average transmission and evaporation losses. The 2 years of essential requirements is based on the drought of record before the first water sharing plan commenced in 2004.<sup>76</sup>

The 2017–2020 drought brought into question whether the assumptions used to calculate annual water determinations, including the essential needs reserve volume, will remain appropriate in a changing climate and ensure there is enough water for essential supplies.

In the future, there are likely to be more times when Burrendong and Windamere dams sit at low levels and the river does not flow. This places basic landholder rights and critical environmental needs at further risk and reduces the certainty of available water delivery for all users. We know that actual volumes to convey water down the system can be higher during dry times and that the use of drought contingency measures has been driven by higher-than-average river conveyancing volumes. There may also be more variability and less certainty about forecast inflows.

We have undertaken a preliminary assessment to understand the benefits and impacts of increasing the reserve volume in Burrendong Dam by 108 GL to provide an additional year of essential needs reserve. Most of the extra water is needed to deliver water down the river.<sup>77</sup>

This analysis only looked at one option around changing the essential needs reserve in Burrendong Dam. A broader assessment of whether changing the essential needs reserve and water accounting methods in the Macquarie Valley is an effective way to secure water for critical needs in dry periods, compared to alternative options, needs to be considered through a risk framework. This will be assessed as part of a statewide work program.

The review of the water allocations framework will consider:

- options for redefining the period of lowest inflows to the water source
- whether different periods should apply to different categories of access licences
- whether the reserve level should be increased during a sequence of dry years and reduced during a sequence of wet years
- the impact of any options on planned environmental water and each category of access licence.

The results of the investigation would help to determine whether a change to water allocation and accounting rules in the Macquarie–Cudgegong Regulated River is warranted in response to new extremes in water availability. Any decision on whether to implement a change in the policy on reserves depends on the level of risk that the community is willing to bear around running out of surface water in droughts, and associated impacts on licence holders and the environment.

### What we heard



During consultation, some stakeholders raised concerns that the regional water strategy had not specifically shortlisted or progressed an action to update the drought of record in the region, citing that updating the drought of record may reduce the need to progress other options in the strategy.

In addition to the amount of water set aside in Burrendong Dam during droughts, some stakeholders requested changes to when the water is allocated from the dam. In the Macquarie Valley, water is often allocated to different uses based on forecasts of inflows likely to come into the dam. In other valleys such as the Gwydir Valley, water is only allocated from dams once the water is in the dam. It was suggested that water allocation from Burrendong Dam should change from a 'credit' model to a 'debit' model that allocates water that is physically in the dam at the time.

76. A summary of the allocation methodology is available at: [www.water.nsw.gov.au/allocations-availability/allocations/how-water-is-allocated/resource-assessment-process](http://www.water.nsw.gov.au/allocations-availability/allocations/how-water-is-allocated/resource-assessment-process)

77. Analysis of increasing the essential needs reserve in Burrendong Dam is available in *Attachment 2 of Draft Macquarie–Castlereagh Regional Water Strategy: Shortlisted Actions – Consultation Paper* available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy)



## Action 2.4: Continue to investigate regional water security solutions for the region's west

Between 2017 and 2020, the region experienced the worst drought on record, exposing the vulnerabilities of the businesses, towns and ecosystems. Our new climate data has also highlighted that we need to focus on long-term options to improve water security for the mid and lower Macquarie. This includes:

- reducing water security risks for major regional cities such as Dubbo, as well as towns and high-priority licences at the end of the Wambuul / Macquarie River system
- ensuring there is no significant reduction of water flowing into the Macquarie Marshes
- improving the drought security of water dependent industries that drive the economy.

Our strategic analysis has identified some shortlisted options that could help support long-term water security for users in the mid and lower Macquarie. These options merit further comparative analysis and include:

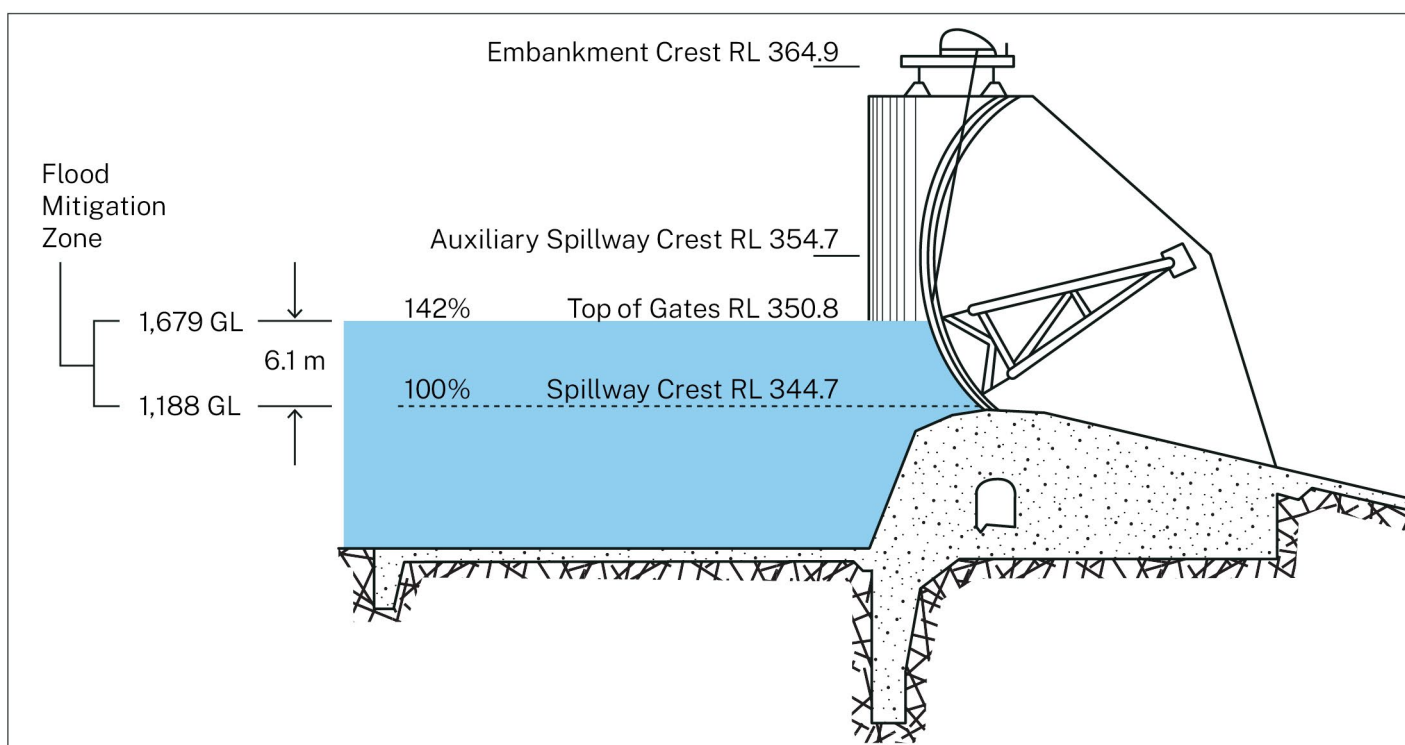
- using some of the flood mitigation storage in Burrendong Dam for water supply
- a regional pipeline connecting Dubbo to Nyngan and other towns
- the proposed new weir for replacement of the aged and damaged Gin Gin Weir.

## Use some of the flood mitigation storage in Burrendong Dam for water supply

Burrendong Dam was built for the dual purposes of storing water to secure supply to a range of water needs and flood mitigation. The maximum amount allowed to be stored for water supply is called the full supply level. This volume is 1,188 GL. The storage capacity above the full supply level, 491 GL, is referred to as the Flood Mitigation Zone (Figure 24). Water is only stored in the Flood Mitigation Zone during times of flood and is released after the peak of the flood to reduce the peak level of flooding downstream.

Since Burrendong Dam's completion in 1967, water has been stored in the Flood Mitigation Zone on 20 separate occasions, with the longest period being 24 months in the early 1970s.

**Figure 24. Critical storage levels of Burrendong Dam**



Source: WaterNSW

This action would repurpose some of the existing capacity of Burrendong Dam from flood mitigation to water supply. Our analysis<sup>78</sup> suggests that increasing the full supply level of Burrendong Dam by 118.5 GL to 1,306.5 GL could:

- reduce the time Burrendong Dam is sitting at low levels and, as a result, reduce the time that downstream towns such as Dubbo are in severe water restrictions
- increase long-term average annual diversions under the historic, long-term climate and dry climate change scenarios while maintaining total diversions below the diversion limit
- improve end-of-year water allocations to general security water users (irrigation and environmental water) under the historical climate
- maintain average end-of-system flows in the lower Bogan
- slightly reduce the average end-of-system flow into the Barwon River, but the option may be able to be operated to ensure there is no reduction in long-term average inflows downstream

- be operated to try and ensure there is no reduction in the average volume of water flowing into the Macquarie Marshes and end-of-system flows into the Barwon River. However, this approach needs further investigation, noting that further analysis is also needed on implications for flow rates, timing, duration and frequency of end-of-system flows
- slightly increase the flood risk downstream at Narromine. There is potential for this to be mitigated by revised operating protocols.

Maintaining or ensuring no reduction in average volumes for end-of-system flows will likely still impact ecological objectives and outcomes under a changing climate. Simply maintaining the status quo of regulated systems may not be enough to protect ecological communities, or enhance them.

Future investigations for this sub-action could consider different levels for the dam, and will consider how those levels will impact on social and ecological outcomes.

## What we heard



During consultation we heard:

- strong support for increasing the full supply level of Burrendong Dam as it was seen as being more cost effective and easier to implement than other major infrastructure options
- that this option should consider how water is shared amongst different water users, including consideration of whether it could support the water security of towns upstream of Burrendong Dam such as Bathurst and Orange
- that operation of the Flood Mitigation Zone needs to be sensitive to the conditions on the ground
- that this action should progress as a high priority for delivery under the regional water strategy.

We also heard concerns that this option would erode planned environmental water, reduce dam spills needed to support bird breeding events in catchment, reduce flows at Carinda and increase flooding risks for Dubbo and Narromine.

### How the department has responded

In response to these concerns an additional fact sheet was published providing further data about how this action could change flows in different parts of the system. The fact sheet is available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy)

Some stakeholders raised concerns that the regional water strategy had not specifically shortlisted or progressed an action to update the drought of record in the region, citing that updating the drought of record would negate the need to progress raising the full supply level in Burrendong Dam or many of the other actions in the strategy. Updating the drought of record (see Action 2.3) would need to be considered alongside this option and may be potentially complementary to further investigations around increasing the full supply level in Burrendong Dam.

78. For more information, refer to *Analysis of the option to raise Burrendong Dam's full supply level* available at: [www.water.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy](http://www.water.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy)



The results of analysis suggest there is merit in further investigating this action. However, immediate tasks required to assess the feasibility of this action are:

- **safety assessments** – an assessment of the infrastructure and safety of the dam is required under Dams Safety's NSW Guidelines for Dam Safety Management System to understand whether the risks associated with changing the full supply level can be mitigated effectively. This assessment will identify any structural costs associated with changing the full supply level, as well as the extent to which enhanced operating protocols and flood risk monitoring and warning systems could minimise the reduction in flood mitigation capacity. WaterNSW has indicated that the Burrendong Dam assessments have previously assumed there is water in the Flood Mitigation Zone at the commencement of the possible extreme flood events. However, the proposed changes to full supply level and operational procedures will need to be considered under the guidelines for the Dam Safety Management System, and any changes in dam safety risk may lead to the need for upgrades to the dam structure. The detailed assessment is estimated to take up to 2 years
- **planned environmental water provisions and ecological and biodiversity impacts** – progressing this option will require discussions with Australian Government agencies about how the option may interact with or impact on planned environmental water provisions. Under the Basin Plan, there can be no net reduction in planned environmental water as a result of changes to water sharing rules or infrastructure. In addition, a preliminary assessment suggested there are key protected fish species and properties immediately upstream of Burrendong Dam (mostly state-owned and a few in private ownership) that are likely to be affected from a decrease in the Flood Mitigation Zone due to an increase in the dam's full supply level. These impacts will need to be assessed in more detail.

## Replace the aged and damaged Gin Gin Weir

The existing 120-year-old Gin Gin Weir is located on the Wambuul / Macquarie River northeast of Trangie. The weir is damaged and presents a barrier for fish in the river. The current concrete structure was damaged by severe floods in 1903, reducing it from 9 m to its present overflow crest height of about 4 m. Locals use the sandy area on the riverbank near the weir, colloquially referred to as the 'beach', for fishing, camping and recreational purposes.

The NSW Government commenced a business case to consider replacing the Gin Gin Weir with a new, modern gated 6 GL mid-system weir and fishway 200 m downstream of the existing weir. The proposed weir could temporarily capture water that was ordered but then cancelled by water users, and then release it downstream for subsequent water orders.

There are concerns that the weir will reduce the water flowing into the Macquarie Marshes and capture water from tributary flows that otherwise flow down the river. If the weir is progressed, these concerns could potentially be addressed through its operating procedures. The gate could be operated to allow for low flow events, tributary flows and floods to pass through. This would have some potential implications on the integrity of flows in the system – such as flow rate, timing, and duration – as well as a potential increase in lentic<sup>79</sup> habitat in the system.

Our analysis suggests that a new re-regulating weir could increase the long-term average annual amount of water taken by general security licences by 2.7% (6.6 GL)<sup>80</sup> under the observed historic record. The modelled benefits are slightly lower under a dry climate change scenario.<sup>81</sup>

A fishway on the weir could open up this section of the river to potentially provide 140 km of uninterrupted fish passage between Narromine and Warren, allowing fish to migrate upstream and downstream.

Community and stakeholder feedback has resulted in significant project design changes including reducing the storage capacity from 9 GL to 6 GL and improving the design of the fishway.

Further consultation will be needed to identify culturally significant sites, minimise impacts on the environment and nearby landowners, reduce project costs and improve river operations.

79. Still or slow flowing waters.

80. A portion of this volume is licensed (held) environmental water.

81. See analysis in Attachment 2 of the *Draft Regional Water Strategy Macquarie–Castlereagh: Shortlisted Actions – Consultation Paper* available at: [www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/macquarie-castlereagh-regional-water-strategy)

## What we heard



There were mixed views on this action. Some stakeholders expressed concerns about impacts on the downstream environment, businesses and landholders and wanted certainty that they would be adequately consulted about the proposed weir. Others called for the NSW Government to cancel the project.

There were suggestions that the structure be removed or replaced by a new structure to allow fish passage, and to improve operational efficiencies.

### Construct a pipeline from Dubbo to Nyngan and other towns

Dubbo Regional Council has proposed constructing a pipeline from Dubbo to Nyngan to improve the efficiency of how water is delivered along the length of the river during droughts, improving water security for towns in the region. If progressed, this project could also link to other urban centres such as Wellington and support the centralised treatment of water. It may also help to inform if improving the efficiency of delivering water down the Albert Priest Channel requires further consideration.

Our initial analysis suggests that this option could have the potential to reduce the time Dubbo is in water restrictions and improve water security for Nyngan, Cobar and nearby mines. The water that is saved from flowing down the river can be used for other purposes, which could slightly increase water available for general security licences or be put towards other needs.

Water flowing through pipes rather than down the river channel has implications for other water users and outcomes, as the water in rivers supports the environment, native fish, vegetation and ecosystem processes that need water to survive and function. It could also mean there is a slight reduction of flows into the Macquarie Marshes (less than 1% on average over the long-term).

There are opportunities to analyse this option in more detail to find ways to reduce the impacts on the environment and other water users while ensuring that water security for towns is prioritised during droughts.

Given the costs associated with the pipeline, other shortlisted, lower-cost options that could improve Nyngan and Dubbo's water security, such as an additional off-river storage for Nyngan, are likely to be progressed first.

## What we heard



During consultation we heard that while there was some support for operating pipelines during droughts, there was little support for using pipelines to deliver water during non-drought periods. We also heard that the use of long-term average impact analysis may not reflect changes in the size, timing, duration and seasonality of water flows that can impact on ecosystems of the Wambuul / Macquarie River and Macquarie Marshes, nor reflect changes between dry and wet periods.

### Progressing this action

Each shortlisted option under this action is independent and they are not presented in any prioritised order. Each option would include appropriate adjustments to water sharing rules so that the benefits can be realised, and the infrastructure can be operated in a way that benefits multiple water users and the environment, with any potential impacts avoided or mitigated as needed.

We heard that further analysis of these options needs to specifically include the economic benefits of grazing in the catchment and any impacts on the grazing industry as a result of the options. We also heard that we need to consider how updating the drought of record in the *Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2016* (refer to Action 2.3) could be combined with these options.



## Action 2.5: Fully implement the NSW Floodplain Harvesting Program

Floodplain harvesting happens when water is collected from floodplains during a flood or after a major or significant rain event (overland flows). It is a form of water take that has not been fully transitioned into the licensing framework provided by the *Water Management Act 2000*.

Floodplain harvesting is accounted for in the legal limits on surface water extractions as set out in the Murray–Darling Basin Agreement (the Cap), NSW water sharing plans (long term average annual extraction limits) and the Basin Plan (sustainable diversion limits).

There has been growth in floodplain harvesting across the NSW northern Basin. Where this growth has resulted in total diversions in a water resource exceeding the legal limits, the floodplain harvesting reform will reduce take so that total diversions within each valley will not exceed legal limits. The reforms will also look at implementing restrictions to make sure water is not taken by floodplain harvesting licences when there are downstream critical needs.

Without having a robust licensing framework in place, we cannot measure or monitor floodplain harvesting and it may mean other licence categories are penalised in order to meet legal limits.

This action will ensure a regulatory framework is in place to regulate, measure and enforce floodplain harvesting water take in the Macquarie–Castlereagh catchment.



Image courtesy of Destination NSW. Newey Reservoir, Cobar.





Image courtesy of CSIRO. Waterbirds, Macquarie Marshes.



# Priority 3

## Support industry and community climate adaptation

In the future, the region is likely to experience higher water demand from a growing population, alongside potentially declining water availability. This will put pressure on all users – including the environment – and have flow-on impacts on the regional economy.

Agriculture, mining and tourism will continue to be important to the regional economy in coming decades, so it is vital to understand the risks and challenges

to our industries and communities to better manage water supply. It is also important that operational, planning and development decisions take into account the likely reliability and security of future water supplies.





The actions shortlisted under this priority will support improved industry and community resilience to climate-related challenges.











### Our starting point

Existing government strategies and programs are supporting the resilience of regions, communities and industries to climate change. This strategy will build on the following initiatives:

- Funding of \$3.9 million has been provided under **Future Ready Communities** to promote resilience and develop drought resilience plans that assess drought impacts and responses. Individual plans can focus on intra- or inter-industry diversification, leadership and social capital building, and planning council works. The **Future Ready Regions Strategy** and **Future Ready Communities Pilot Program** includes a commitment to upgrade the Enhanced Drought Information System to provide farms with world-leading weather and climate data so they can make better business decisions, and to support councils to develop drought resilience plans.
- **Aboriginal water rights** are being advanced through a target of 3% of water entitlements to be owned by Aboriginal people and organisations under the National Agreement on Closing the Gap. A statewide **Aboriginal Water Strategy** is being co-designed with Aboriginal people, that will identify a program of measures to deliver on Aboriginal people's water rights and interests in water management.
- Funding of \$48 million has been provided for the **Farms of the Future Program** to support on-farm connectivity and encourage farmers to adopt technology that boosts productivity, water efficiency and drought preparedness.
- The **Climate Change Research Strategy** is supporting projects that help primary industry sectors adapt to climate change.
- The **Royalties for Rejuvenation Fund** will be a key driver in supporting economic diversification for coal mining communities in NSW. A Regional Expert Panel has been established to represent the state's Central West.
- **Regional Plans** across NSW were updated in 2023. These plans set a 20-year framework, vision and direction for strategic planning and land use to ensure regions continue to be vibrant places for people to live, work and visit.
- The **open data framework** recently published by the Department of Planning and Environment–Water outlines how open data will be managed and driven to improve transparency and data sharing. This is part of a policy to provide more open and easily accessible data.

**Figure 25. Actions for Priority 3: Support industry and community climate adaptation**

Legend				
				
Reducing water supply risks for regional cities and rural and remote towns	Supplying water to high priority needs in the west of the catchment and connected valleys	Maintaining and improving river, floodplain and wetland health	Addressing barriers to Aboriginal people's water rights	Supporting a growing regional economy in a future of potentially reduced water availability

Action number	Action name	Challenges addressed
Action 3.1	Invest in continuous improvement to surface and groundwater modelling	
Action 3.2	Improve the collection, analysis and public access to water data and information	
Action 3.3	Support adoption of farm climate adaptation and water efficiency measures	
Action 3.4	Review groundwater extraction and condition limits using new knowledge	
Action 3.5	Develop ongoing arrangements for participation of local Aboriginal people in water management	
Action 3.6	Support place-based initiatives to deliver cultural outcomes for Aboriginal people	
Action 3.7	Support the development of new water-related Aboriginal business opportunities	
Action 3.8	Modernise the water management framework so it can continue to support sustainable economic diversification	
Action 3.9	Support public access to the Macquarie Marshes Nature Reserve	
Action 3.10	Increase transparency in the management of groundwater resources in the region	



## Action 3.1: Invest in continuous improvement to surface and groundwater modelling

The NSW Government uses computer-based water system models to help inform many decisions in regional water management. There are models for both surface water and groundwater systems:

- **river system models** simulate the way water flows and behaves in rivers over time, the operation of infrastructure, and the demands for and use of water by towns, irrigators and other water users. These models can produce detailed information on water availability and how changes in policy, rules or infrastructure can change the amount of water that flows in the river at different times, and the water available to different users. Recent improvements to the Macquarie regulated river system model have included representation of water taken by floodplain harvesting and how environmental water managers use licensed water. The NSW Government has also developed a river system model for the region's unregulated river catchments, including the upper Macquarie and Castlereagh systems

- **groundwater system models** simulate the behaviour of aquifers over time, including groundwater recharge and the take of water from bores. They help analyse seasonal patterns and longer-term trends in groundwater levels. Models also help to understand the potential risks to groundwater dependent ecosystems and to groundwater quality.

The NSW Government will continue to enhance the capability of the Macquarie–Castlereagh River system model, as well as modelling the upper and lower Macquarie aquifers. Continuing to improve these models as new data and information becomes available will be particularly important for managing and sharing limited water resources, and predicting and mitigating the impacts of increasingly variable and extreme conditions. We have heard that sharing the models, particularly with councils, will help provide greater transparency and could support local level water security studies.

Improved modelling will give stakeholders and the broader community greater confidence that water sharing and management decisions are made using the latest scientific knowledge and a strong and credible evidence base.



Image courtesy of Peter Robey, Department of Planning and Environment. Farmland Cattle, Dubbo.

## Starting point

### Collecting more and better data

The NSW Government is undertaking a range of programs to improve understanding of water flows and water use in the Macquarie–Castlereagh region. The data collected by these programs will improve modelling capabilities.

### Climate risk data

The NSW Government has recently published the long-term climate variability risk data that supports the regional water strategies. This is the first step in providing water users with better access to information on the future risks to water availability. The stochastic datasets for rainfall and potential evapotranspiration for the Macquarie–Castlereagh region and a number of other NSW regions are available on the SEED portal.<sup>82</sup>

### Non-urban water metering framework

Under the non-urban water metering framework, water supply works in the Macquarie–Castlereagh region will be subject to the new metering rules to install meters on their pumps.

The non-urban water metering framework will collect and store data, through its cloud-based data acquisition service, to assist the Natural Resources Access Regulator, WaterNSW and the Department of Planning and Environment to undertake compliance and enforcement, billing, and other water management activities. Water users will also be able to access their water use data via a private online dashboard.

This program will help better understand water use and behaviour in the system and will include improved data on water use in unregulated river and groundwater systems.

### Murray–Darling Basin Compliance Compact

NSW is reviewing its hydrometric (river gauge) network as part of the Murray–Darling Basin Compliance Compact. The review is looking at the coverage and data quality obtained from the existing hydrometric network and identifying ways to improve the information collected.

New gauging stations being delivered through the Compliance Compact will provide transparent, accurate and accessible data in real time to water users, communities and stakeholders, building on more than 1,300 monitoring sites already available in real time to the public. Information available from the new stations will include stream levels, flow volumes, and water quality.

The Murray–Darling Basin Compliance Compact will enhance the network so we can better manage stream connectivity, compliance, environmental water releases, and extreme events. The new stations will add even more localised data, helping us better understand local conditions so we can better balance the needs of water users and the environment, and better prepare for floods and droughts.

Water users can access the data through tools including WaterNSW's [WaterInsights portal](#) and [WaterLive App](#), and the Bureau of Meteorology's [Water Information Portal](#) and [Water Data Online](#).

82. The SEED Portal is the central resource for sharing and enabling environmental data in NSW and is available at: [www.seed.nsw.gov.au/](http://www.seed.nsw.gov.au/)



## Action 3.2: Improve the collection, analysis and public access to water data and information

Many parts of the community and government need access to reliable and timely information to make informed decisions and effectively engage in water planning and decision making.

The delivery of climate and water availability information by government has improved, but more can be done to ensure water-related information products meet the expectations of water users and inform new industries entering the region. For example, the NSW Government is committed to supporting better planning for droughts. Access to reliable and timely climate information, sound risk management and well-informed business planning are significant determining factors in the ability of businesses to withstand prolonged droughts.

The new climate data published in the regional water strategies is the first step towards providing more information to water users about future water availability. However, tailoring the application of this data for industry and communities will deliver the greatest benefits. For example, improving short- and long-term water availability forecasts will help the region's businesses plan with greater certainty and make informed decisions on managing their water allocations. It will also support farm-level climate adaptation decisions. Ongoing maintenance and upgrading of gauges in the region can help inform real time data and decision making. Improving our understanding of the vulnerability of primary industries to climate change is critical for managing risks and making sound adaptation decisions.

Supporting new and diversified businesses to understand water licensing products and climate risks can help them to remain in the region over the long-term.

This action will build upon existing state and national data platforms and products, including the WaterInsights and Water Information Dashboards. It will deliver suitable training and information products and platforms that:

- deliver upfront education and clarity to industry and government on potential water sources
- provide education on how continuous accounting and water markets can help water users create a portfolio of water products tailored to their risk appetite to support their business
- encourage new industries in the region to develop comprehensive drought management plans
- improve forecasting and better understand the movement of water across floodplains and within river channels during higher flow events
- continue to fill gaps in, and maintain, the gauging and monitoring network
- connect forecasts across agencies to make it easier for users and provide consistent messaging for councils, community groups and water users
- communicate potential implications of long-term climate variability on:
  - surface water availability and water quality
  - the likelihood of consecutive years of low or no water availability
  - periods where access to water allocations may be restricted by delivery problems in the regulated river system
  - groundwater availability and quality
  - how future use may affect the condition of groundwater resources.
- develop a Drought and Flood River Index with the aim of providing early warning to water users on whether a regulated valley is at a higher risk of entering into drought or flood conditions.

Ongoing investment will be required to deliver these measures adequately and effectively.

### What we heard



Feedback during consultation showed support for:

- climate data and modelling being made available to assist communities and councils in their planning, including their development of strategic water plans
- helping communities to understand what long-term climate assessments can tell us about future water availability. Communities also need an enhanced understanding of how the new climate data sets will be used in future water allocation decisions.

## Action 3.3: Support adoption of farm climate adaptation and water efficiency measures

Industry associations, research institutions and government have worked together for decades to improve traditional crop and livestock production systems, including their water use efficiency and productivity. Grower-led irrigation research has been underway in the region for more than a decade and we heard from stakeholders during consultation that new land use activities, including carbon and biodiversity offset schemes, are increasing in some areas of the region. Continuing critical research and development will set the industry up for the future, and may go a significant way towards mitigating future climate risks and adapting to climate change.

Farm businesses in the Macquarie–Castlereagh region are considered early adopters of best practice management and new technologies.

On-farm water efficiency projects funded under the Murray–Darling Basin Authority’s Private Irrigation Infrastructure Operators Program in the Macquarie–Castlereagh region included the Tenandra, Marthaguy, Trangie, Nevertire and Narromine Irrigation Board schemes in the mid Macquarie Valley. Different measures were undertaken within each scheme to reduce operational losses and improve delivery, including:

- modernising irrigation channels through upgrading and decommissioning
- installing pumped pipeline systems
- constructing secure stock and domestic water delivery systems
- installing and operating fish-friendly diversion screens to achieve both ecological and operational outcomes.

More than 27 GL of water savings from the program was passed on to the Australian Government as environmental water.

### Starting point

The **NSW Climate Change Research Strategy** is supporting projects that help primary industry sectors adapt to climate change.

For example, the Department of Primary Industries–Agriculture is undertaking a Climate Vulnerability Assessment Project to assess the vulnerability of 28 primary industries and 14 related biosecurity risks to climate change.

The assessment is being conducted in 2 stages:

- an impact assessment looking at how current production might vary under future climate conditions in 2050
- an adaptation assessment looking at how we might respond to negative impacts and provide direction for industry research and development; for example, developing crop varieties more suited to a drier climate.

The impact assessment for cotton, which is nearing completion, suggests that warmer temperatures could benefit cotton production and quality. The next steps are to assess water-related risks and possible responses to negative impacts. This assessment could include developing new cotton varieties or other farming systems that are more suited to a drier climate.

The rangeland component of the Climate Vulnerability Assessment Project is looking at the impact on existing livestock production systems. The project will focus on the suitability of adaptation options, including changing management systems, shifting the focus of livestock enterprises to include carbon farming or adopting an increased focus on goat production.

This action will:

- integrate water data from the regional water strategies into the vulnerability assessment analysis for selected agriculture industries and investigate adaptation responses
- explore ways to reduce evaporation from on-farm storages and improve water use efficiency through the use of smart sensors and automated irrigation systems
- limit deep drainage by increasing soil water holding capacity using novel compounds such as hydrophilic polymers.

In addition, research and development into new practices and enterprises that are best suited to the warmer and drier conditions projected for regional NSW could be fast-tracked. This research will build on the Department of Primary Industry’s Climate Vulnerability Assessment to provide farm businesses with information on what types of crops could be best suited to the region in the context of a changing climate.



## Action 3.4: Review groundwater extraction and condition limits using new knowledge

A better understanding of groundwater recharge rates, volumes, aquifer boundaries and their connectivity with ecosystems and other water sources can be used to understand the capacity of the water source to support different water needs during climate extremes. It can also help refine groundwater source extraction limits as the state's water sharing plans are progressively reviewed.

Additional considerations – such as the effects of climate change on groundwater recharge, changing user behaviour and demand, and socio-economic data – can also be incorporated into the understanding of how groundwater sources can continue to support water needs in the region. These can also be considered in the revision of the groundwater source extraction limits.

The NSW Government has begun researching and assessing different methods to inform the definition of groundwater source extraction limits in NSW. This work is based on a review of the historical context for defining sustainable groundwater source extraction limits, as well as a comparative analysis of international best-practice cases. The review will consider groundwater risk assessments recently undertaken (where available), incorporate up-to-date hydrogeological and ecological information, and consider these in the context of new climate change data and risks.

The Murray–Darling Basin Plan will be revised in 2026 and a solid evidence base is needed to support any changes, such as increasing or decreasing the extraction limits, or to support retaining existing limits. Several stakeholders considered improving our knowledge and understanding of groundwater sources and processes and recharge to be a high priority.

Reviewing the resource conditions limits is also important for defining acceptable water levels and quality parameters. This is becoming more of a concern in the Talbragar Alluvium, Upper Macquarie Groundwater Source, and Lower Macquarie Groundwater Sources Zone 1, 2 and 6. In these areas, the concentration of groundwater extraction is increasing, and both larger-scale extraction limits and smaller-scale resource condition limits need to be considered.

This action involves:

- undertaking field investigations and desktop analyses to provide up-to-date information on current and predicted long-term trends in water levels, recharge rates and connectivity (with surface water and between groundwater systems)
- considering the impacts of climate variability/change using new climate information and updated modelling
- establishing the groundwater extraction limits needed to ensure sustainable access to groundwater by consumptive users and the environment, with consideration to the Murray–Darling Basin sustainable diversion limits
- establishing the groundwater condition limits we need to ensure fair access to groundwater for towns, industries and the environment.



Image courtesy of Destination NSW. Sun sets over a water tank and windmill in Gulargambone.



## Action 3.5: Develop ongoing arrangements for participation of local Aboriginal people in water management

Consultation with Aboriginal people on water issues has been infrequent and poorly executed. Community sentiment is that government agencies often come out to communities to 'tick a box' and ongoing consultation and partnerships are rare.

To address this now and in the future, an approach is needed that allows Aboriginal people in each local area and region to get the right people involved or appointed to positions where decisions about water are being made. Aboriginal people need to have a direct line of contact with regional water managers, compliance officers and decision makers. Aboriginal knowledge and science should be actively sought, respected and incorporated.

In the Macquarie–Castlereagh region, an effective Aboriginal water engagement committee needs to be the first step in fundamentally improving Aboriginal people's involvement in water management. For it to be successful, the makeup and function of groups engaged in water management need to be led by local communities – experience has shown that government-dictated governance models for Aboriginal communities do not work.

NSW has set up an Aboriginal Water Program led by an all-Aboriginal team to develop an Aboriginal Water Strategy. The program will work with and fund existing or new Aboriginal groups to develop a governance approach for involvement in water management processes. The success of this action will be driven by the extent to which it enables self-determination and provides an adequate level of support to these groups.

This action supports Priority Reform 1 in the National Agreement on Closing the Gap – to enter formal partnerships and shared decision-making arrangements and develop place-based partnerships to respond to local priorities.

Local Aboriginal groups in the Macquarie–Castlereagh can:

- develop programs and initiatives to improve cultural competency within the water sector
- develop culturally appropriate water knowledge programs
- outline a process the NSW Government can follow to ensure water decisions have been appropriately considered by the community
- progress on-ground initiatives
- deliver compliance and monitoring programs.



Image courtesy of Destination NSW. Peter Peckham of First Lesson Cultural Tours, Dubbo.



## Action 3.6: Support place-based initiatives to deliver cultural outcomes for Aboriginal people

The Australian Government's Closing the Gap Report and Local and Indigenous Voice program have highlighted that Aboriginal people have expressed the desire for strong and inclusive partnerships, in which local communities set their own priorities and tailor services and projects to their unique situations. Programs with demonstrated successful initiatives are typically those that are tailored to local circumstances, are place-based, well resourced, locally driven and often cannot be scaled up.

This action will provide NSW Government support for Aboriginal organisations and communities to develop tailored projects for their communities. It aims to move away from centralised decision making to develop a flexible program that is driven by the principle of self-determination – local communities 'speaking with their voice' to make decisions about which programs are needed for their community and their region.

In the Macquarie–Castlereagh region, this could include:

- developing a **cultural watering program** that identifies the specific sites or locations where water should be delivered at certain times to improve cultural, economic, social and recreational outcomes. The Beemunnel Aboriginal site could be an important place to focus on. This project could involve working with the Department of Planning and Environment–Water, WaterNSW and environmental water holders to identify whether cultural water access licences or water for the environment could help deliver water to these locations

- **improving access to Country**, including sites that have local significance. This could include opening up local parcels of public land that have access to waterways but are otherwise gated or locked – such as Travelling Stock Reserves or Crown roads
- a **restoration reach**, which would use cultural knowledge and science to rehabilitate riparian land, through planting of native species and caring for Country
- **programs that engage Aboriginal youth** in water and landscape management, with the aim of building cultural awareness and give a sense of ownership and cultural connectivity
- locally run programs that **identify and record significant water-dependent sites** in the Macquarie and Castlereagh valleys. Information would be stored in a culturally appropriate way.

To receive government support, these initiatives would need to have local champions, effective local governance arrangements and a strong capacity building component, such as activities that focus on water legislation, licensing structures, landscape management or knowledge activities for schools and youth programs.

## Action 3.7: Support the development of new water-related Aboriginal business opportunities

During consultation on the Macquarie–Castlereagh Regional Water Strategy, stakeholders stressed the need for economic development and business opportunities in the region that are led by Aboriginal communities and allow for local Aboriginal people to be employed. Investing in regional Aboriginal-run businesses and initiatives can help diversify incomes in the region, create employment and deliver social and economic outcomes for Aboriginal people. Realising some of these opportunities may require access to surface water or groundwater resources.

The NSW Government is supporting Aboriginal business development opportunities in the Macquarie–Castlereagh region through a range of programs including the Aboriginal Partnership Program led by the Department of Regional NSW. The program will support government agencies and communities in progressing economic development opportunities. A dedicated Aboriginal Partnership Manager will work with Aboriginal organisations, businesses, and individuals to identify and develop new business opportunities or better manage existing ones and access support or grant funding. Other support is also available through the NSW Department of Aboriginal Affairs, the NSW Aboriginal Land Council and the National Indigenous Australians Agency.

### Jinchilla Gardens

Jinchilla Gardens, a property 10 km north of Dubbo, forms part of the country of the Tubba-Gah Wiradjuri people. The gardens and function centre are used for cultural burns and walks, educational purposes, re-vegetation, a nursery to grow native trees and bush foods, seed collection for sale and tourism. There are opportunities to progress further caring for Country projects at Jinchilla Gardens to support land and water outcomes.



Image courtesy of Destination NSW. Indigenous Cultural Adventures, Orange.



## Action 3.8: Modernise the water management framework so it can continue to support sustainable economic diversification

The NSW Government is committed to Net Zero, which is the foundation for NSW's action on climate change and goal to reach Net Zero emissions by 2050. We need to ensure the Macquarie–Castlereagh region is set up to help attract new industries whilst helping to reduce emissions over the coming decades.

The NSW Government is also making significant place-based investments in the region and surrounding areas to build strong communities and support industry development and diversification.

Many of the new opportunities will require access to water, which will need to come from trading of existing water entitlements, groundwater sources that are not fully allocated, or recycled and re-used water sources. Our water entitlement and access framework will need to be able to cater for these new businesses and initiatives by supporting sustainable access to water. It will also need to ensure that additional access does not adversely impact the existing water security or pricing of water for urban centres.

This action will:

- use evidence from this regional water strategy when informing future industrial and land use planning strategies, to ensure there are sustainable water sources available to support new opportunities
- begin investigations and preparation for the long-term transition away from coal dependent economies including how water will be needed to support the transition
- address water-related policy and regulatory barriers around supporting new and diverse initiatives in the region
- encourage new businesses to have comprehensive drought management plans.

## Action 3.9: Support public access to the Macquarie Marshes Nature Reserve

Much of the Macquarie Marshes is in private ownership, and some landholders provide campground facilities and nature-based activities for visitors. Additional eco-tourism experiences in and around the Macquarie Marshes can help to diversify the economy in the region and improve visitor experience and access to the Macquarie Marshes.

The Macquarie Marshes Nature Reserve, covering over 23,000 ha, is managed by the NSW National Parks and Wildlife Service, and is not open to the general public. Requests for access to the nature reserve are assessed on a case-by-case basis and may be authorised for Aboriginal cultural practice, education, research and monitoring, and appropriate low-impact, nature-based recreation and experiences. The NSW National Parks and Wildlife Service also conducts annual guided tours for the public.

Over the coming years, there are opportunities to support further Traditional Owner involvement in management of the Macquarie Marshes Nature Reserve. This is consistent with the aspirations set out in the Development of a new Aboriginal joint management model for NSW national parks.<sup>83</sup>

This action will:

- improve knowledge of current access to the Macquarie Marshes Nature Reserve
- improve interpretation and understanding of the landscape at existing visitor areas
- expand Traditional Owner management and access to Country
- support development of ecotourism opportunities, including those led by local Aboriginal people.

83. Available at: [www.environment.nsw.gov.au/research-and-publications/publications-search/development-of-a-new-aboriginal-joint-management-model-for-nsw-national-parks](http://www.environment.nsw.gov.au/research-and-publications/publications-search/development-of-a-new-aboriginal-joint-management-model-for-nsw-national-parks)

## Action 3.10: Increase transparency in the management of groundwater resources in the region

Groundwater users in the Macquarie–Castlereagh region have raised concerns about the transparency of government decisions about the risks associated with activation of inactive licences and responses to ongoing groundwater level declines. Improving the transparency of the actions that government water managers take to manage groundwater declines and other risks will give users more certainty when making business decisions and more confidence in the decision-making processes.

This action will:

- review risks associated with inactive licences with a view to providing clarity to water users about how fully committed groundwater systems will be managed if licence activation and use further increases over the next 30 years
- prepare a guideline with a series of escalating management actions corresponding to stages of groundwater level decline. This will provide certainty to all water users about the actions the NSW Government will take, and when, in areas where groundwater extraction is causing declines in water levels. This will help towns, stock and domestic and industry users plan for more extreme droughts when groundwater may not be a viable backup.



Image courtesy of Destination NSW. Scenic country landscapes surrounding a vineyard in Mudgee.



# Priority 4

## Improve the health and resilience of natural systems

People and communities in the Macquarie–Castlereagh region value its water resources and catchments for their environmental, cultural and social values. There is strong support for sustainable water use and management to ensure the health of rivers, floodplains and wetlands is protected.

This priority focuses on improving the resilience and health of the Macquarie–Castlereagh region’s rivers, floodplains, wetlands and aquifers.

### Our starting point





The strategy builds on the existing evidence base and programs being implemented across government. These include:













- the **Macquarie–Castlereagh Long-Term Water Plan**, which has been developed to describe the flow regimes that are required to maintain or improve environmental outcomes in the region
- **Water Quality Management Plan**, developed for the Macquarie–Castlereagh Surface Water Resource Plan and the Macquarie–Castlereagh Alluvium Water Resource Plan, aim to provide a framework to protect, enhance and restore water quality for the region.

The **NSW Water Strategy** contains actions under Priority 3 to improve river, floodplain and aquifer ecosystem health and system connectivity. These provide a strong foundation for actions taken in the Macquarie–Castlereagh Regional Water Strategy. They include:

- taking landscape-scale action to improve river and catchment health
- adopting a more intense, statewide focus on improving water quality
- monitoring and reporting on environmental water delivery and management to inform adaptive management and reporting
- maintaining a water science strategy and prospectus that provides sector-wide guidance on future science, research and development.

**Figure 26. Actions for Priority 4: Improve the health and resilience of natural systems**

Legend				
				
Reducing water supply risks for regional cities and rural and remote towns	Supplying water to high priority needs in the west of the catchment and connected valleys	Maintaining and improving river, floodplain and wetland health	Addressing barriers to Aboriginal people's water rights	Supporting a growing regional economy in a future of potentially reduced water availability

Action number	Action name	Challenges addressed
Action 4.1	Modify or remove impediments to effective environmental watering	
Action 4.2	Mitigate impacts to native fish communities	
Action 4.3	Remediate unapproved floodplain structures	
Action 4.4	Provide clarity for environmental needs during drought operations	
Action 4.5	Assess gaps and better understand how a changing climate could impact flow regimes and identify adaptation options	  
Action 4.6	Identify regionally significant riparian, wetland and floodplain areas to protect or rehabilitate	 
Action 4.7	Investigate ways to improve connectivity with the Barwon–Darling on a multi-valley scale	  



## Action 4.1: Modify or remove impediments to effective environmental watering

Removing physical and operational barriers that constrain the delivery of water for the environment can help improve the ecological outcomes of water management, enhance habitat for aquatic organisms and build ecological resilience.

Through the Northern Basin Toolkit measures, the Australian Government has committed \$2.9 million for the Macquarie Marshes Enhanced Watering Project. This project includes investigating the potential to deliver larger flows to the Macquarie Marshes, and assisting the connection of the river and wetlands to key areas of the floodplain. Funding will cover the construction of a regulator on Oxley Break, which includes a fish passage. It also covers a scoping study and basic design and options assessment for treating a series of breaks immediately upstream of Marebone Weir.

Building on the Enhanced Watering Project, the NSW Government will seek funding to further reduce constraints that impact on the ability of water to move through rivers and across floodplains, coupled with an analysis of the impacts on other water users.

These sites are:

- **Mumblebone Breaks** – while the Northern Basin Toolkit has funded a scoping study and basic design, funding for detailed design and the implementation of solutions is needed if the solutions are viable and proceed

- **Cudgegong River at Rocky Waterhole Bridge** – Cudgegong River flows are restricted to around 1,500 ML/day by the limited capacity of the Rocky Waterhole Bridge. The Cudgegong River crossing could be upgraded to allow higher flows
- **Upper Crooked Creek** – investigation of options to reduce the channel constraint at the inlet to Crooked Creek.

This action will also support erosion mitigation and rehabilitation strategies such as river channel bed restoration works in the southern Macquarie Marshes. Changes to the shape of a river channel – including its depth and width – affect how water moves through a river system. In-river erosion can cause channels to become so deep and wide that the surrounding floodplain and wetlands are disconnected from the river. Target areas for restoration of channels will include:

- **the Breakaway** – this project will comprise of 1 weir and 5 downstream structures along a 2 km stretch
- **Monkeygar Creek** – a scoping study to determine locations, costs, justification and community perspectives on potential work along this creek
- **Oxley Break** – complementary works to the regulator and fish passage.<sup>84</sup>

This action could link to Action 4.6 Identify, protect or rehabilitate regionally significant riparian, wetland and floodplain areas. Restoration works such as revegetation can help stop erosion, stabilise banks and support a natural bank profile.



Image courtesy of John Spencer, Department of Planning and Environment. Macquarie Marshes, NSW.

84. Informed by previous work for the Southern Macquarie Marshes Geomorphic Scoping Study.

## Action 4.2: Mitigate impacts to native fish communities

### Native fish passage

Many native fish species need free access within and between rivers and waterways to access food, avoid predators and find shelter, escape the impacts of drought, and seasonally to spawn, migrate and recruit. Physical barriers to fish passage such as weirs and dams can limit fish movement, leading to a decline in the health and viability of native fish populations. Currently, native fish can only move through many parts of the Macquarie–Castlereagh system during high flow conditions when water overflows weirs and other in-stream barriers.

This action will improve fish passage at 7 priority sites in the Wambuul / Macquarie River:

- Dubbo North Weir
- Gin Gin Weir
- Marebone Break Regulator
- Bulgeraga Creek regulator at the Bifurcation
- Narromine Weir
- Warren Shire Council (town) Weir
- Gum Cowal regulator at the bifurcation.

Remediation of fish passage at the first 3 sites will restore waterway connectivity to nearly 150 km of the mainstem Wambuul / Macquarie River and significantly improve fish movement connectivity with the Ramsar-listed Macquarie Marshes.

There are an additional 39 priority barriers to fish passage on mainstem rivers of the Macquarie–Castlereagh region that could be explored as part of future fish passage remediation programs.

### Cold water pollution

Cold water pollution has damaging impacts on riverine ecological function, particularly in summer when biological cues such as fish spawning are disrupted. Burrendong Dam is identified as a high priority dam in the NSW Cold Water Pollution Strategy. The water released from Burrendong Dam can be 10°C colder than the ambient river temperature, and the cold water pollution can extend more than 300 km downstream.

In 2014, a prototype thermal curtain was installed around the intake tower of Burrendong Dam to assist in mitigating cold water pollution. Its purpose was to draw water from the upper warmer levels of the lake into the intake. However, the curtain was damaged twice and was only in operation for short periods.

The thermal curtain has since been removed and further action needs to be taken to manage cold water pollution.

WaterNSW and Department of Primary Industries–Fisheries are undertaking preliminary investigations into alternative cold water pollution mitigation options for Burrendong Dam. The presence of potentially toxic surface algae needs to be considered as it often impedes alternative mitigation measures.

Through this action, the NSW Government will:

- advance understanding of the improvements in fish populations that can be achieved by addressing cold water pollution
- progress investigations into alternative infrastructure, new technologies and operational changes to arrive at a preferred solution for Burrendong Dam.

### Fish diversion screens

Every year an estimated 800,000 or more fish are extracted from rivers by unscreened pumps in the NSW Murray–Darling Basin. Adult fish, as well as juveniles, larvae and eggs, are extracted by pumps and diverted into irrigation channels, along with debris such as sticks and leaves. This impacts the sustainability of native fish populations and can also damage irrigation infrastructure.

Modern screens can solve these problems by stopping fish and debris entering pumps and diversions. Screens can reduce fish losses at these sites by over 90%, protect native fish during upstream and downstream migrations, help more fish survive to maturity and boost native fish populations. This protection also extends to other aquatic species such as crayfish and turtles. Screening also improves pump operation, water delivery and extraction efficiency for asset owners through fewer blockages caused by debris.<sup>85</sup>

The NSW Government has announced \$13 million to install 50 fish exclusion screens at 11 offtake points between Dubbo and the Macquarie Marshes. Implementation is based on expression of interest and further ongoing funding is needed to maximise outcomes from initial investment at other sites in the valley.

85. Boys, C., Baumgartner, L., Rampano, B., Robinson, W., Alexander, T., Roswell, M., Fowler, T. and Lowry, M 2012, *Development of fish screening criteria for water diversions in the Murray–Darling Basin*, Fisheries Final Report Series No. 134, Department of Primary Industries, Sydney.



## Action 4.3: Remediate unapproved floodplain structures

Floodplain development includes levee banks, earthworks, on-farm storages, raised roads and water supply channels. Structures on the floodplain in the Wambuul / Macquarie River Valley can block or significantly alter the natural flow of water and have negative impacts on ecological and cultural assets.

Some areas of ecologically important assets in the Macquarie–Castlereagh region rely on floodplain flows for their maintenance and survival. These assets include river red gum (*Eucalyptus camaldulensis*), coolabah (*E. coolabah*), black box (*E. largiflorens*), lignum (*Muehlenbeckia florulenta*) and non-woody wetland vegetation, such as reedbeds and water couch meadows.

This action will be delivered through the Improving Floodplain Connections Program, which commenced in January 2022. It will remediate or remove up to 24 priority unapproved works in the Macquarie Valley floodplain that are altering the flow of floodwaters in the region and potentially impeding the delivery of water to ecological assets.

The program could enhance cultural sites and values held by local Aboriginal people. This action will explore how Aboriginal people's cultural heritage values and ecological balance can be restored in partnership with Aboriginal communities.

## Action 4.4: Provide clarity for environmental needs during drought operations

During the most recent drought, the NSW Government altered normal regulated river operations in the Macquarie–Castlereagh region to adapt to the extreme dry conditions. Regulated flows were ceased downstream of Warren Weir in September 2019 and environmental water provisions in the water sharing plans were suspended in July 2019. This was the first time that the regulated river system was cut at Warren since Burrendong Dam was constructed.

A changing climate could increase the likelihood that drought operations are required. Greater transparency and information about when these drought responses will be triggered will help water users and environmental water managers to plan and manage their water needs and use during these periods.

This action will improve transparency about how surface water will be managed during drought by:

- clarifying the measures that could be applied during increasing stages of drought. This will be done by updating the Incident Response Guide and developing a drought management plan for the Macquarie–Cudgegong Regulated River Valley
- identifying critical triggers and potential actions in relation to water quality events
- developing guidance on how to restart the river after dry times or cease-to-flow events to minimise the risk of fish deaths occurring from hypoxic blackwater events or the destratification of pools
- investigating the impact of drought management responses on alluvial groundwater sources and designing responses to account for this influence.



Image courtesy of Destination NSW. Murray Cod, Narrandera Fisheries Centre.

## Action 4.5: Assess gaps and better understand how a changing climate could impact flow regimes and identify adaptation options

All water has the potential to contribute to the ecological condition of rivers, wetlands, and floodplains. The way the river is operated to deliver consumptive (irrigation) water can either enhance environmental outcomes or exacerbate environmental impacts.

Reduced water availability in a changing climate will mean fewer opportunities to use environmental water licences to support environmental outcomes in the region during extended dry periods. Mechanisms need to be in place to maximise the benefits of water for the environment.

A more detailed assessment of current and possible future flow regimes in the Macquarie–Castlereagh catchment is required. We need to identify how changes in the climate could lead to changes of different flow types and what adaptive strategies are required to maintain and protect important ecological assets and functions in the catchment.

Through this action, we will:

- review current flow regimes in the Macquarie–Castlereagh region to identify what environmental water requirements are currently being met, or are absent (the relevant environmental water requirements are documented in the Macquarie–Castlereagh long-term water plans)
- assess the impact of future climate change scenarios (generated through the Macquarie–Castlereagh Regional Water Strategy) on the achievement of environmental water requirements of the Macquarie–Castlereagh region
- identify what short and long-term actions need to be taken to address any of the identified at-risk flows in achieving environmental outcomes.

### Starting point

#### Understanding the impact of climate change on ecosystems

The Murray–Darling Basin Authority is working with the Department of Planning and Environment–Water to develop a method for investigating the performance of water policy settings and operation under a changing climate. The Macquarie catchment is being used as a case study.<sup>86</sup> The objective of the case study will be to understand the river system’s vulnerability to climate change, identify adaptation options and evaluate their effectiveness.

86. [getinvolved.mdba.gov.au/murray-darling-water-and-environment-research-program](http://getinvolved.mdba.gov.au/murray-darling-water-and-environment-research-program)



## Action 4.6: Identify regionally significant riparian, wetland and floodplain areas to protect or rehabilitate

The health and resilience of rivers and the ecosystems they support are directly linked to the condition of waterways and their floodplains. Conserving remnant biodiversity and restoring degraded riverine and wetland ecosystems can strengthen their long-term resilience and improve ecological responses and other benefits from environmental watering.

Land-use changes and land clearing for urban and agricultural development have had adverse impacts on the health of the rivers throughout the Macquarie–Castlereagh region. Water now moves more quickly and with more energy through the catchment, eroding land and waterways, reducing water quality and leading to less water being stored in the landscape. The degradation of native riparian vegetation along water courses is recognised as a key threatening process under the *Fisheries Management Act 1994* (NSW).

Riparian restoration at site and landscape scales can help both mitigate and support recovery following high flow and flooding events.

### What we heard



During consultation, there was strong support for rehabilitating riparian vegetation across the catchment. Priority areas identified were along the effluent creeks and calls that action is needed to clear log jams that are blocking river flows below Warren.

This action will deliver targeted, on-ground activities at high priority locations to conserve and protect riparian, wetland and floodplain habitat and species, or areas of high cultural value in the Macquarie–Castlereagh region. This work will build on existing programs such as Fencing the Northern Basin Riverbanks to support a whole-of-catchment program to improve river health, connectivity and ecosystem resilience. The economic and environmental benefits of this action can help support the resilience and sustainability of the region.

This action will:

- map existing programs and potential overlaps
- develop a system to prioritise areas to protect or rehabilitate using potential factors such as the severity of land degradation, native fish conditions and the distribution of threatened species. Potential prioritisation tools include detailed habitat mapping data and the River Styles Framework
- establish a phased and prioritised program of management measures for the life of the Macquarie–Castlereagh Regional Water Strategy
- identify funding models, including consideration of landholder incentives
- develop a clear decision-making and program-delivery governance framework
- understand and include local Aboriginal people's knowledge and expertise in delivering river improvement works – for example, through a River Ranger program
- develop a monitoring and evaluation framework based on the outcomes and targets identified through the Macquarie–Castlereagh Long-Term Water Plan.

## Action 4.7: Investigate ways to improve connectivity with the Barwon–Darling on a multi-valley scale

The Macquarie–Castlereagh catchment is one of several NSW and Queensland catchments that provide water to the Barwon–Darling River.

The NSW Government is taking action to improve connectivity and strengthen downstream protections for the environment and high priority needs. This includes:

- ensuring that there are adequate statutory protections in place so that ‘first flush flows’ are prioritised for downstream critical human needs before floodplain harvesting licences are issued

- accelerating an independent expert panel review into the adequacy of the protections in water sharing plans across the northern Basin to meet downstream needs following critical dry periods
- improving water quality and allowing native fish to move.

This work is part of implementing the Western Regional Water Strategy, which aims to deliver a more coordinated, system-scale approach. Rule changes that significantly affect the amount of water available to water licence holders may trigger compensation under the *Water Management Act 2000* (NSW).

### What we heard



We heard that many stakeholders outside of the Macquarie–Castlereagh region expect additional actions in the Macquarie–Castlereagh catchment to help meet needs downstream by improving connectivity. We also heard it may not be possible to improve connectivity during periods when the river dries up.

Some stakeholders told us that assessing connectivity actions should not be based on average or median flows, given the high level of variability within the system, and that the majority of the flows from the Wambuul / Macquarie River into the Barwon–Darling River occur during high flow periods and floods.

Feedback provided in earlier consultation included:

- support for restoration of river health and a commitment to reversing historic ecological damage, with connectivity considered a key component in the resilience of water-dependent ecosystems
- the need to consider what connectivity actions can feasibly be achieved
- acknowledgement that protecting environmental water flows through active management has helped to improve connectivity through the Macquarie River and into the Barwon River
- concern that improving flows across connected systems will be an increasing priority under a drying climate.



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# Implementing the strategy

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# 6

Image courtesy of Department of Primary Industries.  
Sunrise at Ben Chifley Dam, Bathurst.

# Getting our timing right

A critical feature of developing the Macquarie–Castlereagh Regional Water Strategy is deciding which actions and investments are needed now, and which will be needed in the future. With a 20-year timeframe, the strategy aims to time various actions to meet existing challenges, identify and prepare for coming challenges and lay the groundwork for adapting to future uncertainties and changed circumstances.

The actions in this strategy have a strong focus on drought security following the experience of the 2017–2020 drought. However, this drought was closely followed by major flood events from 2020–2022.

Some of these actions may also have the capability to mitigate low to moderate flooding events. Analysing the flood management benefits of many of the actions in this strategy will require enhanced investment by governments in flood modelling and mitigation works.

The floodplain management plans being developed for the northern NSW valleys are the cornerstone for whole-of-catchment floodplain management in western NSW and will be extended into the southern NSW valleys. Local councils, the NSW Office of Local Government and the Department of Planning and Environment take specific lead roles in flood risk management for towns and regional centres across the state.

The strategy has a separate implementation plan that prioritises the delivery of actions. The implementation plan also outlines responsibilities and timeframes for delivery, so that we can monitor the progress of the actions, assess the effectiveness of the strategy and identify areas where we need to adapt.

Not all actions will be commenced at once, and funding will be a key consideration in planning when and how the actions will be implemented. The regional water strategies will be a key tool in seeking funding as future opportunities arise.

The implementation plan sets out priorities over the next 3 years and is located at [www.dpie.nsw.gov.au/macquarie-castlereagh-regional-water-strategy](http://www.dpie.nsw.gov.au/macquarie-castlereagh-regional-water-strategy)

The implementation plan also identifies the key partners who will be involved in delivering its actions.

- NSW Government agencies will lead implementation of actions that develop and review policies and regulatory arrangements in consultation with the community, undertake research, deliver regional programs and take action when there is a market failure or other need for government intervention. The NSW Government will also support local water utilities when needed.
- Local councils will be involved in actions that influence town water supply at the local level and will lead actions directly related to local-level strategic planning.
- State-owned corporations, such as WaterNSW, will be involved in actions that result in changes to the design, operation and management of major infrastructure and the way water is delivered in regulated rivers.
- Community and industry groups and research organisations will be engaged in the implementation process and may partner with different levels of government to progress or deliver certain actions.



Figure 27. Regional water strategy process

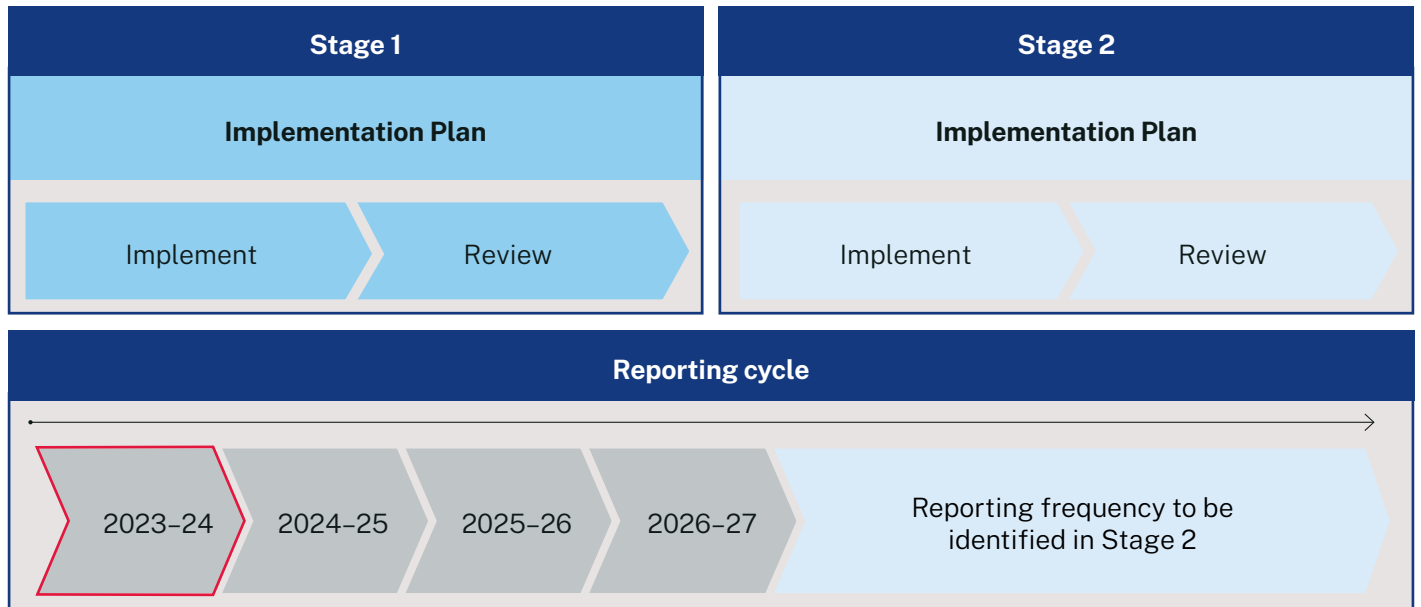


Image courtesy of Peter Robey, Department of Planning and Environment. River landscape, Dubbo.

# Ongoing monitoring, adaptation and reporting

The Macquarie–Castlereagh Regional Water Strategy is designed to respond to changing circumstances. We will undertake a formal review of the strategy at least every 5 years, or in response to significant changing circumstances. The formal reviews will ensure that the key assumptions, such as population and demographics, have not significantly changed.

Amendments may also be made in response to key changes in water demand, social preferences, science and technology, economic conditions or other events,

including how climate change assumptions and responses evolve. These amendments may result in a shift in priorities, and the implementation plan will be updated to reflect this.

We will report every year against actions in the implementation plan, so that the community can track our progress and we can demonstrate which actions have been delivered, or continue to be delivered, in that year.

**Figure 28. Regional water strategy process**

