

Draft Regional Water Strategy

Murrumbidgee: Strategy

April 2022



Published by NSW Department of Planning and Environment

www.dpie.nsw.gov.au

Title: Draft Regional Water Strategy

Subtitle: Murrumbidgee: Strategy

First published: April 2022

Department reference number: PUB22/261

Cover image: Image courtesy of Destination NSW. Blowering Dam pondage, Snowy Mountains.

More information: www.dpie.nsw.gov.au/murrumbidgee-regional-water-strategy

Acknowledging Aboriginal people: The NSW Government acknowledges Aboriginal people as Australia's first people and the traditional owners and custodians of the country's lands and water. Aboriginal 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 cultures on earth.

The NSW Government acknowledges the Barapa Barapa, Mutthi Mutthi, Nyeri Nyeri, Nari Nari, Wiradjuri, Wadi Wadi, Wemba Wemba, Yita Yita, Wolgalu, Ngunnawal/Ngunawal and Ngarigu people as having an intrinsic connection with the lands and waters of the Murrumbidgee Regional Water Strategy area.

The landscape and its waters provide these people with essential links to their history and help them to maintain and practise their culture and lifestyle.

The NSW Government recognises that the Traditional Owners were the first managers of Country and that incorporating their culture and knowledge into management of water in the region is a significant step for closing the gap.

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Photography

Image courtesy of John Spencer, Department of Planning and Environment.
Murrumbidgee River, Wagga Wagga.

Minister's foreword



The NSW Government is committed to managing our state's water, improving water security and better preparing our communities for future droughts. Our towns, industries, and natural and cultural assets all rely on water, and the way we manage it deeply affects the lives and livelihoods of the people of NSW. Water is our most precious resource.

That is why we are investing in cutting-edge scientific modelling to bolster our knowledge and understanding of our waterways and enhance our policies and long-term planning, so we can manage our water for the benefit of everyone.

The Murrumbidgee is the 4th largest region of NSW, home to 262,000 people and the thriving regional centres of Wagga Wagga, Griffith and Queanbeyan.

Farms and agriculture are a significant driver of the Murrumbidgee's \$15.9 billion a year economy, providing jobs for the region and producing food and fibre for our state. Water drives agriculture, supports towns and ensures a healthy local environment, which in the Murrumbidgee includes 16 nationally important wetlands, two of which are Ramsar-listed.

Through the development of the Murrumbidgee Regional Water Strategy, we have gained significant knowledge of the region's unique water needs and challenges and considered how much water the Murrumbidgee will need to meet future demand.

Working closely with the community, we are now making decisions around future investments that will optimise water management and help ensure a safe, secure and resilient supply in the decades to come.

Engaging with our Aboriginal communities is vital, given water is an essential part of their connection to Country and culture. Ensuring that these communities have access to water and cultural water holdings will be crucial to creating local jobs into the future.

Local government has contributed greatly to the draft strategy, and I thank councils for their engagement and support. We will continue to partner with them to ensure the strategy addresses the needs of all communities across the Murrumbidgee.

Our state is no stranger to extremes; we have always had to manage our water resources through prolonged floods and droughts. In the face of an increasingly variable climate future, we must prepare for even longer and more severe wet and dry periods. During 2017-2020, the Murrumbidgee region—alongside other NSW regions—experienced severe drought conditions. This experience taught us a great deal about managing our water resources and we need to put these lessons to good use in preparing for future extreme weather events.

This draft strategy, alongside 11 other regional and two metropolitan strategies across the state, has been developed using the best and latest scientific evidence to ensure we can understand and mitigate risk even in the most extreme climactic circumstances.

We engaged leading academics, including experts from the University of Adelaide, to undertake paleoclimate-informed rainfall and evaporation modelling. This climate modelling is based on a deliberately conservative ‘dry’ scenario that is intended to ‘pressure test’ the effectiveness of the strategy in a worst-case scenario. Such climate scenarios may not necessarily eventuate, but they give us an idea of the possible climate risks and will allow us to begin planning to mitigate these risks should they arise. With the help of other state and the federal governments, we are currently running the river system models with this new data to see how our water resources respond.

The Murrumbidgee Regional Water Strategy will put forward the best mix of solutions to address the region’s water-related challenges

and support environmental, social and economic outcomes. We will assess all options, including infrastructure, water recycling, improved water efficiency and policy and regulatory and operational changes.


To complement the regional water strategies, the NSW Government is delivering the Future Ready Regions Strategy, which aims to improve resilience and drought preparedness in regional NSW by drawing on lessons learnt from previous droughts.

In short, the evidence and information we now have means we can better plan for the future to ensure this precious shared resource is managed to sustain secure regional lifestyles, create jobs, support industry and protect our precious natural environment.

There is no ‘one size fits all’ policy to manage water in our regions. I encourage all members of the community and stakeholders in the Murrumbidgee to get involved and have their say to help improve the draft strategy. Water is for everyone, and we are ensuring our water management policies support the future of the Murrumbidgee and all of NSW.

We need healthy rivers, healthy farmers and healthy communities. The way we manage water deeply affects the livelihoods of people in NSW.

**The Hon. Kevin John Anderson, MP
Minister for Lands and Water,
and Minister for Hospitality and Racing**



Photography

Image courtesy of Department of Primary Industries.
Blowering Dam, NSW.



Photography

Image courtesy of Department of Primary Industries.
Rice aerial, Murrumbidgee.

Contents

Overview	10
<hr/>	
Chapter 1: Context	26
<hr/>	
1.1 Purpose of regional water strategies	28
1.2 Objectives of regional water strategies	29
1.3 What has informed the draft regional water strategies?	35
1.4 Policy and planning context	42
Chapter 2: The Murrumbidgee region, its climate and water resources	44
<hr/>	
2.1 What we know about the Murrumbidgee region's climate	48
2.2 The landscape and its water	59
2.3 Managing water in the Murrumbidgee region	90
Chapter 3: More resilient water resources for the Murrumbidgee	118
<hr/>	
3.1 Recognise and protect Aboriginal water rights, interests and access to water	122
3.2 Protect and enhance the environment	131
3.3 Deliver and manage water for local communities	154
3.4 Enable economic prosperity	178
Chapter 4: Options for the Murrumbidgee Regional Water Strategy	192
<hr/>	
4.1 Our vision for the Murrumbidgee Regional Water Strategy	194
4.2 Identifying and developing the options	195
4.3 Which options will be progressed?	197
4.4 Murrumbidgee: Long list of options and government commitments	199
Chapter 5: Where to from here?	208
<hr/>	
5.1 Finalising the strategy	209
5.2 Implementing the strategy	210
Attachments	212
<hr/>	
Attachment 1 Targeted stakeholder engagement	213
Attachment 2 Glossary	224

The Murrumbidgee region



262,000
population



84,000
km² area



First Nations:
Wiradjuri, Nari Nari, Barapa Barapa, Wemba Wemba, Yita Yita, Mutthi Mutthi, Wadi Wadi, Nyeri Nyeri, Ngunnawal/Ngunawal, Wolgalu and Ngarigu



Key regional centres include:
Wagga Wagga, Griffith, Queanbeyan



Major river systems:
Murrumbidgee River, Tumut River, Yanco Creek System. Plus a number of unregulated rivers and creeks



Main groundwater sources:
Bungendore Alluvial, mid-Murrumbidgee Alluvial, lower Murrumbidgee Alluvial, Lachlan Fold Belt Murray–Darling Basin



Smaller regional towns include:
Cooma, Tumut, Yass, Cootamundra, Gundagai, Junee, Narrandera, Hay, Leeton and Balranald



Connections:
Snowy Scheme, the Australian Capital Territory, the Murray River region and broader southern connected basin



Major investments:
Wagga Wagga Special Activation Precinct, South Jerrabomberra Regional Job Precinct, Inland Rail Project, Snowy 2.0



Major water storages:
Burrinjuck Dam on the Murrumbidgee River, with storage capacity of 1,026 GL
Blowering Dam on the Tumut River, with a storage capacity of 1,628 GL



Key environmental assets:
Fivebough and Tuckerbil Swamps, mid-Murrumbidgee Wetlands, lower Murrumbidgee (Lowbidgee) Floodplain including Gayini Nimmie-Caira
Threatened and vulnerable native species including 12 fish species, 6 frog species, 44 bird species

Gross Value Added (2018/19):

Key sectors and engine industries: agriculture, manufacturing, health care, public administration and tourism

\$15.9 billion



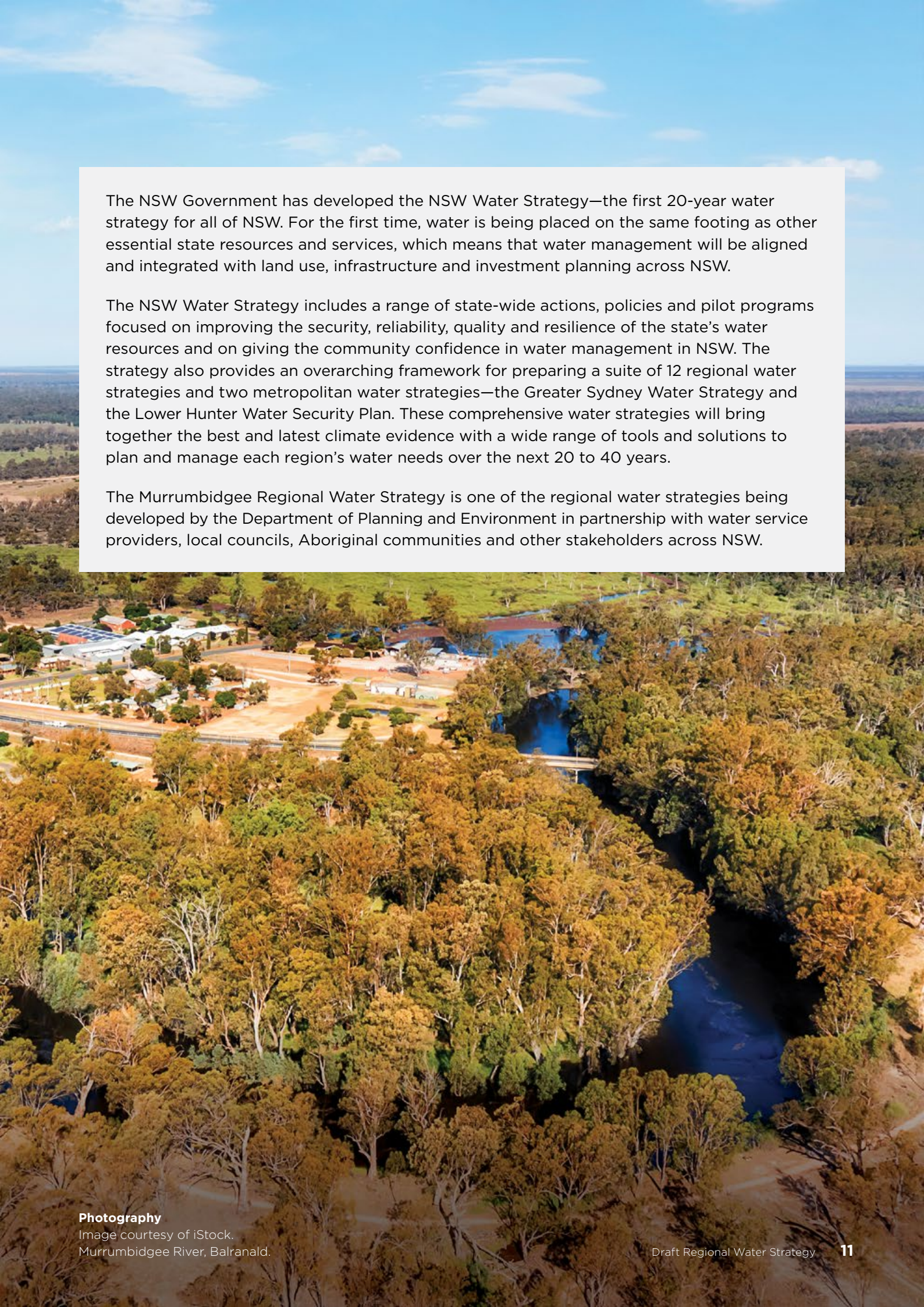


Photography

Image courtesy of iStock.
Township, Wagga Wagga.

Overview

Across NSW, our valuable and essential water resources are under pressure. Changing industry and employment patterns, and a more variable climate mean we face difficult decisions and choices about how to balance the different demands for this vital resource and manage our water efficiently and sustainably into the future.



The NSW Government has developed the NSW Water Strategy—the first 20-year water strategy for all of NSW. For the first time, water is being placed on the same footing as other essential state resources and services, which means that water management will be aligned and integrated with land use, infrastructure and investment planning across NSW.

The NSW Water Strategy includes a range of state-wide actions, policies and pilot programs focused on improving the security, reliability, quality and resilience of the state's water resources and on giving the community confidence in water management in NSW. The strategy also provides an overarching framework for preparing a suite of 12 regional water strategies and two metropolitan water strategies—the Greater Sydney Water Strategy and the Lower Hunter Water Security Plan. These comprehensive water strategies will bring together the best and latest climate evidence with a wide range of tools and solutions to plan and manage each region's water needs over the next 20 to 40 years.

The Murrumbidgee Regional Water Strategy is one of the regional water strategies being developed by the Department of Planning and Environment in partnership with water service providers, local councils, Aboriginal communities and other stakeholders across NSW.

Photography

Image courtesy of iStock.
Murrumbidgee River, Balranald.

The Murrumbidgee region

The Murrumbidgee region (Figure 1) lies west of the Great Dividing Range in southern NSW. The region varies from mountainous terrain in the east to open plains in the west. Extending across more than 84,000 km², the region is home to almost one-third of the Murray–Darling Basin’s population. It includes the key regional centres of Wagga Wagga, Griffith, and Queanbeyan, as well as smaller regional towns such as Cooma, Yass, Cootamundra, Gundagai, Hay, Leeton and Balranald. The Australian Capital Territory (ACT) is a separate jurisdiction, situated wholly within the upper Murrumbidgee catchment.

Over the next 20 to 40 years, significant changes are expected in the region. Based on the NSW Government Common Planning Assumptions, the population of the region is estimated to grow by between 9,000 and 29,000 people between 2016 and 2036.¹ More localised planning indicates that population growth could be significantly higher in some parts of the region.

The Murrumbidgee region is the fourth largest region in NSW in terms of economic output, population and employment. The economic output for the region was \$15.9 billion in 2018/19 and accounted for 2.7% of NSW’s output as measured by Gross Value Added.² Agriculture drives the regional economy together with value-added manufacturing, health care, public administration and tourism.

The region’s industry mix is also changing—horticulture is expanding, tourism is increasing, and value-adding agricultural industries and the renewable energy sector are expected to grow in coming decades. The Wagga Wagga Special Activation Precinct, the Inland Rail Project, the South Jerrabomberra Regional Growth Precinct, the South-West Renewable Energy Zone,³ and work on the Snowy 2.0 Project⁴ will encourage further industry development and drive further job growth. The region is also well-placed to leverage employment and economic opportunities from NSW’s transition to meeting the state’s future energy needs through hydro-electricity generation, solar energy and emerging industries such as hydrogen.

The Murrumbidgee region is located within the traditional lands of the Wiradjuri, Nari Nari, Barapa Barapa, Wemba Wemba, Yita Yita, Mutthi Mutthi, Wadi Wadi, Nyeri Nyeri, Ngunnawal/Ngunawal, Wolgalu and Ngarigu people. Water is deeply entwined with Aboriginal culture and Aboriginal peoples’ connection to Country. As the first managers and carers of this natural resource, Aboriginal people have rights and a moral obligation to care for water under their law and customs, and water is an essential part of Aboriginal peoples’ culture and heritage.

1. Population growth figures are based on the NSW Government’s Common Planning Assumptions, which are agreed datasets, model and tools used by the government; and other prepared proposals, business plans and strategies that rely on projections. The range of population projections gives an idea of the different possible futures that might arise within the Murrumbidgee region due to variations between the NSW Common Planning Assumptions and other sets of assumptions—such as fertility, mortality and migration rates—at the whole of state level.
2. Gross Value Added (GVA) is the value of the amount of goods and services that have been produced, less the cost of all inputs and raw materials that are directly attributable to that production. GVA measures the contribution of a region to the economy. GVA adjusts Gross Domestic Product (GDP) by the impact of subsidies and taxes (tariffs) on products. Murrumbidgee GVA includes the Local Government Areas of Balranald, Coolamon, Cootamundra–Gundagai, Greater Hume, Griffith, Hay, Junee, Leeton, Lockhart, Murrumbidgee, Narrandera, Queanbeyan–Palerang, Snowy Monaro, Snowy Valleys, Yass Valley and Wagga Wagga City.
3. South-West Renewable Energy Zone, www.energy.nsw.gov.au/renewables/renewable-energy-zones
4. Snowy Hydro Limited, *Snowy 2.0 About*, www.snowyhydro.com.au/snowy-20/about/

The Murrumbidgee region is home to 16 nationally significant wetlands, including the Lowbidgee and mid-Murrumbidgee wetlands and the Ramsar-listed Tuckerbil and Fivebough swamps (Figure 1). Tuckerbil and Fivebough swamps are of international importance because of the presence, abundance and diversity of waterbirds, including migratory shorebirds and threatened species.⁵ The rivers, floodplains and wetlands in the region cover around 2.4% of the catchment area⁶ and support a range of water-dependent ecosystems and threatened and iconic species including the Murray Cod, Macquarie Perch, Australasian Bittern and the Southern Bell Frog.

The region has some unique features that pose both challenges and opportunities for managing water resources:

- The Murrumbidgee region is part of the broader ‘southern connected basin’,⁷ linked hydrologically and through water management arrangements to the Murray River and, by extension, to Victoria and South Australia.
- The Snowy Scheme provides inflows to both the Murrumbidgee and Murray regions under the Snowy Water Licence.⁸ On average, the Murrumbidgee derives around 25% of total inflows via Blowering Dam from the Snowy Scheme and up to 60% of total inflows during drought years.⁹

- The Murrumbidgee region fully surrounds the ACT. This means that inter-jurisdictional water sharing and management arrangements are imperative, as the ACT relies on water supplied from the Murrumbidgee. Managing population growth within and around the ACT (including Queanbeyan) requires an integrated and inter-jurisdictional water management approach in the upper Murrumbidgee region.
- The Murrumbidgee Regional Water Strategy boundary does not fully align with local government area boundaries, regional plan or regional economic development strategy boundaries. Several local government areas overlap with the Lachlan, Murray and Western regional water strategies or the Greater Sydney region. Several regional water supply schemes also extend beyond the Murrumbidgee region.

The complexities of the system and the unique linkages between the Murrumbidgee and the broader southern connected basin have resulted in a substantial work program that is currently being carried out by the NSW Government. The regional water strategies will account for and integrate this existing work, and seek to identify opportunities to improve how existing programs are delivered.

5. Ramsar Wetlands Information sheet—Fivebough and Tuckerbil Swamps, rsis.ramsar.org/ris/1224

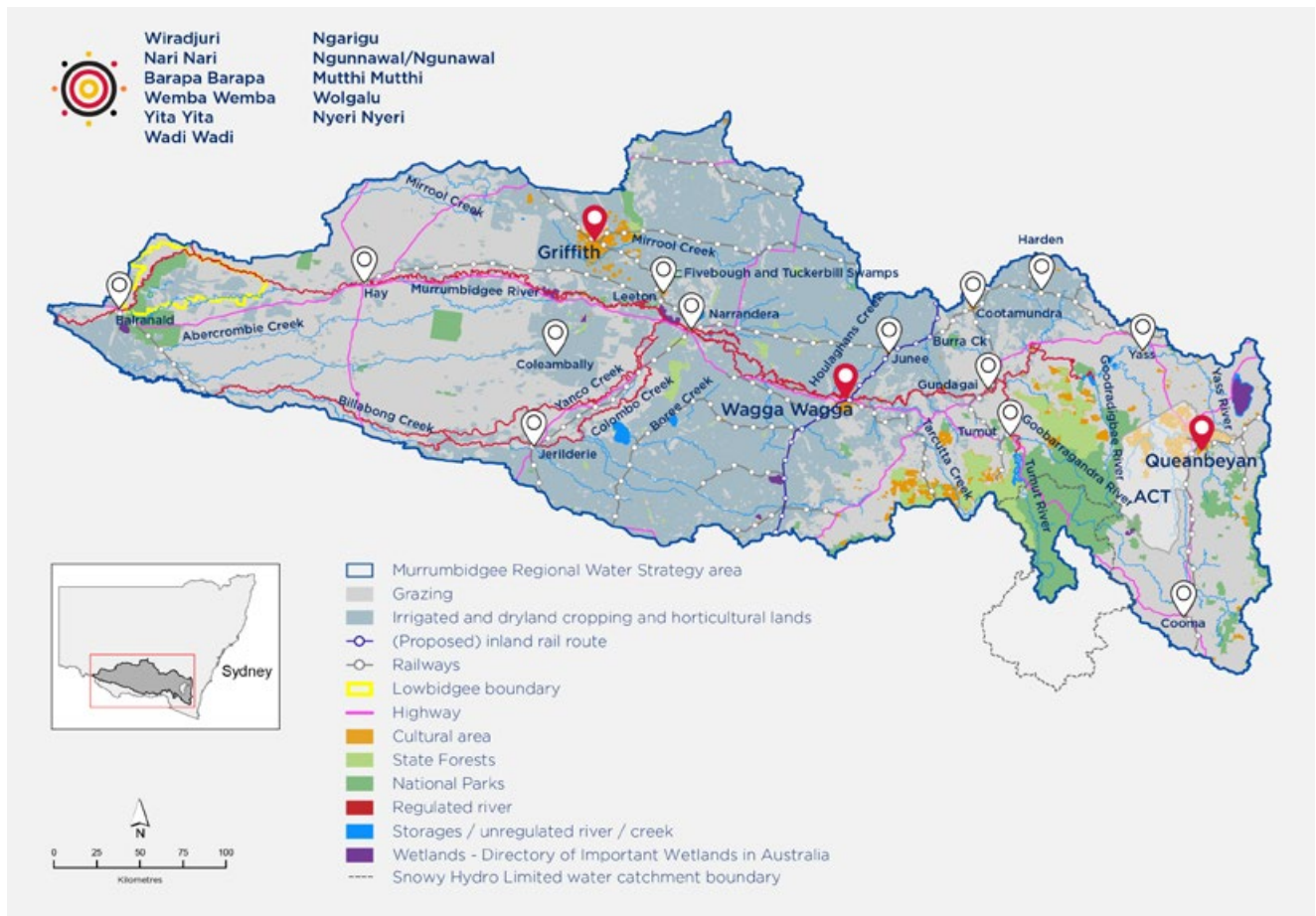
6. Murray–Darling Basin Authority 2012, *Assessment of environmental water requirements for the proposed Basin Plan: Lower Murrumbidgee River Floodplain; Assessment of environmental water requirements for the proposed Basin Plan: Mid-Murrumbidgee River Wetlands*

7. The southern connected system includes the Murrumbidgee, Lower Darling and Murray catchments in NSW, Victoria and South Australia.

8. The Snowy Water Licence was issued to Snowy Hydro Limited (SHL) in 2002 under Part 5 of the *Snowy Hydro Corporation Act 1997* (NSW) for a period of 75 years. The Snowy Water Licence is the primary legal document defining how SHL is to account for and release water. It defines the rules for releases into the Murray and Murrumbidgee rivers and other montane rivers. www.legislation.nsw.gov.au/#/view/act/1997/99

9. Snowy Hydro Limited 2008, *Snowy Hydro Water Operations Reference Report*

Figure 1. Map of the Murrumbidgee region



Water in the Murrumbidgee region

The Murrumbidgee River is the third-longest river in Australia, starting in the Australian Alps and extending to the semi-arid plains before joining the Murray River, west of Balranald.¹⁰ The region is supported by multiple sources of water, including the regulated Murrumbidgee River, the Tumut River and the Yanco Creek system as well as unregulated rivers, creeks and extensive groundwater systems. The water resources in the Murrumbidgee were historically developed to unlock opportunities for irrigated agriculture and food production.

Diverting east-flowing rivers in the Snowy Mountains westward enabled further development of the region and provided more reliable water supplies to the semi-arid regions in the west of the catchment.

Water management in the Murrumbidgee is complex. As the region is part of the southern connected basin, interstate agreements and rules govern water sharing between NSW, Victoria and South Australia. In addition, specific rules govern water management arrangements between the ACT, the Snowy Scheme and the Murray and Murrumbidgee catchments.

10. Murray-Darling Basin Authority, *Murrumbidgee catchment*, www.mdba.gov.au/discover-basin/catchments/murrumbidgee

The upper Murrumbidgee has many unregulated rivers and creeks that are vital water sources for communities, industries and the environment. Water availability in the upper Murrumbidgee is reliant on rainfall and this part of the catchment is susceptible to short intense droughts. This poses risks to water users in the upper Murrumbidgee, particularly those reliant on the unregulated rivers as a sole source of water supply. This includes towns such as Cooma, Batlow and Yass and some in the Queanbeyan-Palerang area.

From Burrinjuck and Blowering dams to Darlington Point, the mid-Murrumbidgee consists of extensive alluvial plains with a few major tributaries and several anabranches. Downstream of Narrandera, the Yanco Creek system links the Murrumbidgee and Murray rivers through 800 km of interconnected waterways, including Colombo Creek, Billabong Creek and Forest Creek. Towns and industries in the mid-Murrumbidgee rely on both the regulated river system and groundwater sources. The lower reaches of the Murrumbidgee expand into a broad floodplain and a complex area of effluent channels, wetlands and swamps known as the 'Lowbidgee'.

The Murrumbidgee region has two main water storages—Burrinjuck Dam and Blowering Dam—which have a combined operating capacity of 2,656 GL. Burrinjuck Dam, constructed during the First World War, was NSW's first major irrigation dam, enabling development of the Murrumbidgee Irrigation Area. The Snowy Scheme, constructed between 1940 and 1974, was originally designed to capture and move water from east to west, releasing water into the Murrumbidgee and Murray rivers to support industries and communities in NSW, Victoria and South Australia. Blowering Dam, one of the largest dams in NSW, was built in the 1960s to store water released from the Snowy Scheme so it could be used in the Murrumbidgee region.

Since their construction, the region's major storages have expanded their functions to include providing water to communities and other users in the Murrumbidgee.

The east to west extent of the catchment stretches from mountainous terrain with high average rainfall to very flat, semi-arid plains in the west, resulting in large variations in rainfall and climate conditions. Rainfall in winter and spring and additional spring snowmelt in elevated areas of the east are critically important for inflows into the region's main storages. This reliance on winter-spring rainfall contrasts with the summer dominated rainfall and storms experienced in northern NSW.

Rainfall in the Murrumbidgee region varies from year to year and shows distinct dry and wet cycles in observed historical records, some spanning 10-20 years. Although recent droughts have been less severe in the Murrumbidgee region than in northern NSW, the 24 months from January 2018 to February 2020 saw well below average rainfall and some of the lowest two years of inflow on record for Burrinjuck Dam. However, in 2020 and early 2021, above average rainfall and dam inflows increased the region's storages to above 90%¹¹ and led to spills of Burrinjuck Dam and Blowering Dam in mid-2021. This pattern of extended drought followed by intense wet conditions is not uncommon in the Murrumbidgee region.

The Murrumbidgee River downstream of Blowering and Burrinjuck dams is highly regulated, with eight major weirs that regulate flows to towns, the main irrigation areas, environmental assets, and effluent streams. Balancing water supply from the region's two main storages and meeting different water demands can be complex and challenging, particularly during spring and summer periods when physical constraints limit the river's conveyance capacity.

11. WaterNSW real time data 2020, realtimedata.waternsw.com.au

Groundwater is also an important water source in the region. During droughts, reliance on groundwater can increase significantly to support regional industries and some town water needs. Some parts of the region have been affected by concentrated groundwater extraction, with declining groundwater levels and increasing salinity posing a risk to future groundwater access.

The Mid-Murrumbidgee Alluvium—comprising the Gundagai, Kyeamba, Wagga Wagga and Mid-Murrumbidgee Zone 3 alluvial groundwater sources—are fully allocated and highly used by two large, linked regional town water schemes (Goldenfields Water and Riverina Water), which supply many communities in the Murrumbidgee and Lachlan regions, including Wagga Wagga. Expected future growth stimulated by the Wagga Wagga Special Activation Precinct, the Inland Rail Project and other NSW Government investments may further increase pressure on fully-allocated groundwater resources.¹²

The Lower Murrumbidgee Deep Groundwater Source has the highest use of any groundwater source in NSW. It supports irrigated agriculture, as well as several towns. This groundwater source is fully allocated.¹³ Large seasonal drawdowns in the main irrigation districts between Coleambally, Yanco and Darlington Point may pose additional future risks to towns and industries.

The Murrumbidgee region is the most diverse agricultural region in NSW, producing citrus, wine, almonds, cotton, rice, vegetables, winter cereals and annual pastures, beef, sheep and dairy. Recent growth in permanent plantings with year-round water demand and the expansion of cotton—which competes with other annual crops for water in the region—are changing water use and demand. Future climate variability and climate change may further test the resilience of the region's industry base.

The development of water resources and the extensive regulation of the river system have altered flow regimes and impacted key environmental assets in the region. For example, around 58% of the original wetland area of the Lowbidgee floodplain has been lost¹⁴ and the remaining wetlands are substantially degraded. More effective watering of this floodplain (through the shared management of Gayini Nimmie-Caira, the *Nimmie-Caira Infrastructure Modification* and the Yanga National Park Project) will improve environmental and cultural outcomes in the Lowbidgee. The Bitterns in Rice Project is another example of a collaborative management project between local rice growers and wildlife conservation groups; that supports a large breeding population of bitterns.¹⁵

12. Recent water use in the Mid-Murrumbidgee Zone 3 Alluvial Groundwater Source is approaching the extraction limit and groundwater levels are declining in areas of large, concentrated extraction.

13. Department of Planning, Industry and Environment 2020, *Groundwater Annual Report—Lower Murrumbidgee Groundwater Sources—2020*, www.industry.nsw.gov.au/__data/assets/pdf_file/0014/341411/lower-murrumbidgee-groundwater-sources.pdf

14. Kingsford, RT & Thomas, R. 2004, *Destruction of wetlands and waterbird populations by dams and irrigation on the Murrumbidgee River in arid Australia*, *Environmental Management* 34 (3), p383–396.

15. Bitterns in Rice project, www.bitternsinrice.com.au/

The Murrumbidgee region has a large volume of licensed environmental water (1,147 GL in registered entitlements that are managed by the Commonwealth Environmental Water Holder and NSW agencies).¹⁶ These entitlements are managed for the benefit of the environment to deliver water to specific sites, including culturally and nationally significant environmental assets (such as the Fivebough and Tuckerbil swamps, the mid-Murrumbidgee wetlands and the Lowbidgee floodplain) and to support ecosystem functions and native species (such as the Murray Cod, the Southern Bell Frog and the Australasian Bittern). Planned environmental water in the Murrumbidgee region is equally important to the environment and is managed through several rules in the NSW water sharing plans.

Effective delivery of environmental water is a challenge because of:

- physical constraints and barriers
- associated flow management within the regulated river
- demand and timing of water delivery to a large number of users whose needs must be balanced with the needs of the environment.

Aboriginal people in the region rely on water for their health, wellbeing and connection to Country. Aboriginal people consider that current cultural water access licence arrangements are unable to meet the full spectrum of their spiritual, cultural, environmental, social and economic needs, as defined by the 2007 Echuca Declaration.¹⁷ Aboriginal people also seek more opportunities to manage water using their cultural knowledge, along with improved economic opportunities either as licence holders or as partners in decision making. The Murrumbidgee Regional Water Strategy is an opportunity to consider how to better meet the needs and aspirations of Aboriginal people in the region.

The Murrumbidgee Regional Water Strategy also provides an opportunity to better understand the challenges facing the region's water resources and to explore the best ways to share, manage and use these resources in the future.

16. Murrumbidgee licensed environmental water include 1,130 GL of regulated river, 10 GL of unregulated river and 7 GL of groundwater entitlements. This figure does not include any environmental water allowances under the Water Sharing Plan.

17. The Echuca Declaration. See www.mldrin.org.au/what-we-do/cultural-flows/

Definitions

We are using the following definitions in the regional water strategies:

Water security in the context of town water supplies refers to the acceptable chance of not having town water supplies fail. This requires community and government to have a shared understanding of what is a 'fail event' (for example, no drinking water or restrictions below a defined level for longer than a defined period, or unacceptable water quality) and the level of acceptability they will pay for.

The NSW Government's guidance around an appropriate level of security for town water supply is the 5/10/10 rule. Under this approach, the total time spent in drought restrictions should be no more than 5% of the time, restrictions should not need to be applied in more than 10% of years and when they are applied there should be an average reduction of 10% in water use. This allows full demand to be met in most years and also allows for water restrictions to be implemented infrequently to conserve supplies.

Water reliability refers to how often an outcome is achieved. It is often considered to be the likelihood, in percentage of years, of receiving full water allocations by the end of a water year for a licence category. For example, a 60% reliability means that in 60% of years a licence holder can expect to receive 100% of their licensed entitlement by the end of the water year. Other measures of volumetric reliability could also be used: for example, the percentage of allocation a licence holder could expect to receive at a particular time of the year as a long-term average. Reliability may also refer to how often an acceptable level of water quality is available. A reliable water supply gives some clarity to water users and helps them plan to meet their water needs.

Resilient water resources mean water users are able to withstand extreme events, such as drought and flood, and/or adapt and respond to changes caused by extreme events.

Photography

Image courtesy of iStock.
Blowering Dam, NSW.

Future climate risk

The NSW Government is investing in new climate datasets and improved modelling to provide a more sophisticated understanding of the historic climate variability in the Murrumbidgee region, as well as likely future climate risks. This means that we can move from making decisions that are based largely on a single 'worst-case' scenario to a much more comprehensive understanding of natural variability and potential extreme events.

We will be able to better predict and plan for plausible future climate scenarios (such as the possible frequency, duration and severity of extended droughts), better understand climate risks faced by water users and the environment across NSW and better manage our water resources over the medium and long term to mitigate these risks.

This new information is the basis for preparing robust new water strategies for our regions and offers fresh evidence for examining our existing water policies, operational rules and management plans.

Existing climate studies and the new climate data being developed for this draft regional water strategy suggest that the Murrumbidgee region could see:

- changed rainfall patterns with reductions in critical winter and spring rainfall and snowmelt, and a decline in average annual rainfall

- increased evapotranspiration across the region
- more frequent and prolonged droughts with extreme low rainfall periods.

We also need to gain a better understanding of the flood intensity and frequency in the region, as well as the impact of future climate scenarios on groundwater resources. The hydrologic models being developed for the regional water strategies are surface water resource planning models, which do not directly represent surface water-groundwater interactions and cannot represent complex flood behaviour or floodplain inundation. Despite these limitations, the new climate datasets and modelling will be an important first step in advancing our understanding of the risks to surface water systems across NSW. The Murrumbidgee Regional Water Strategy provides an opportunity to highlight areas of future work that could improve our understanding of the region's climate and how to better prepare for future extreme events.

The new climate datasets and modelling are under development and will be released in the future as we progress to the final version of the Murrumbidgee Regional Water Strategy.

Southern region integrated hydrologic modelling

In parallel with the development of new climate datasets for the southern regions, significant improvements are being made to the department's hydrological models as part of the Murrumbidgee, Murray and Western regional water strategies. These improvements reflect the inter-jurisdictional complexities and linkages with Victoria, the ACT and the Snowy Scheme, and the physical connectivity of the southern connected basin. This important piece of work brings separate models into an integrated modelling framework for the first time.

This new, integrated model will provide a more robust tool for understanding climate risks and for assessing the broader benefits and impacts of our options across the southern regions.

We have worked collaboratively with the Murray–Darling Basin Authority; Victoria's Department of Environment, Land, Water and Planning; Snowy Hydro Limited; the Australian Capital Territory Government; Icon Water; and South Australia's Department for Environment and Water to enhance our model integration and functionality, and to ensure we have state of the art models which will allow us to better understand the risks to water security and reliability.



Photography

Image courtesy of Destination NSW.
Yarrangobilly River Walk, Kosciuszko National Park.

Making choices for the future

Like most regions across Australia, the Murrumbidgee region faces choices and challenges in balancing different water needs, both current and emerging, as climate conditions change. However, the region's towns, industries and rural communities have adjusted to variable rainfall and river flows, and past droughts have led to government and industry investment in water use efficiency improvements and more diverse and inter-connected water supplies.

Communities, local councils and local water utilities in the region have already demonstrated an awareness of the need for action to secure water in a drier, more variable climate. Against the backdrop of the most recent drought conditions across NSW, many households, communities and businesses are eager to better understand future climate risk and to explore ways to build drought resilience in regional communities. This will put the Murrumbidgee region in a good position to deal with the region's other key challenges, which include:

- inadequate water management framework to meet the needs and aspirations of Aboriginal people, which also prevents Aboriginal people from fulfilling their rights and obligations to care for Country under their law and customs
- current water sharing arrangements that are based on only 120 years of recorded data, which limits our understanding of how vulnerable the region could be to future extreme events

- insufficiently integrated land and water planning and management, which can lead to population and industry growth occurring in areas that have pre-existing water availability constraints
- vulnerable town water supplies and amenity, which are key factors in fostering liveable and vibrant regional towns and maintaining the wellbeing of communities
- degradation of riverine and floodplain ecosystems, which has led to a loss of native vegetation and wetlands and a decline in the conditions of fish communities and waterbird habitats
- limitations of existing water infrastructure, delivery and operations, which hinder efficient water delivery
- limits to water availability in times of drought and as climate changes, which increases competition for water and could hinder growth and prosperity of the region's industries.

The Murrumbidgee Regional Water Strategy aims to address these challenges and provide options to better use, share, store and deliver water in the Murrumbidgee region.

A new, comprehensive water strategy for the Murrumbidgee region

The Murrumbidgee Regional Water Strategy will guide how we address future water resource challenges, make the right policy and infrastructure choices, support regional development and growth, and open up new opportunities for the region.

The strategy will bring together all the tools we have—policy, planning, behavioural, regulatory, technology and infrastructure solutions—in an integrated package. This package will be based on the best available evidence and respond to the region’s risks and challenges. It will seek to optimise the delivery and sequencing of existing commitments; and build on investments and new work that will improve water security and reliability for all water users, including the environment.

The Murrumbidgee Regional Water Strategy covers the whole Murrumbidgee region and all water sources—regulated and unregulated rivers, and creeks and groundwater. As the region is part of the southern connected basin, the Murrumbidgee Regional Water Strategy will also cover broader regional issues, meaning that it will inform and be informed by work on the Murray and Western regional water strategies.

Our vision for the strategy

Our vision for the Murrumbidgee Regional Water Strategy is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous region. To achieve this, we need to position the region so there is the right amount of water of the right quality available for people, Aboriginal communities, towns, industries and the environment.

In line with the objectives we have set for all regional water strategies, the Murrumbidgee strategy has a strong focus on working closely with communities to deliver healthy, reliable and resilient water resources that:

- deliver and manage water for local communities
- enable economic prosperity
- recognise and protect Aboriginal people’s water rights, interests and access to water
- protect and enhance the environment
- are affordable.



The final strategy will set out clear and accountable actions for all levels of government to maximise opportunities and tackle the challenges facing the Murrumbidgee region. The strategy will seek to maximise opportunities that support the population growth in the upper Murrumbidgee region, growing agribusiness around Griffith and Wagga Wagga, emerging renewable energy projects and new transport investments and developments such as the Wagga Wagga Special Activation Precinct, the South Jerrabomberra Regional Job Precinct and the Inland Rail Project.

The final strategy will help improve the integration of water reforms and water planning actions across the southern NSW regions to ensure they are implemented effectively. This will ensure all existing and new actions and investments are integrated and aligned to achieve the best possible outcomes for regional towns and communities, Aboriginal people, the environment and industries.

A detailed implementation plan that contains actions and timeframes will also be developed as part of the final Murrumbidgee and Murray regional water strategies.



Photography

Image courtesy of Destination NSW.
Citrus Trees, Griffith.

The options

A long list of potential options that focus on the key challenges in the region is presented as part of this draft strategy.

These options build on the NSW Government's current and planned investment in water planning and infrastructure in the region, including the new Refreshing River Management project,¹⁸ investments in critical water and wastewater treatment plant upgrades, and funding to support integrated water cycle management planning. They also complement and build on state-wide reforms to introduce non-urban water metering, improve compliance with water sharing rules and enhance transparency. Where relevant, we included references to where the potential options could advance the priorities and actions of the NSW Water Strategy.

Recognising the challenges and risks facing the region, the long list of options emphasises the need to:

- better meet the needs and aspirations of Aboriginal people in the region
- improve the reliability and access to surface water and groundwater for towns and water users in the Murrumbidgee
- better understand groundwater sources and processes in the region and develop solutions to support the long-term sustainability of these sources
- build resilience of the region's industries to future climate variability and changing climatic conditions
- improve river flows and flows across floodplains, and remove constraints to water reaching vital environmental assets

- use water more efficiently and make use of non-climate dependent water sources.

The strategy considers how government and local councils can adopt a more integrated approach to managing surface water, groundwater and their catchments. It also acknowledges that improving the efficiency of water use and the effectiveness of water delivery is key to optimising shared benefits in the region—such as supporting regional economic growth, improving liveability and protecting the region's rich environmental and cultural assets.

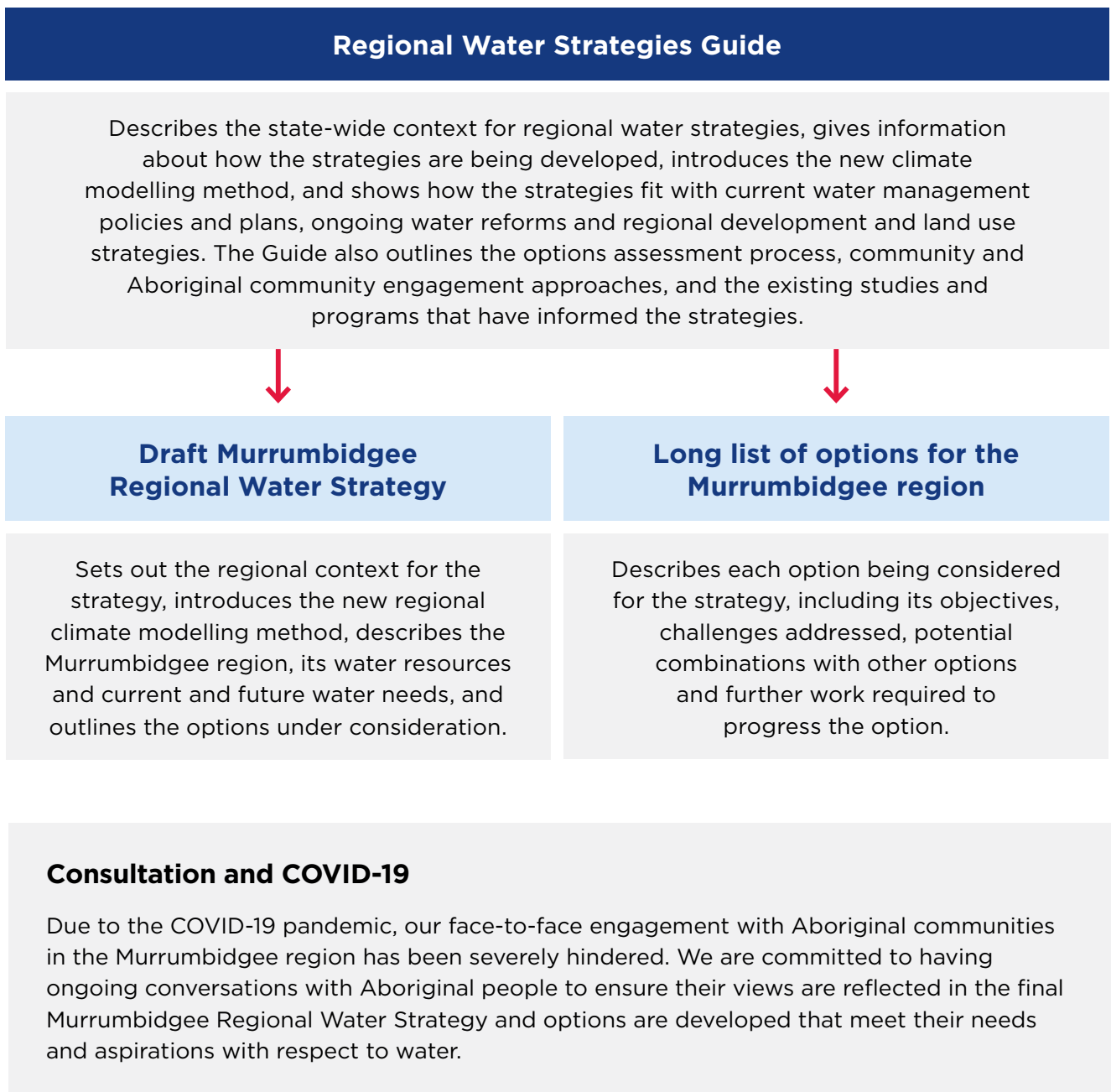
Several of the options could have an impact beyond the Murrumbidgee region and hence their net benefit would need to be assessed across the southern NSW regions. In addition, many of the options are interrelated. This means that to get the most benefit out of these options—and make the best use of the region's water resources—the options may need to be combined.

Not all options will be progressed, and many have not been costed. Following feedback on the draft strategy, we will conduct an evidence-based assessment to identify the best options for the Murrumbidgee region. These actions will form the final, comprehensive Murrumbidgee Regional Water Strategy.

The Draft Murrumbidgee Regional Water Strategy is accompanied by a more detailed description of the long list of options and an overarching explanatory guide that outlines the broader context for the development of regional water strategies across NSW (Figure 2).

18. Refreshing River Management Project, www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/grants-available/river-connections/refreshing-river-management-to-improve-river-health

Figure 2. Draft Murrumbidgee Regional Water Strategy



Chapter 1

Context

Snapshot

We are preparing comprehensive regional water strategies across NSW, bringing together the best and latest climate evidence with a wide range of tools and solutions to plan and manage each region's water needs over the next 20 to 40 years.

- The regional water strategies will assess the future water needs of each region, identify the challenges and choices involved in meeting those needs, and set out the actions we can take to manage risks to water security and reliability.
- Through better strategic planning, the NSW Government aims to provide and manage water for towns and communities, support regional industries, enable economic prosperity, and safeguard and enhance the environment. The strategies will also recognise and protect Aboriginal people's cultural values, rights, access to water and assets.
- The Murrumbidgee Regional Water Strategy is one of 12 regional water strategies and two metropolitan strategies—the Greater Sydney Water Strategy and the Lower Hunter Water Security Plan—the Department of Planning and Environment is developing in partnership with local councils, local water utilities, Aboriginal people, communities and other stakeholders across NSW.

New climate data, plans, studies and investments have also influenced the direction of the Murrumbidgee Regional Water Strategy. New hydrologic modelling will strengthen this.

- A significant amount of work since the Millennium Drought has improved our understanding of the risks affecting

water resource management in the Murrumbidgee region. Community engagement over the last few years has also given insights into the best way to prepare for future droughts and floods in the region.

- The NSW Government is investing in new climate datasets and improved modelling to provide a more robust and sophisticated understanding of future climate risks in the Murrumbidgee region. A new model for the upper Murrumbidgee—that incorporates the region's unregulated rivers, the ACT water supply and improved Snowy Scheme inflows—will improve our understanding of water availability in the upper Murrumbidgee unregulated rivers. The NSW Government is also undertaking work to integrate the hydrologic models for the Murray, Murrumbidgee and Snowy Mountains system in collaboration with Snowy Hydro Limited, the Murray-Darling Basin Authority and other basin governments. By integrating these models, NSW will be able to undertake a more detailed climate risk assessment for the Murrumbidgee and Murray regional water strategies. These modelling results will be released in the future as we progress the Murrumbidgee and Murray regional water strategies to their finalisation.
- The regional water strategies will build on existing NSW Government commitments to improve water security, resilience, and reliability across regional NSW, including investment in water infrastructure, a range of state-wide water reforms.

1.1 Purpose of regional water strategies

Regional water strategies bring together the most up-to-date information and evidence with a wide range of tools and solutions to plan and manage each region’s medium and long-term water needs.

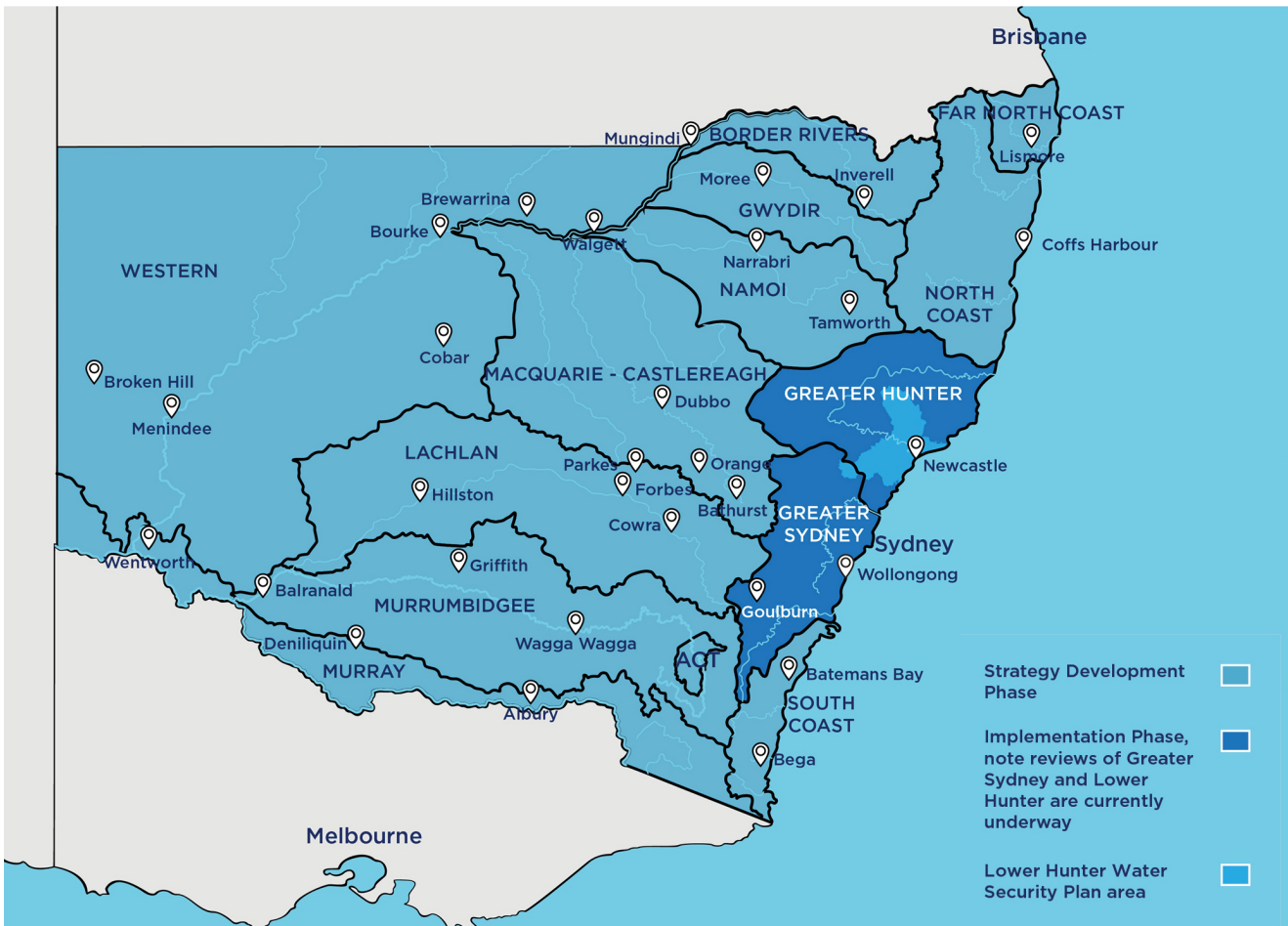
The strategies look out over the next 20 to 40 years and identify the challenges and choices involved in meeting the region’s future water needs. They also determine the actions we can take to manage risks to water availability and to secure healthier, more reliable water sources.

The strategies also explore new solutions to tackle these issues. These solutions have the potential to add value to the way we manage water, generate community-wide benefits and create new economic opportunities for each region.

With improved strategic planning for water, the NSW Government aims to achieve resilient water resources for towns and communities, industry, Aboriginal people and the environment.

The Murrumbidgee Regional Water Strategy is one of 12 regional water strategies the Department of Planning and Environment is developing in partnership with local councils, local water utilities, Aboriginal people, communities and other stakeholders across NSW (Figure 3).

Figure 3. Map of NSW regional water strategy regions



1.2 Objectives of regional water strategies

Regional water strategies will set out a long-term 'road map' of actions to deliver five objectives (Figure 4).¹⁹

Figure 4. NSW regional water strategies: objectives



19. The objective of affordability will be assessed through cost benefit analysis to estimate the economic, social and environmental costs and benefits of options in monetary terms. This assessment is part of the final strategy development.

Options selected for inclusion in the final strategy for each region will need to address at least one of these objectives. Our aim is for each strategy to have a comprehensive, balanced package of options that delivers on all of these objectives and also aligns with the

strategic priorities of the NSW Water Strategy (Table 1), the Future Ready Regions Strategy²⁰ and the regional goals and directions set out in the Riverina Murray²¹ and South East and Tablelands²² Regional Plans 2036 (Table 2).

20. The Future Ready Regions Strategy 2021, supports the NSW Water Strategy and the regional water strategies www.nsw.gov.au/regional-nsw/future-ready-regions
21. The Riverina–Murray Regional Plan includes the local government areas of Albury City Council, Berrigan Shire Council, Bland Shire Council, Carrathool Shire Council, Coolamon Shire Council, Cootamundra–Gundagai Regional Council, Edward River Council, Federation Council, Greater Hume Shire Council, Griffith City Council, Hay Shire Council, Junee Shire Council, Leeton Shire Council, Lockhart Shire Council, Murray River Council, Murrumbidgee Shire Council, Narrandera Shire Council, Snowy Valleys Council, Temora Shire Council and Wagga Wagga City Council. www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans
22. The *South East and Tablelands Regional Plan 2036* area includes the local government areas of Hilltops Council, Upper Lachlan Shire Council, Wingecarribee Shire Council, Goulburn–Mulwaree Council, Eurobodalla Shire Council, Bega Valley Shire Council, Snowy Monaro Regional Council, Queanbeyan–Palerang Regional Council and Yass Valley Shire Council. www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans



Photography

Image courtesy of Murray Vanderveer, Department of Planning and Environment. Murrumbidgee Bridge Crossing, Kosciuszko National Park.

Table 1. State and regional water strategies: priorities and objectives

NSW Water Strategy core objectives	NSW Water Strategy strategic priorities	Regional water strategy objectives	Affordability—identify least cost policy and infrastructure options
Protecting public health and safety	Priority 1 Build community confidence and capacity through engagement, transparency and accountability	Aligned with all regional water strategy objectives.	
Liveable and vibrant towns and cities	Priority 2 Recognise First Nations/ Aboriginal people’s rights and values and increase access to and ownership of water for cultural and economic purposes	Recognise and protect Aboriginal water rights, interests and access to water —including Aboriginal heritage assets.	
Water sources, floodplains and ecosystems protected	Priority 3 Improve river, floodplain and aquifer ecosystem health, and system connectivity	Protect and enhance the environment —improve the health and integrity of environmental systems and assets, including by improving water quality.	
Cultural values respected and protected	Priority 4 Increase resilience to changes in water availability (variability and climate change)	Aligned with all regional water strategy objectives.	
Orderly fair and equitable sharing of water	Priority 5 Support economic growth and resilient industries within a capped system	Enable economic prosperity —improve water access reliability for regional industries.	
Contribute to a strong economy	Priority 6 Support resilient, prosperous and liveable cities and towns	Deliver and manage water for local communities —improve water security, water quality and flood management for regional towns and communities.	
	Priority 7 Enable a future focused, capable and innovative water sector	Aligned with all regional water strategy objectives.	

Alignment between regional water strategies and the purpose of regional (landuse) plans

The objectives of the regional plans cover similar themes to the regional water strategies, including managing and conserving water resources for a healthy environment, increasing resilience against natural hazards and climate change, sustainable management of water for economic opportunities, coordinating infrastructure in a cross-border setting, and building connected and healthy communities.

Table 2 shows how the objectives of the Murrumbidgee Regional Water Strategy align with the goals and directions of the *Riverina Murray Regional Plan 2036* (shaded in orange) and the *South East and Tablelands Regional Plan 2036* (shaded in blue).²³

Table 2. Alignment between regional water strategy objectives and the relevant regional (landuse) plans

Regional water strategy objective	Regional plan goal	Regional plan directions
Deliver and manage water for local communities: improve water security, water quality and flood management for regional towns and communities	Goal 3: Efficient transport and infrastructure networks	Direction 21: Align and protect utility infrastructure investment
	Goal 4: Strong, connected and healthy communities	Direction 22: Promote the growth of regional cities and local centres Direction 23: Build resilience in towns and villages Direction 28: Deliver healthy built environments and improved urban design
	Goal 3: Healthy and connected communities	Direction 22: Build socially inclusive, safe and healthy communities
	Goal 4: Environmentally sustainable housing choices	Direction 25: Focus housing growth in locations that maximise infrastructure and services Direction 26: Coordinate infrastructure and water supply in a cross-border setting
Enable economic prosperity: Improve water access and reliability for regional industries	Goal 1: A growing and diverse economy	Direction 10: Sustainably manage water resources for economic opportunities
	Goal 3: Efficient transport and infrastructure networks	Direction 21: Align and protect utility infrastructure investment
	Goal 1: A connected and prosperous economy	Direction 5: Promote agricultural innovation, sustainability and value-add opportunities Direction 6: Position the region as a hub of renewable energy excellence

23. The five-yearly reviews of the Riverina Murray and the South East and Tablelands Regional Plans 2036 are expected to be finalised by late 2022.

Table 2. Alignment between regional water strategy objectives and the relevant regional (landuse) plans (continued)

Regional water strategy objective	Regional plan goal	Regional plan directions
Recognise and protect Aboriginal peoples' water rights, interests and access to water, and their assets	Goal 4: Strong, connected and healthy communities	Direction 29: Protect the region's Aboriginal and historic heritage
	Goal 1: A growing and diverse economy	Direction 8: Enhance the economic self-determination of Aboriginal communities
	Goal 1: A connected and prosperous economy	Direction 10: Strengthen the economic self-determination of Aboriginal communities
Protect and enhance the environment: Improve the health and integrity of environmental systems and assets, including by improving water quality	Goal 2: A healthy environment with pristine waterways	Direction 13: Manage and conserve water resources for the environment Direction 14: Manage land uses along key river corridors Direction 15: Protect and manage the region's many environmental assets Direction 16: Increase resilience to natural hazards and climate change
	Goal 2: A diverse environment interconnected by biodiversity corridors	Direction 14: Protect important environmental assets Direction 15: Enhance biodiversity connections Direction 16: Protect the coast and increase resilience to natural hazards Direction 17: Mitigate and adapt to climate change Direction 18: Secure water resources
Affordability: Identify least cost policy and infrastructure options	Goal 3: Efficient transport and infrastructure networks	Direction 21: Align and protect utility infrastructure investment
	Goal 4: Environmentally sustainable housing choices	Direction 25: Focus housing growth in locations that maximise infrastructure and services Direction 26: Coordinate infrastructure and water supply in a cross-border setting

Although we will aim to meet all objectives of the regional water strategies, it needs to be stressed that the order of the objectives does not reflect the priority of how we manage water in the state under the *Water Management Act 2000*. It is also important to note that when formulating water sharing plans, the NSW Government must take all reasonable steps to prioritise the protection of the water sources and their dependent ecosystems.²⁴

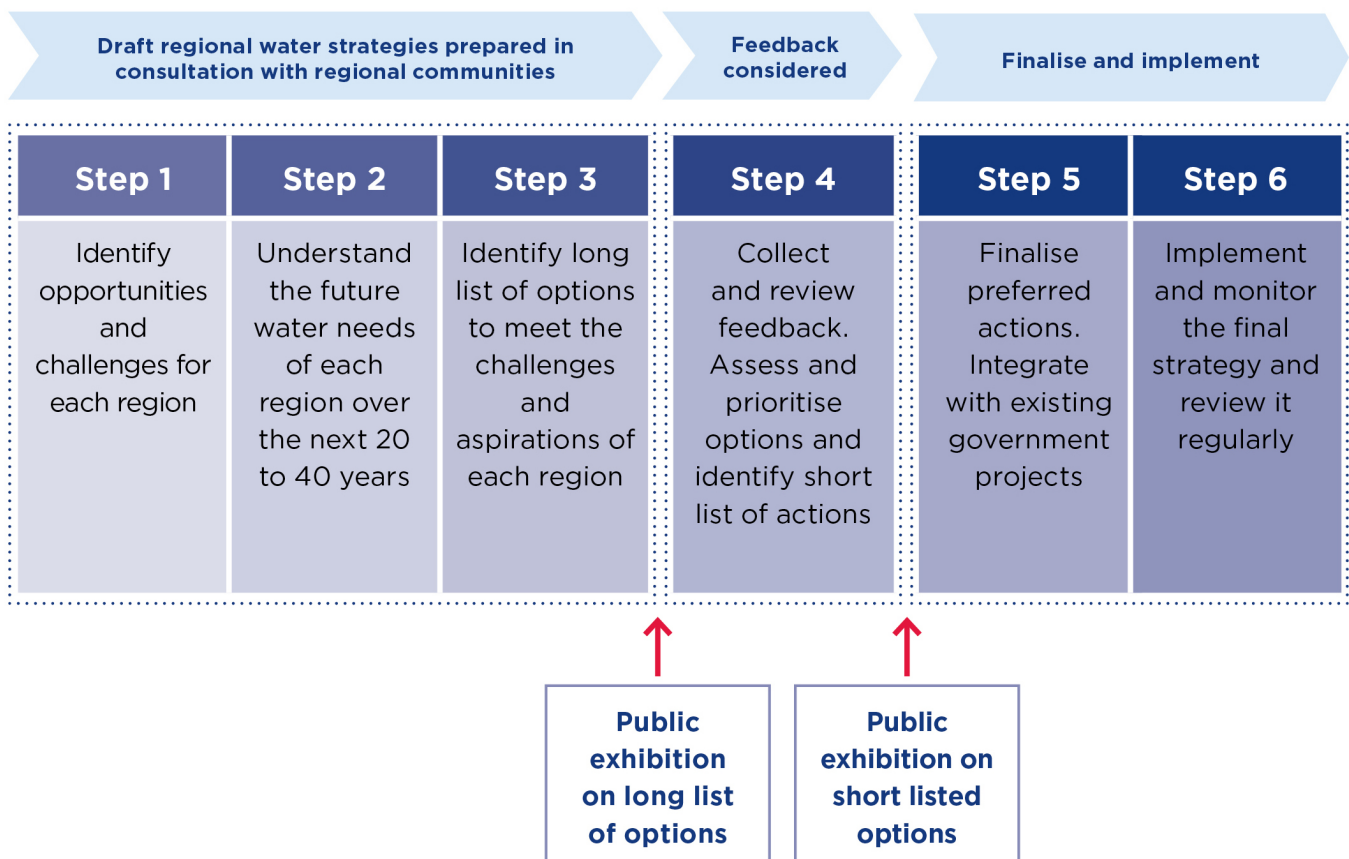
This means that during normal times, the needs of the environment and basic landholder rights are the highest priorities in water sharing. After these needs are met, water for towns and local water utilities, stock and domestic users will be allocated, followed by high security and general security entitlement holders. During extreme droughts or severe water shortages, the *Water Management Act 2000* provides rules for water

sharing plans to be suspended, during which time the priority for water sharing changes to secure critical human water needs and then secure basic landholder rights and essential town water supplies. More detail is provided in Section 2.3.

Through the regional water strategies, we aim to be better prepared for the future and manage these extreme events effectively and equitably for all water users in the region.

The NSW Government is taking a six-step approach to preparing and implementing the regional water strategies, as shown in Figure 5. However, due to the time required to complete the complex hydrologic modelling for the Murrumbidgee Regional Water Strategy, steps 1 and 2 are expected to be finalised at the same time as step 4.

Figure 5. Six step approach to NSW regional water strategies



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

1.3 What has informed the draft regional water strategies?

To ensure we are using the best evidence and most recent data, and fully considering ideas and options for each region, we have used a wide range of sources to inform each strategy.

1.3.1 New climate datasets and improved modelling

Until now, water management in NSW has been based on historical data and observations going back to the 1890s. This has provided a limited understanding of extreme events. The NSW Government is investing in new climate datasets and modelling to develop a more sophisticated depiction of past and future climate conditions. These improved datasets integrate recorded historical data with paleoclimate data (data reconstructed from before instrumental records began, using sources such as tree rings, cave deposits and coral growth) to give us 500 years of climate data. A stochastic modelling method uses this extended data to generate 10,000 years of synthetic climate data. Combining this with other sources of climate data such as climate change projections will help us to better understand natural climate variability—including the probability of wet and dry periods in each region—and estimate risks to future water availability.

This new method is an important advance on previous climate datasets and models. The improved modelling means that we will move from making decisions based heavily on a single ‘worst case’ scenario drawn from a short climatic record to a much more comprehensive understanding of the distribution, length and frequency of past wet and dry periods.

Through this work, we will be able to assess and plan for the impacts of changes in flows and water security over a much wider range of climatic conditions than if we had only considered the observed historical records.

A pilot study is underway to test whether there has already been a step-change in climatic conditions in the southern Basin (see Section 2.1.2).

Chapter 2 sets out the preliminary climate data and observed trends in water resources for the Murrumbidgee region. Hydrologic modelling using the new climate data is under development and will be released in the near future. Trends from hydrologic modelling from other inland regional water strategies, where applicable, have been used to infer potential climate impacts for the Murrumbidgee. The updated climate information used to develop the draft strategy and, together with the improved modelling, will assist in the assessment of the long list of options. It will also support all water users in making more informed decisions to better plan and prepare for climate risks.²⁵

Ongoing analysis will yield more specific and robust results, including an updated understanding of the risks to town water supply, industry and environmental water availability in the Murrumbidgee region. The final Murrumbidgee Regional Water Strategy will use this new data and modelling to identify the best ways to share, manage and use water to manage these risks.

25. More information about these new climate datasets and modelling is provided in the *Regional Water Strategies Guide*.

1.3.2 Community engagement

Over the last few years, the NSW Government has been consulting on a range of water-related issues, including water resource plans,²⁶ metering reforms, environmental water management, the Sustainable Diversion Limit Adjustment Mechanism (SDLAM), floodplain harvesting and responses to drought. Through this consultation, we have heard many ideas about how to be better prepared for future droughts and floods and a more variable climate.

Due to the COVID-19 pandemic we had to redesign our engagement program, replacing some face-to-face consultation with virtual,

online and contactless methods. We have continued to talk with local councils, local water utilities and joint organisations of councils, as well as NSW government agencies, about their thoughts on what the focus of the Murrumbidgee Regional Water Strategy should be. Face-to-face engagement with Aboriginal communities in the Murrumbidgee region was significantly hindered due to the pandemic. As we progress the development of the Murrumbidgee Regional Water Strategy, we will continue to engage with Aboriginal people in the region to ensure their voices are heard.

Further information about the outcomes of these initial meetings can be found in Attachment 1.

26. Over 100 meetings were held with First Nations across the Murray and Murrumbidgee regions for the water resource plans.



Photography

Image courtesy of Destination NSW. Wiradjuri Aboriginal Cultural Tour, Tumut.

What local councils, local water utilities and joint organisations have told us so far

- Councils generally support the use of the new climate datasets and updated hydrological modelling, but there is a need for more clarity around how it may be used in future water management and planning decisions especially for groundwater sources. Local water utilities are interested in how the data could be shared and used, and how the work of the regional water strategies will align with their Integrated Water Cycle Management Strategies (IWCM).
- Many councils and joint organisations raised the need for more clarity on the roles and responsibilities of different agencies involved in water management.
- Groundwater is considered an essential resource and there are concerns regarding its management. In particular, councils expressed concerns about water sharing arrangements, contamination risks and access challenges in the mid Murrumbidgee and upper Murrumbidgee, given the expected population growth in this part of the region.
- There is a need for the regional water strategies and the NSW Government to be clear and transparent about how water is allocated, traded and licensed. Some local councils would like to be able to expand their trading opportunities without penalty, including local water utility entitlements, wastewater discharges and excess bulk water.
- Some councils suggested that the management of water for the environment could be improved and there is a desire for more information and transparency about the use of water for the environment.
- There are a range of factors affecting water quality in the region and these are exacerbated during high rainfall events and drought periods. Algal blooms and contamination of groundwater sources are seen as a significant threat to water security.
- The Murrumbidgee and Murray regions are highly connected, but each region has specific issues that need to be addressed in the respective strategy.
- Councils queried how the regional water strategies will take account of and integrate existing government commitments and other water management policies and plans. Some councils feel that a lack of integration and sequencing between existing and ongoing projects and programs, past enquires, reviews and studies is leading to delays and sub-optimal water management outcomes.
- Councils welcomed the engagement on the regional water strategies but suggested that the conversation needed to be broadened to also include water access licence holders and other local groups with an interest in water.
- Securing town water security is important given the predicted population growth and changes in the regional economy. There is concern over the difference between local population projections and the projections developed through the NSW Government Common Planning Assumptions.

What Aboriginal people have told us so far

- Aboriginal people emphasised the cultural significance of water and the significance of traditional medicines and the need to protect native plants. There were concerns that the water management framework lacks an understanding of the importance of the rivers and the sacred and spiritual connection of Aboriginal people to water.
- There are concerns that Aboriginal people are locked out of culturally significant sites and have limited access to water entitlements. In addition, Aboriginal people told us that they find it difficult and confusing to apply for Aboriginal Cultural Access Licences and that the application process needs to be improved.
- The health of the rivers and waterways in the region has been affected by the long-term land and water management. There are concerns that there is significant variability in flows (including no flow periods) in the upper Murrumbidgee and that artificial bank stabilisation is having an environmental, ecological and cultural impact.
- Aboriginal people stressed the importance of meaningful consultation with Aboriginal communities when developing the regional water strategies, including promoting engagement activities to ensure greater participation. There is continued frustration regarding ongoing consultations with Aboriginal communities regarding water and perceived inaction.
- There is an interest to improve how Aboriginal people could play a more active role in water management.

Photography

Image courtesy of Destination NSW.
Murrumbidgee River, Balranald.

1.3.3 Building on existing commitments and reforms

The Murrumbidgee and Murray regional water strategies are being developed against the backdrop of significant water reforms since the mid-1980s. These reforms, together with other drivers, have led to a significant program of work that is currently being carried out by the NSW Government in these regions. The ongoing work program is extensive, complex and in some cases

requires inter-regional and inter-jurisdictional engagement and cooperation.

Although not exhaustive, the Murrumbidgee and Murray regional water strategies will need to consider the existing programs and projects currently underway, including the SDLAM Program, the relevant water sharing plans, the water resource plan implementation programs and the Snowy Water Licence Review implementation plan.

Reconnecting River Country Program

The NSW Government has announced the Reconnecting River Country Program to achieve a balance of economic, social, cultural and environmental outcomes across southern NSW by improving wetland and floodplain connectivity. The program is part of the SDLAM Program and was developed based on extensive feedback from the local community.

The program focuses on relaxing or removing some of the constraints or physical barriers impacting the delivery of water for the environment in the following areas of the southern connected Murray–Darling Basin:

- Hume to Yarrawonga (Murray River)
- Yarrawonga to Wakool (Murray River)
- Murrumbidgee River.

The program aims to more efficiently deliver water for the environment, to connect rivers to floodplains more often without the need for further water purchases.

Better Bidgee Program

The NSW Government is investigating a range of initiatives for the Murrumbidgee River system as part of rescoping the Yanco Offtake SDLAM Project. These measures are part of a new Better Bidgee Program. The investigation of options for the program is in the very early planning stage.

The program will take a holistic, system-wide approach to water infrastructure planning and operations, working in tandem with changes in water policy and strategy. Past and current stakeholder and community feedback and input will be critical in shaping what these initiatives look like and which initiatives are progressed.

The regional water strategies will need to factor in commitments made by the NSW Government, including those made under the NSW Water Strategy and the proposed state-wide Aboriginal Water Strategy and NSW Groundwater Strategy. We also need to

ensure we reflect progress on commitments associated with the 2017 Water Reform Action Plan—such as improving compliance and transparency around water use and access and introducing robust new metering laws—and joint Basin government initiatives.

In the Murrumbidgee region, the NSW Government has committed to:

- integrated water cycle management strategies for Murrumbidgee Council, Snowy Monaro Regional Council, Yass Valley Council, Griffith City Council, Lockhart Shire Council, Snowy Valleys Council and Balranald Shire Council
- projects under the Safe and Secure Water Program for Jerilderie, Darlington Point, Narrandera, Leeton, Berrigan and Hay; and wastewater treatment plant projects for Queanbeyan, Gundagai, Junee and Hay
- projects in the Restart NSW suite including the Narrandera Replace No 1 Bore, Yass Water Supply Quality Improvement Project, Wamoon Sewerage Scheme and Griffith Villages Sewerage Project
- a range of projects to improve water and sewerage services for Aboriginal communities.

These and other investments will be supported by a new Town Water Risk Reduction Program,²⁷ which will identify long-term solutions to challenges and risks in providing water supply and sewerage services in regional NSW.

The regional water strategies also need to consider work for the Murrumbidgee region by other agencies and government departments, including:

- the Future Ready Regions Strategy, which will support the 20-year Economic Vision for regional NSW and commits to building stronger communities and diversified regional economies to be better prepared for future droughts²⁸
- the scheduled reviews of the South East and Tablelands and Riverina-Murray regional plans 2036
- the regional economic development strategies for Queanbeyan-Palerang, Snowy Monaro, Snowy Valleys, Southern Tablelands, South West Slopes, Eastern Riverina, Western Murray and Western Riverina
- the Australian Government's National Water Grid Connections pathway, which is jointly funding the Lake Wyangan Water Sustainability Project with the NSW Government
- the Wagga Wagga Special Activation Precinct, the South Jerrabomberra Regional Job Precinct, the South West Renewable Energy Zone and work underway for the Inland Rail Project
- efforts underway for Snowy 2.0.

Bringing in the work of other agencies will help to target and narrow down the draft long list of options for the regional water strategy to take full advantage of the opportunities that arise in the Murrumbidgee region.²⁹

27. Town Water Risk Reduction Program, www.industry.nsw.gov.au/water/plans-programs/risk-reduction. Further details of the Town Water Risk Reduction Program are provided in Section 3.3.

28. The Future Ready Regions Strategy can be viewed at www.nsw.gov.au/regional-nsw/future-ready-regions. Several commitments in the strategy address drought readiness challenges identified in the Murrumbidgee region and align with some of options in the Draft Murrumbidgee Regional Water Strategy.

29. More information about the NSW Government's water reforms is in the *Regional Water Strategies Guide*.

Responding to the 2017-2020 drought

From 2017 to August 2021, over \$4.6 billion have been committed to the drought response in NSW. This commitment to drought relief and water security provided immediate support to farmers, families, towns and businesses impacted by drought.

- \$436 million in loans to farmers and eligible businesses from the Farm Innovation Fund, Drought Assistance Fund Loans and Seafood Innovation Fund.
- \$282 million for on-farm support to help meet the costs of transporting fodder, water and stock.
- \$202 million for community support for mental health services, sports grants, pre-school support, waivers including vehicle registration fees and Local Land Services rates, road repairs, reskilling and business support.
- Over \$1 billion was committed to nearly 200 water projects since 2016, which included building and upgrading water storages, pipelines and bores across regional NSW through programs like the Safe and Secure Water Program, Resources for Regions, Water Security for Regions and Regional Water and Wastewater Backlog Program.
- Over \$285 million (2017-20) of this funding went to water infrastructure, water carting and emergency works to ensure communities did not run out of water.
- In June 2021, the NSW Government released the \$64 million Future Ready Regions Strategy to improve industry and council self-reliance ahead of the next drought.
- A \$2.4 billion support package remains available for primary producers, businesses and communities for on-farm support, community, and water projects.

1.4 Policy and planning context

Each regional water strategy sits within a broader policy and planning context. This includes a range of policies and plans that guide the management of water resources in NSW (Figure 6).

The NSW Government has developed a 20-year NSW Water Strategy, which establishes guiding principles and sets strategic priorities to improve the security, reliability, quality and resilience of the state's water resources and to continue to rebuild community confidence in water management in NSW. As outlined in Table 1 (Section 1.2), the NSW Water Strategy identifies seven strategic priorities focused on meeting core objectives based on the NSW *Water Management Act 2000*. The Act provides a clear direction that NSW must provide for the sustainable and

integrated management of the water sources of the state for the benefit of present and future generations.

The regional water strategies also align with the NSW Government's broader strategic planning priorities and will be integrated with current land use and regional plans.³⁰ This includes local strategic work being done by joint organisations and local councils' integrated water cycle management plans.

Regional water strategies are an opportunity to explore how we can bring together existing commitments and better integrate and shape these plans, policies and investment for improved water outcomes.

30. More information about how the strategies relate to strategic, regional and water planning is in the *Regional Water Strategies Guide*.

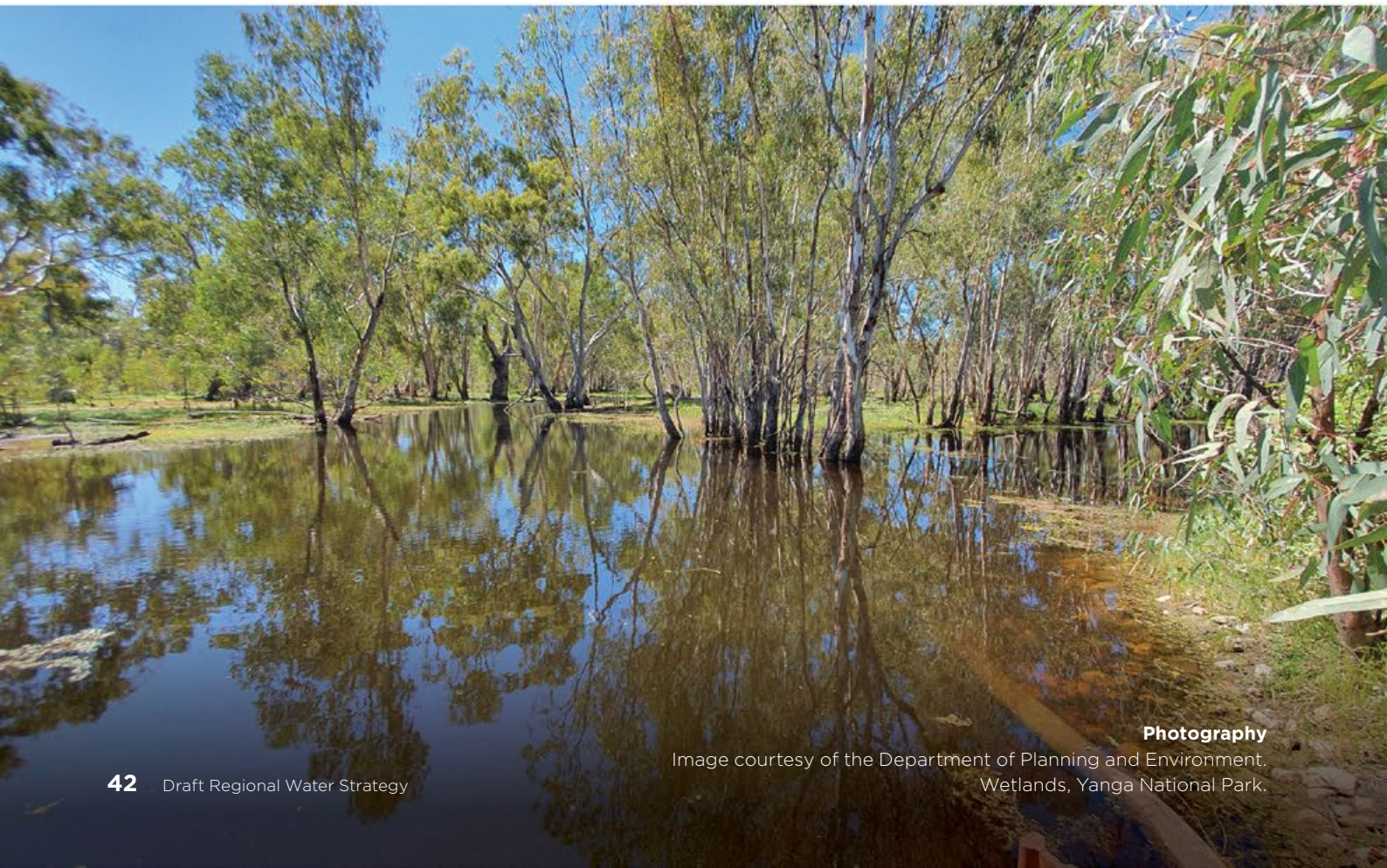
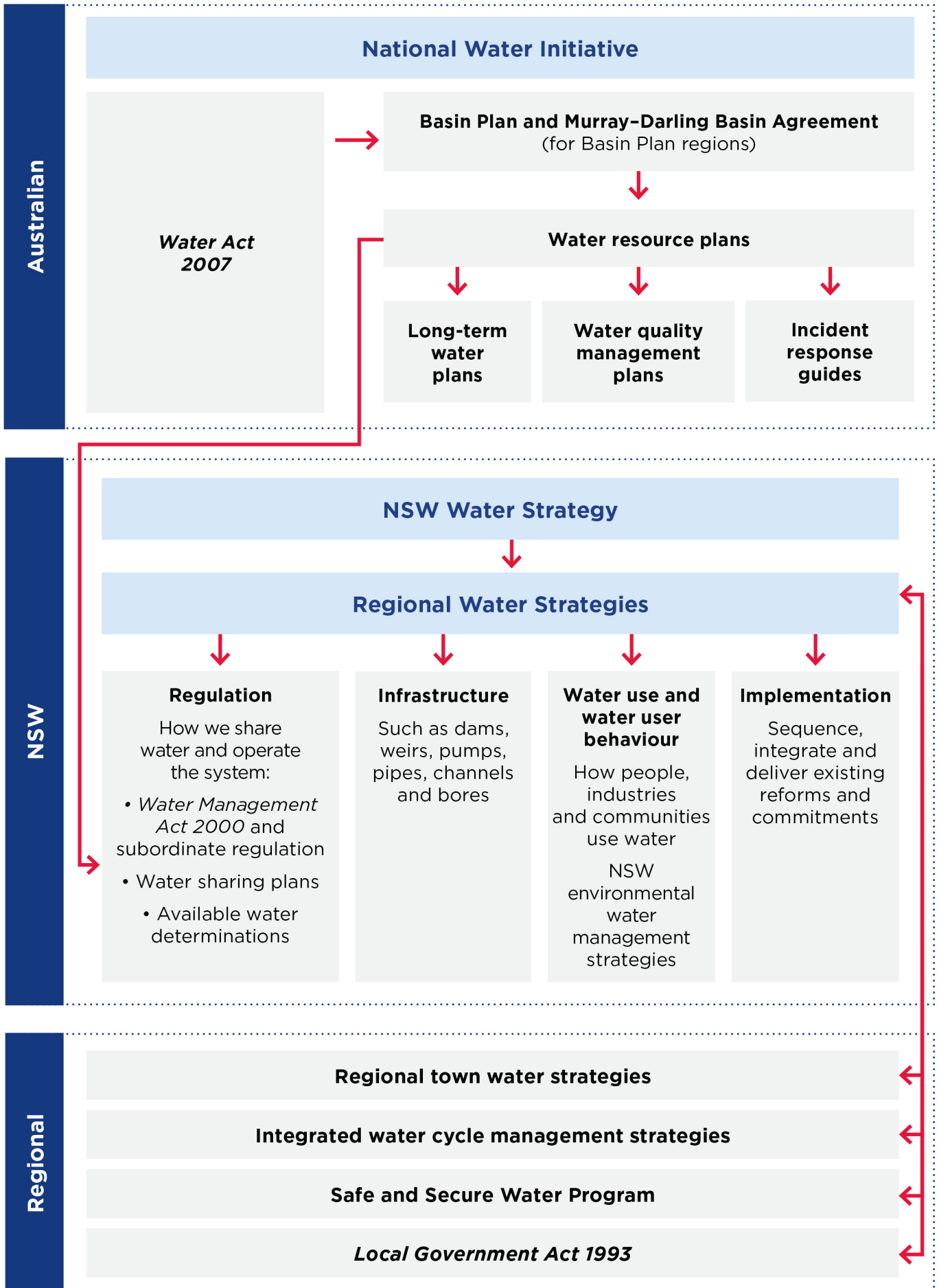


Figure 6. NSW water policy and planning context



An aerial photograph of Wagga Wagga, NSW, Australia. The image shows a river in the foreground, a large building with a distinctive roof, and surrounding greenery. The background features a town and hills under a clear sky.

Chapter 2

The Murrumbidgee region, its climate and water resources

Snapshot

The Murrumbidgee region has a variable climate that is dominated by wet or dry periods.

- The region has experienced several extended and severe dry periods as well as intense wet periods:
 - The most well-known droughts in the Murrumbidgee region are the Federation Drought (1895 to 1902), the World War II Drought (1937 to 1945) and the Millennium Drought (1997 to 2009).
 - The region has experienced several major floods events, notably in 2010, 2012 and 2016.
- The new climate datasets show that the wet and dry cycles we have seen over the last 120 years are fairly normal when compared against the long-term records and are an important characteristic of the Murrumbidgee region.
- In the southern connected basin, we have already seen a shift in the climate over the last 20 years. There has been a trend of decreasing rainfall in autumn and early winter and an increase in temperatures.

The future climate in the Murrumbidgee could be more variable.

- Our new climate datasets suggest that the region could experience changes in rainfall patterns, a decrease in overall annual rainfall and higher evapotranspiration.
 - Critical winter and spring rainfall could decrease and coupled with higher expected evapotranspiration rates could impact inflows into the region's major storages.
- The Department's climate change snapshot suggest that the Murrumbidgee could also experience higher minimum and maximum temperatures, more hot days, less cold nights, decreased snowfall and snowmelt and more severe fire conditions in the future.
- Work is being progressed to further enhance our understanding of the region's climate and better understand the impacts of future climate variability and climate change on our surface water and groundwater resources.
- Demand for and pressure on the region's fully committed groundwater sources is likely to increase under a drier future climate. There are some areas where groundwater levels are declining and salinity is an issue in some groundwater sources.

Managing, sharing and delivering water across the southern connected basin is complex.

- The Murrumbidgee region is part of the southern connected basin. Interstate agreements and rules govern how water resources are shared between NSW, Victoria and South Australia. For the Murrumbidgee, there are also other relevant rules that govern water sharing arrangements between NSW and the Australian Capital Territory and water releases from the Snowy Scheme.
- The Snowy Scheme contributes crucial flows to the Murrumbidgee River via Bowering Dam, but inflows to the Murrumbidgee region have reduced over the last 20 years.
 - Bowering Dam inflows during the most recent drought (2017 to 2020) have been the second lowest 36-month inflow sequence on record and 64% of the long term average annual inflow.
- Delivery constraints across the Murrumbidgee region can make it difficult to get water to where it is needed and can create storage volume imbalances between Burrinjuck and Bowering dams.
 - The river channel constraints in the Tumut River creates particular challenges for Murrumbidgee as it limits the releases that can be made from Bowering Dam.
- The vast majority of irrigators in the Murrumbidgee hold general security entitlements. Based on NSW's water allocation system and due to the region's variable climate, the amount of water allocated each year to general security entitlements has varied widely.
- In the southern connected basin, water allocations can be traded between the Murrumbidgee, NSW Murray, Lower Darling, Victoria and South Australian regulated river water sources. Recently proposed changes to the Goulburn inter-valley trade rules that limit the volume of traded water may place increased pressure on the Murrumbidgee inter-valley trade account.
- Water quality is managed through several legislative and regulatory instruments, and by various agencies. Current challenges include salinity, elevated nutrient levels, blue-green algae, hypoxic blackwater and cold-water pollution. These challenges require a suite of integrated management options targeted at source catchments, rivers and infrastructure.



Photography

Image courtesy of Destination NSW.
Township, Narrandera.

2.1 What we know about the Murrumbidgee region's climate

2.1.1 Today's climate

The topography of the region results in large spatial variations in climatic conditions, ranging from the alpine climate of the Snowy Mountains in the east to temperate conditions in the central parts and semi-arid conditions further west.

Historical climate data, hydrological data (streamflow, river heights, dam and reservoir levels and volumes), groundwater level data and observations going back to the 1890s provide a limited understanding of climate variability in the Murrumbidgee region.

The whole Murrumbidgee region experienced dry conditions between 1900 and 1950, as well as since 2000. In contrast, the period from 1950 to 2000 was comparatively wet. This trend is less pronounced in the region's elevated east. Since 2000, there has been no consistent trend, with annual rainfall between 2010 and 2017 generally above average, and then drier than average since 2017, leading to some water security risks to towns.

Embedded within the long-term wet and dry cycles there have been extreme dry periods and large storm events that resulted in major flooding in the region, as discussed in more detail in Section 2.2.2.

Temperature and evapotranspiration

Summers are warm to hot in the northwest of the region with average maximum temperatures ranging from 32 to 35°C. The elevated eastern part of the region experiences cold winters, with average temperatures ranging from -2 to 5°C. The peaks of the main mountain range are subject to variable winter snowfall. Milder conditions are found in the central parts of the region along the south west slopes, with cooler summer temperatures than the plains and warmer winter temperatures than the mountains.³¹

Recorded temperatures in the region have been increasing since around 1950, with the largest increase in the most recent decades.³² From 1970 to 2020, average spring temperatures have increased the most (0.4 to 0.6°C per decade) across the region. The increase in average winter and autumn temperatures has been higher in the Snowy Mountains and around the ACT (0.2 to 0.3°C per decade) than in the mid and lower parts of the region (0.05 to 0.15°C per decade).³³

In 2020, the region experienced above average temperatures, particularly east of the ACT. Across NSW, spring was very warm, with the warmest mean minimum temperatures since 1914.³⁴

Average annual potential evapotranspiration ranges from around 1,000 mm in the Snowy Mountains to 1,150 mm at Balranald. Evapotranspiration is strongly seasonal across the region and around four to five times higher in summer than in winter.³⁵

31. Office of Environment and Heritage 2014, *Murray Murrumbidgee Climate Change snapshot*

32. Office of Environment and Heritage 2014, *Murray Murrumbidgee Climate Change snapshot*

33. Bureau of Meteorology, *Climate change—trends and extremes*, www.bom.gov.au/climate/

34. Bureau of Meteorology 2020, *Annual Climate Statement: Australia's fourth-warmest year on record, with below average rainfall for parts of Queensland and Western Australia*, www.bom.gov.au

35. Evapotranspiration is the combined process of water surface evaporation, soil moisture evaporation and plant transpiration. It is affected by climate, the availability of water and vegetation. As evapotranspiration is difficult and costly to measure in the field, it is generally determined as an approximate average over time using modelling. Further explanation about the evapotranspiration modelling used for the regional water strategies is provided at Bureau of Meteorology, Canberra, www.bom.gov.au/climate/

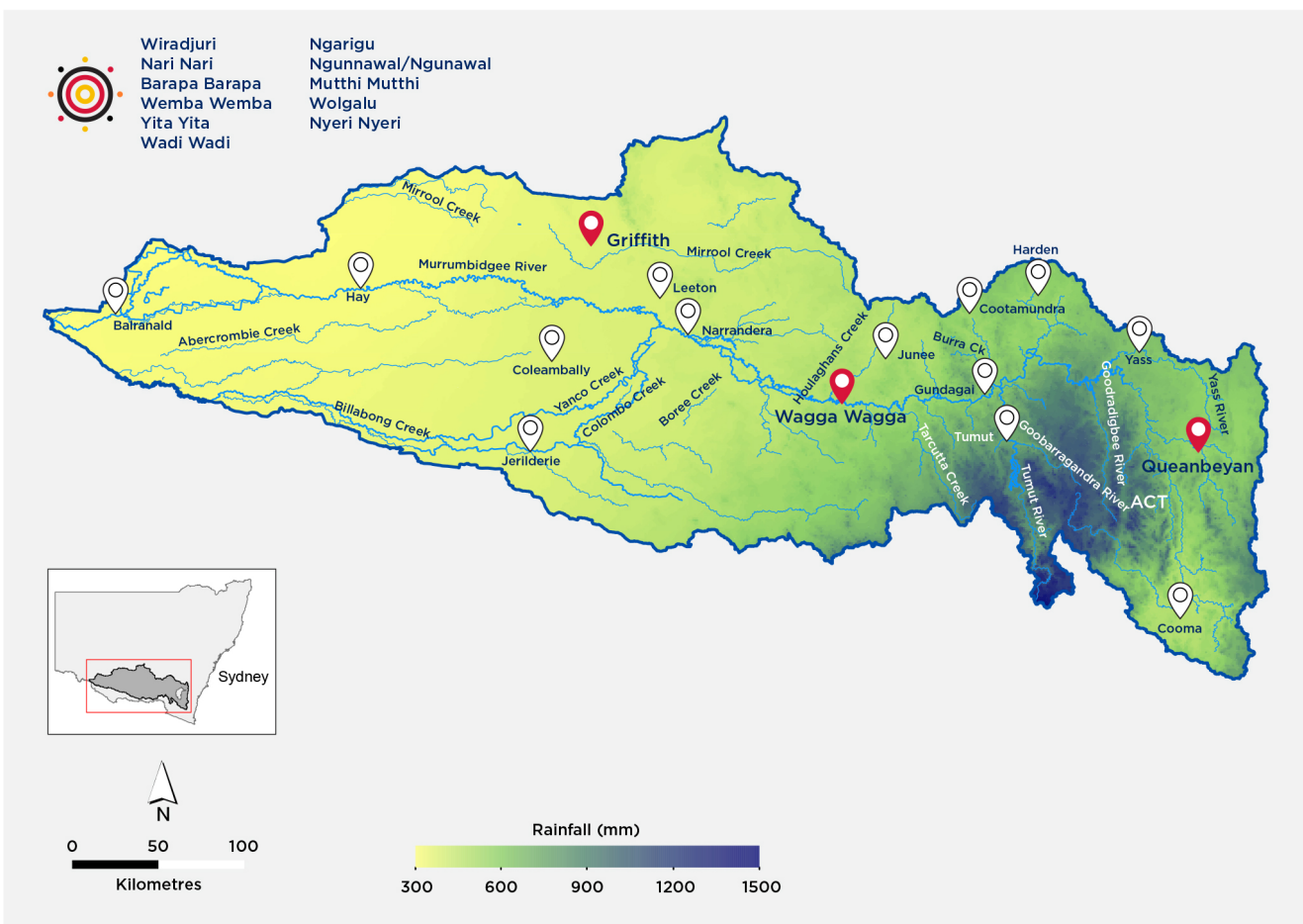
The number of hot days per year—maximum temperatures above 35°C—varies widely across the region. There are rarely days over 35°C in the Snowy Mountains, while more than 40 hot days per year are frequently observed in the western parts of the region near Hay.

The number of cold nights per year—minimum temperatures below 2°C—also varies considerably across the region. The west experiences fewer than 30 cold nights per year, while there are over 200 cold nights in the peaks of the Snowy Mountains. In the last three decades, the average number of cold nights in the Snowy Mountains has decreased by 10 days per year, reducing conditions necessary for snowfall.

Rainfall and snowmelt

Rainfall is highly variable across the region (Figure 7). Average annual rainfall varies from 1,500 mm per year in the higher elevations of the Snowy Mountains to around 300 mm per year in the far west. Rainfall is relatively uniform throughout the year, with marginally higher winter and spring rainfall in the elevated east of the region. The proportion of winter precipitation that falls as snow and rain is directly related to minimum daily temperatures.³⁶ On average, the Snowy Scheme receives 50% of inflows from snowmelt and spring rainfall.³⁷ However, this amount varies each year as some amount is lost due to evaporation or seepage into the ground, depending on the prevalent climate conditions.

Figure 7. Observed average annual rainfall in the Murrumbidgee region



Source: Bureau of Meteorology

36. Alejandro Di Luca, Jason P. Evans, Fei J. 2017, *Australian snowpack in the NARClIM ensemble: evaluation, bias correction and future projections*

37. Snowy Hydro Limited 2015, *Water Report for 2014/2015*, www.snowyhydro.com.au/generation/water/

Rainfall and snowmelt are important for water supply in the Murrumbidgee region. They feed rivers and groundwater sources and lead to inflows into the region's two major storages.

Since 1950, the greatest decline in annual rainfall in the region has been in the upper Murrumbidgee.³⁸ Declines of between 20 to 40 mm per decade have been observed across the upper Murrumbidgee, with up to 60 mm decline around the Goodradigbee River.

Maximum snow depths in the Kosciuszko National Park have also shown a downward trend over the last 50 to 60 years, declining by around 10% from 1961 to 2001 and 15% from 2001 to 2013. The major factors responsible for these declines are increasing minimum temperatures and a reduction in winter rainfall. Over the last 25 years, maximum snow depth and the total number of light snow days³⁹ has declined, mainly in spring due to higher temperatures. Higher temperatures in recent years are also reducing suitable conditions to generate snowpack.⁴⁰

In addition to the amount of snowpack, snowmelt is strongly influenced by the weather conditions experienced during late winter and spring. Small changes in the weather can lead to vastly different outcomes for inflows. For example, heavy rain falling on a dense snowpack melts the snow quickly and maximises runoff. However, hot, dry air can lead to higher evaporation and reduce runoff into streams and rivers.

Snowy Hydro has been conducting cloud seeding operations since 2012, to enhance the amount of snow falling over a 2,110 km² area of the Snowy Mountains.⁴¹ The additional snowfall provides improved snow conditions for winter sports as well as more snowmelt for energy production and subsequent release to the Murray and Murrumbidgee rivers. The Murrumbidgee and Murray regional water strategies provide an opportunity to investigate the expansion of cloud seeding in the region's key water supply catchments (Option 50).

The region has experienced both short, intense and extended drought periods, often ended by intense wet periods

The Murrumbidgee region has experienced extreme droughts over the past 120 years of observed records. The most well-known are the Federation Drought (1895 to 1902), the World War II Drought (1937 to 1945) and the Millennium Drought (1997 to 2009) (Figures 8 and 9).⁴² A review of the observed historical records indicates that persistent droughts have commonly and increasingly ended with significant rainfall events. For example, significantly above-average rainfall in 2010 and 2011 effectively ended the sequence of dry years of the Millennium Drought.⁴³

38. Upper Murrumbidgee relates to catchments of the Murrumbidgee River above Burrinjuck and Blowering dams.

39. The proportion of precipitation falling as snow is related to the minimum temperature. Light snow days are considered to be days of snowfall between 1 and 10 cm. Sonya L. Fiddes, Alexandre B. Pezza and Vaughan Barras. 2014, *A new perspective on Australian snow*. Atmospheric Science Letters 16(3) p.246-252.

40. Acacia S. Pepler Blair Trewin and Catherine Ganter. 2015, *The influences of climate drivers on the Australian snow season*. Australian Meteorological and Oceanographic Journal 65(2), July 2015.

41. NSW Natural Resources Commission independent assessment found that cloud seeding trials resulted in a 14% increase in precipitation for targeted weather events. There are only a limited number of opportunities each year during the cooler months for cloud seeding to result in snowfall.

42. Drought is defined in terms of periods of rainfall deficit (meteorological drought), low catchment streamflow (hydrological drought) and soil moisture depletion (agricultural drought) This strategy discusses meteorological and hydrological drought. The Federation Drought recorded the lowest rainfall for the region north-east of the ACT. The World War II Drought recorded the lowest 10-year rainfall total on record for the region's western areas. The Millennium Drought recorded the lowest 10-year rainfall record for the central and south-eastern parts of the region. Australian Government Bureau of Meteorology, Previous droughts, www.bom.gov.au/climate/

43. Bureau of Meteorology, *Special Climate Statement 38*, www.bom.gov.au/climate/current/statements/

Figure 8. Lowest ten-year average rainfall in the upper Murrumbidgee region (1890 to 2019)

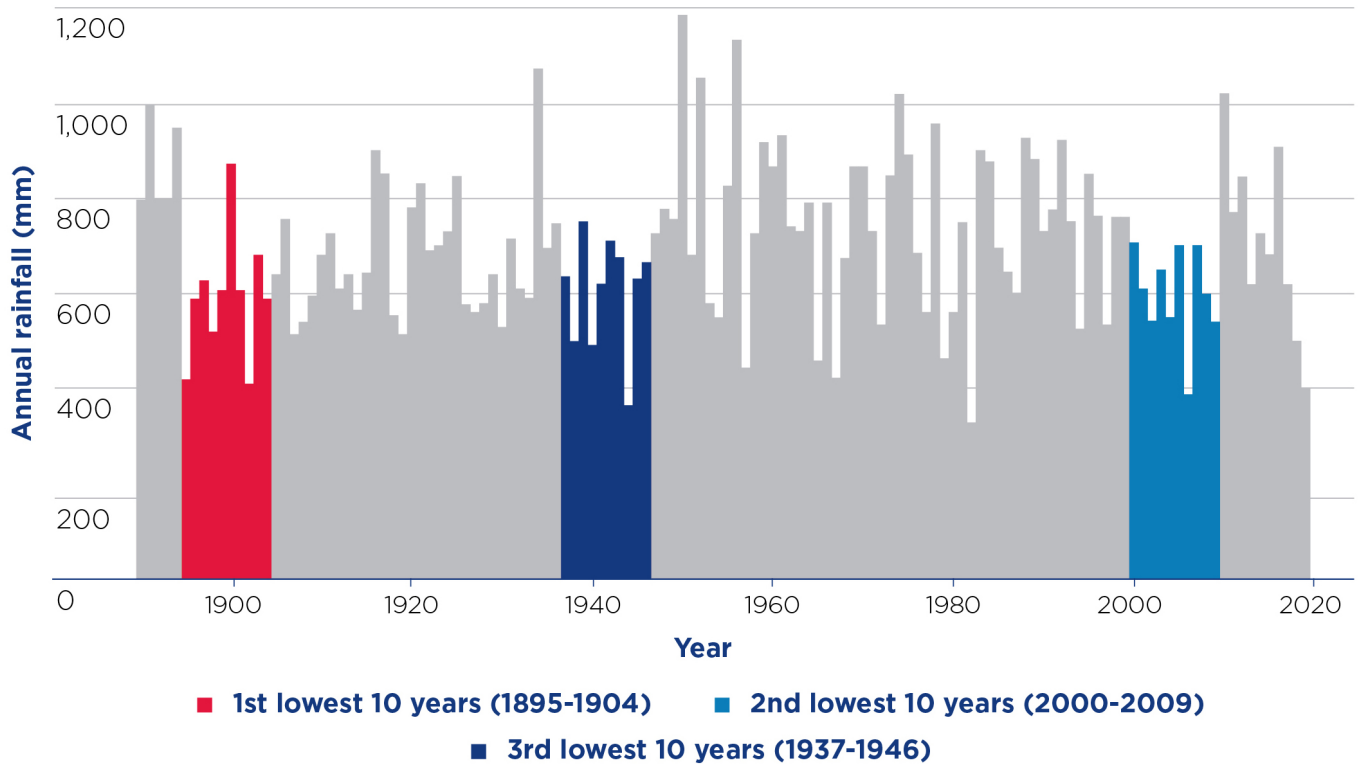
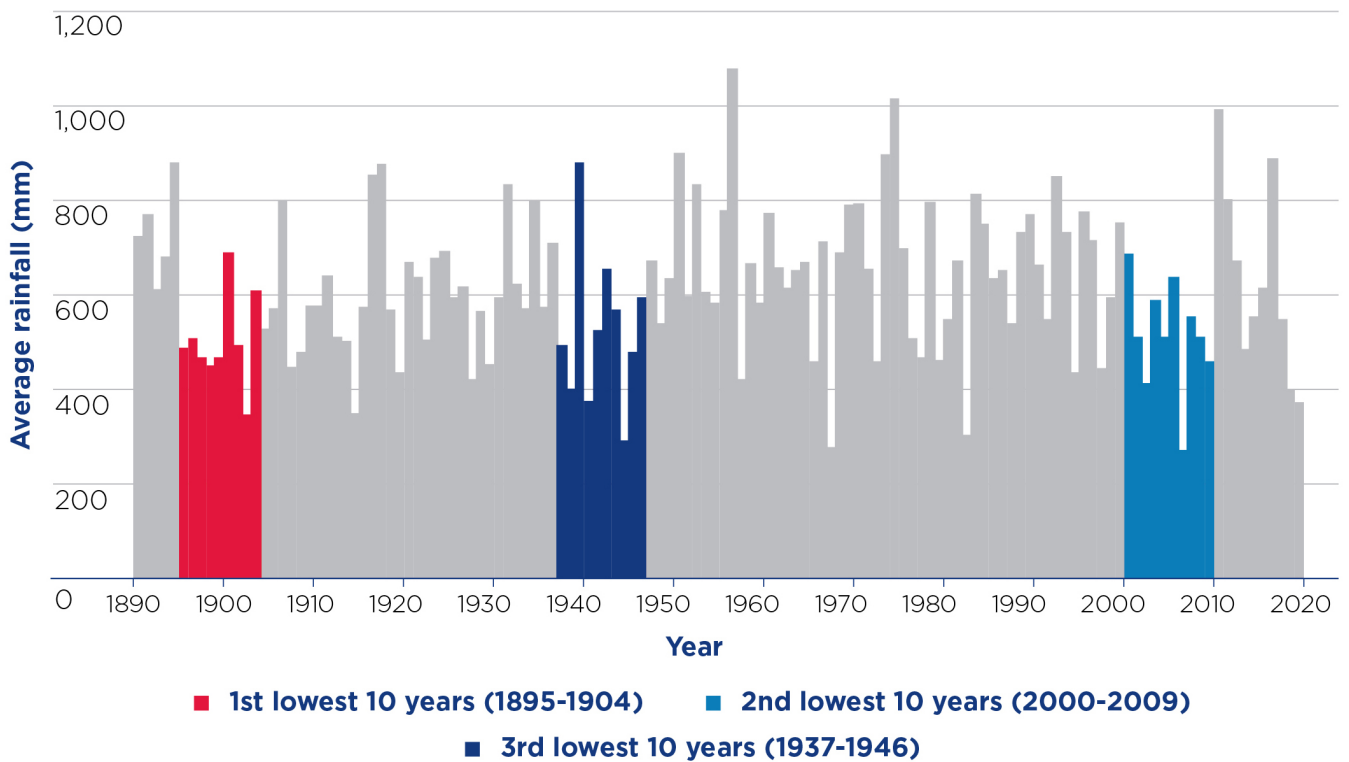


Figure 9. Lowest ten-year average rainfall in the regulated* Murrumbidgee region (1890 to 2019)



*Note: The regulated Murrumbidgee region includes data from the areas below Blowering and Burrinjuck dams and inflows into Blowering and Burrinjuck dams. It does not include data from the upper Murrumbidgee region.

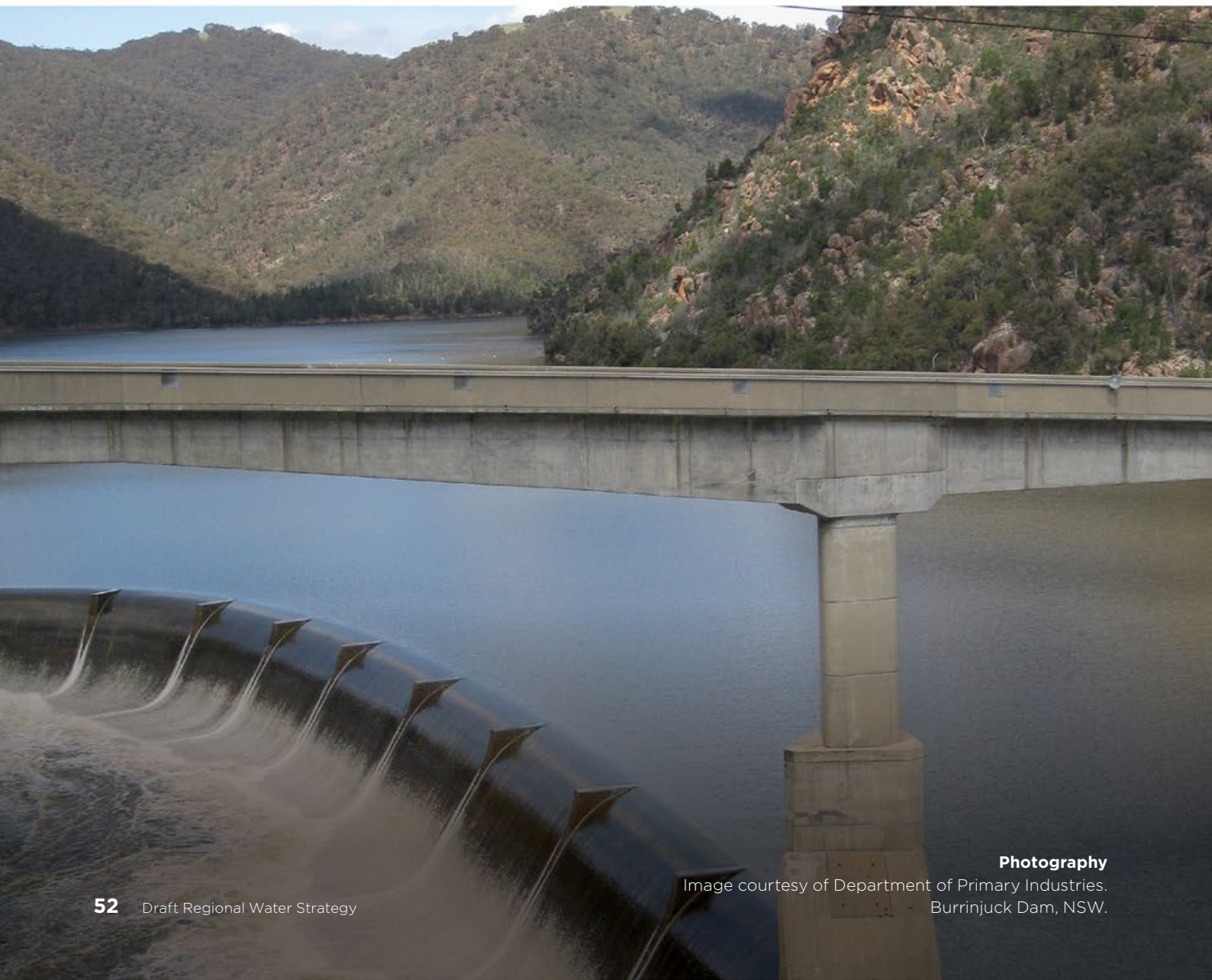
The most recent drought (2017 to 2020) includes some of the lowest 24-month and 36-month rainfall periods across the region and took place against the backdrop of rising temperatures, increasing evaporation and record low root-zone soil moisture (Figures 10 and 11). In the 24 months to January 2020, rainfall in the region was 30% to 40% below average.⁴⁴ Later in 2020, the region experienced above average rainfall, particularly in the upper Murrumbidgee.⁴⁵

Considering the historical records, the 2017–2020 drought was not the worst in terms of combined storage inflows into Burrinjuck and Blowering dams for any 24-month or 36-month consecutive periods. However, February 2018 to January 2020 was the worst 24-month inflow period for Burrinjuck Dam.⁴⁶

44. See www.bom.gov.au/climate/drought/ and Bureau of Meteorology 2019, *Special Climate Statement 70 update—drought conditions in Australia and impact on water resources in the Murray-Darling Basin*

45. Bureau of Meteorology 2020, *Annual Climate Statement*, media.bom.gov.au/releases/807/2020-annual-climate-statement/

46. Prior to January 2020, the worst 24-month consecutive inflow period for Burrinjuck Dam occurred during the Millennium Drought (2008–2010).



Photography

Image courtesy of Department of Primary Industries.
Burrinjuck Dam, NSW.

Figure 10. Lowest two and three-year average rainfall in the upper Murrumbidgee region (1890 to 2019)

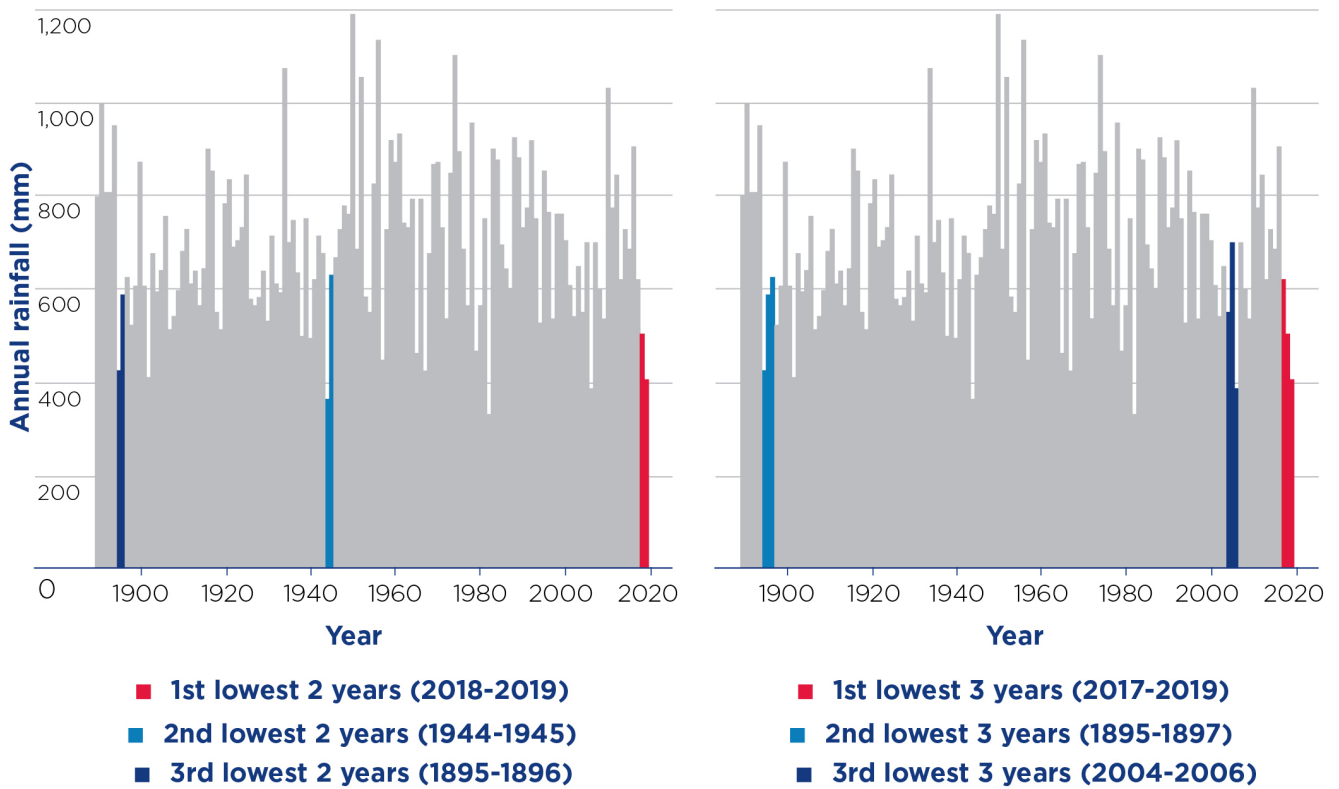
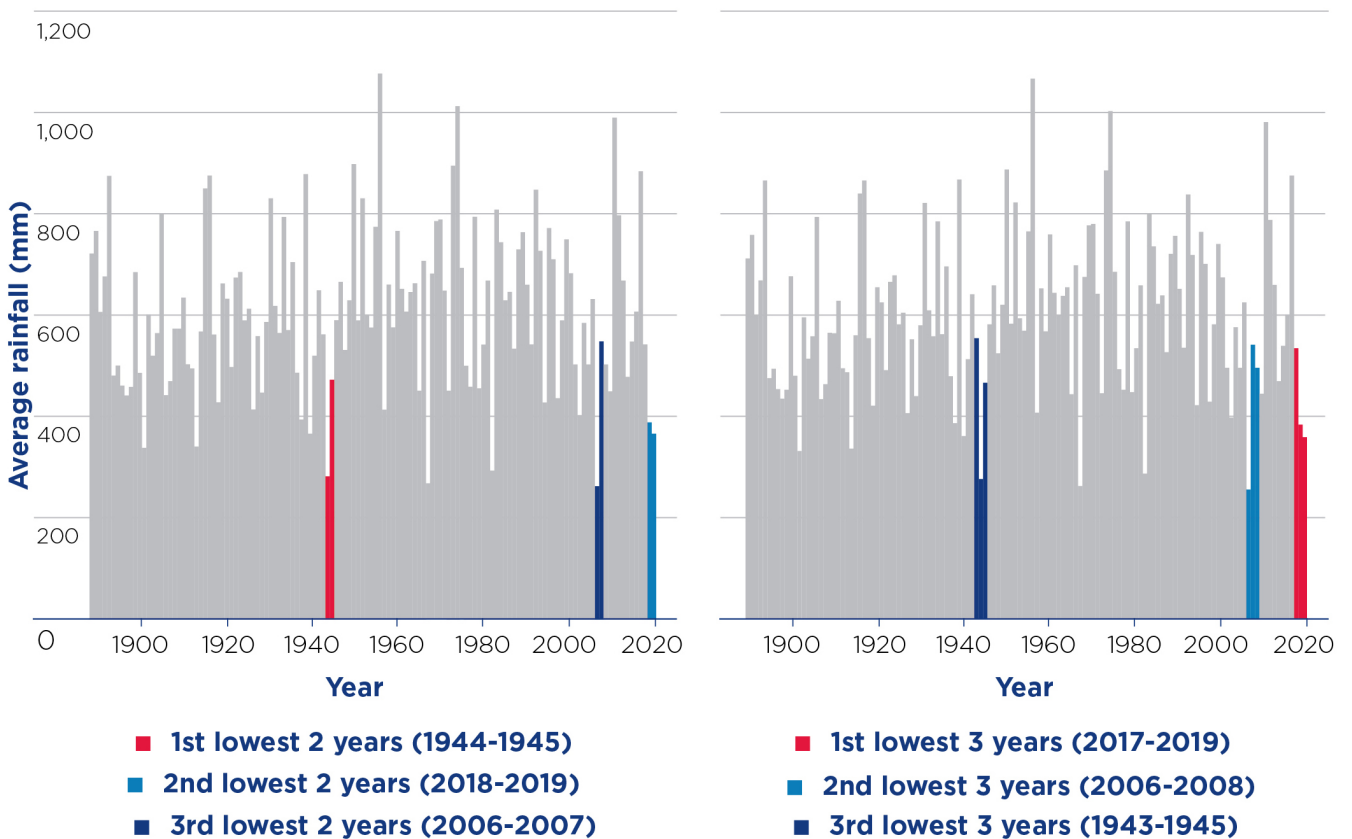


Figure 11. Lowest two and three-year average rainfall in the regulated* Murrumbidgee region (1890 to 2019)



*Note: The regulated Murrumbidgee region includes data from the areas below Blowering and Burrinjuck dams and inflows into Blowering and Burrinjuck dams. It does not include data from the upper Murrumbidgee region.

2.1.2 A better understanding of natural climate variability and future climate change

Our new climate datasets will provide a better understanding of the natural climate variability in the Murrumbidgee region beyond the observed historical records. This section compares observed climate data with long-term natural climate variability and plausible future climates, including potential changes to the amount and seasonality of rainfall, snowmelt and evapotranspiration and potential changes to wet and dry cycles.

The potential impacts of greater climate variability and climate change on the region's water resources and the associated challenges for future water security are discussed in Section 2.2.2.

Wet and dry cycles have occurred in the past

The new climate datasets show that the wet and dry cycles we have seen over the last 120 years are fairly normal when compared to the long-term climate beyond historical records. However, the stochastic datasets indicate that there have been more extreme dry and wet conditions in the long-term past than what we have seen in the last 120 years.

In the southern Basin, we have already seen a shift in climate over the last 20 years. Trends of decreasing autumn and early winter rainfall of 10–20%, decreasing number of wet days in south east Australia since the mid-1990s, and temperature increases in this region, especially post 1960, were at least partly attributable to climate change.⁴⁷ More work is being done by Adelaide University to incorporate this

non-stationarity in new climate datasets for the next stage of the Murrumbidgee and Murray regional water strategies to help us more accurately assess current and future drought risk.

A future climate could be more variable, with shifts in rainfall patterns and higher evaporation

Our new climate datasets⁴⁸ suggest that, if the worst-case dry climate change scenario eventuates, the Murrumbidgee region could have:

- **changing rainfall patterns**—shifts in seasonal rainfall could occur, with a tendency for lower annual rainfall
 - in the upper Murrumbidgee, by 2079 average winter rainfall may drop by 20%. Average autumn rainfall may drop by 11%, with very little reduction in summer and spring rainfall (Figure 12)
 - in the regulated Murrumbidgee, by 2079 average winter and spring rainfall may drop by 17 to 18%. Average summer rainfall may increase by 8% (Figure 12).
- **higher evapotranspiration**—average evapotranspiration could increase by up to 2% by 2039 and up to 4% by 2079 compared to levels between 1990 and 2009 (Figure 13).

These changes in rainfall and evapotranspiration could impact inflows into the region's major storages and increase the water-related risks to water users and the environment.

47. Devanand, A., Leonard, M., & Westra, S. 2020, *Implications of Non-Stationarity for Stochastic Time Series Generation in the Southern Basin*. Pilot Study undertaken by Adelaide University.

48. Further information about how these forecasts have been used in combination with the new climate datasets is provided in Attachment 2 of the *Regional Water Strategies Guide*.

Figure 12. Average monthly changes in rainfall for the Murrumbidgee for the periods 2060 to 2079 compared to the period 1990 to 2009 from NARClIM projections

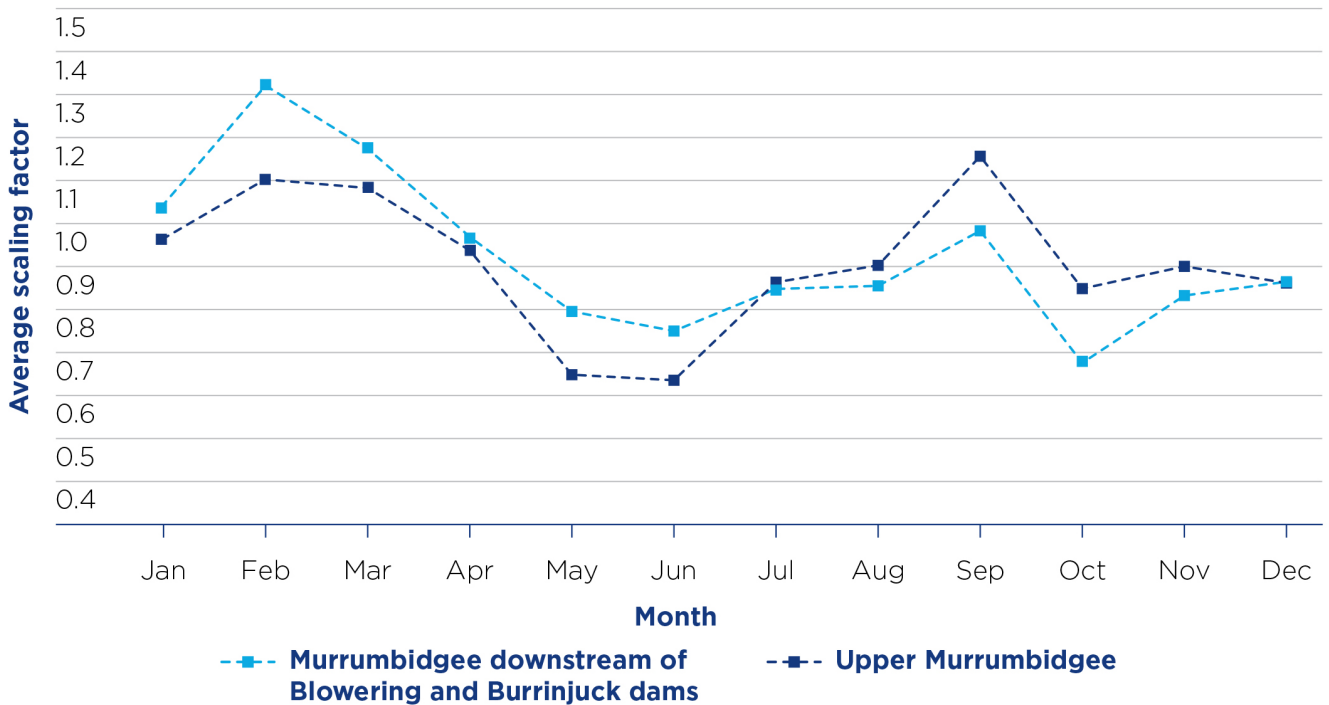
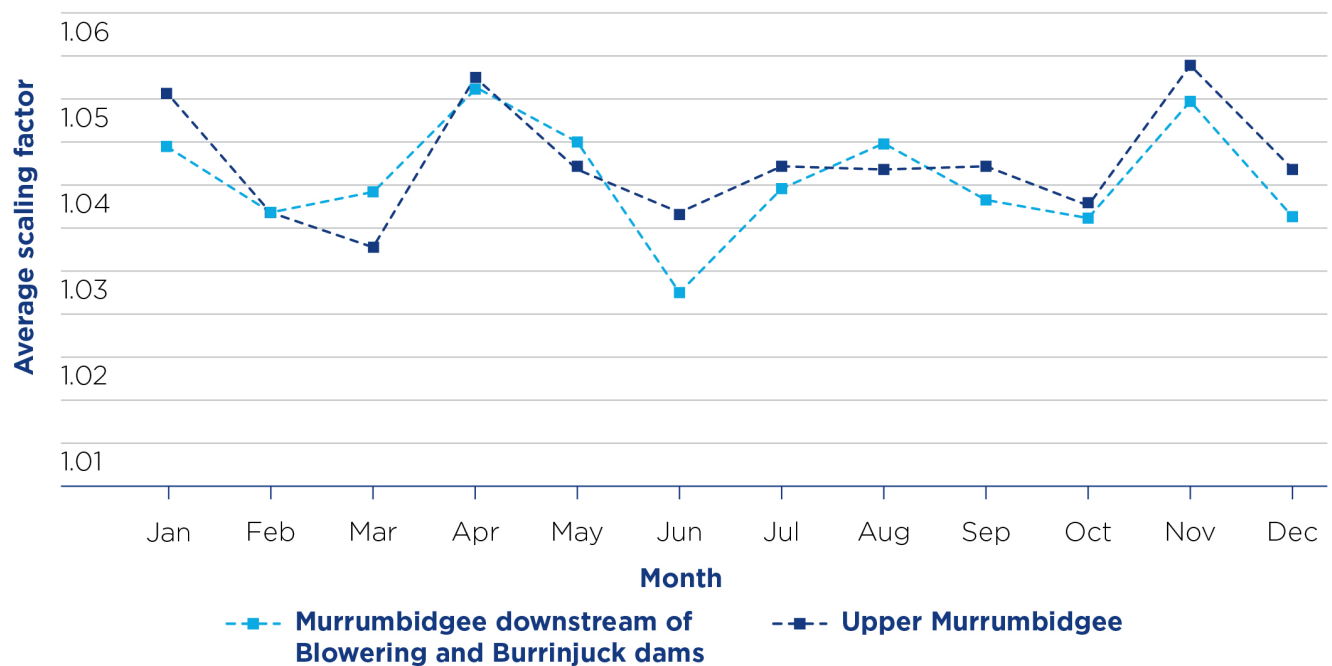


Figure 13. Average monthly changes in potential evapotranspiration (PET) for the Murrumbidgee for the periods 2060 to 2079 compared to the period 1990 to 2009 from NARClIM projections



In addition, climate change snapshots⁴⁹ for the region, which take the average of a range of plausible future changes in climate, suggest that the Murrumbidgee could experience:

- **changing rainfall patterns**—greater inter-annual variability in rainfall is expected with annual rainfall likely to decrease in dry years by up to 9% and increase in wet years by up to 16%. Spring rainfall is expected to decrease across the region by up to 26% in the near future and up to 19% in the long term. Summer and autumn rainfall is expected to increase across the region, with the greatest increase of 10% to 30% likely in autumn in the long term
- **higher minimum and maximum temperatures**—across the region, temperatures are expected to increase by 0.6 to 0.7°C in the near future (2020 to 2039) and 1.9 to 2°C over the long term (2060 to 2079)
- **more hot days (temperatures over 35°C)**—while the region is likely to experience an additional 5 to 10 hot days in the near future and an additional 20 to 30 hot days each year by 2070, little change in the number of hot days is expected for the Snowy Mountains

- **less cold nights (temperatures below 2°C)**—the greatest decrease is expected in the Snowy Mountains with 10 to 20 fewer cold nights in the near future and 20 to 30 fewer cold nights in the long term. The rest of the region is likely to experience 5 to 10 fewer cold nights in the near future and 14 to 27 fewer cold nights in the long term. The largest decreases are expected in winter and spring
- **more ‘severe fire weather’ days**—severe fire weather is measured by a combination of temperatures, humidity and windspeed; resulting in a Forest Fire Danger Index score of 50 or greater. This is expected to worsen continually over both spring in summer through to 2070
- **decreased snowfall and snowmelt**—the expected temperature increases and reduced number of cold nights in the Australian Alps is expected to substantially decrease snowfall. The snowpack is expected to decrease by about 15% by 2030, and 60% by 2070.⁵⁰ The expected decrease in spring rainfall is likely to reduce snowmelt

A projected future with less rainfall in key run-off areas such as the Snowy Mountains, higher evapotranspiration, higher temperatures, and more severe fire conditions will likely change the volume of water available across the region. These changes are discussed throughout this regional water strategy.

49. Office of Environment and Heritage 2014, *Murray Murrumbidgee climate change snapshot and South East and Tablelands climate change snapshot*, climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region

50. Di Luca, A., Evans, J.P., and Fei J. 2017, *Australian snowpack in the NARCLIM ensemble: evaluation, bias correction and future projections*, *Climate Dynamics* 51(11), July 2018.

Using climate change projections in water modelling

Climate change projections are being used in several ways to test the effectiveness and resilience of options proposed in the regional water strategies and to inform other water management reforms and decisions. These are summarised below and further details are provided in the Regional Water Strategies Guide and on the department's website at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/climate-data-and-modelling

NARClIM 1.0

The NSW and ACT Governments' NARClIM 1.0 (climate change) datasets⁵¹ include a range of different future climate scenarios. The NARClIM 1.0 projections were generated from four global climate models, which were downscaled by three regional climate models to provide a total of 12 models. The NARClIM 1.0 projections have been used to develop regional climate snapshots and to develop our new regional water strategies' climate change datasets. The snapshots and the new climate change datasets for the regional water strategies are not directly comparable due to the use of different models, assumptions and spatial resolution, and they have been developed for different purposes.

Regional climate change snapshots

In 2014, the NSW Government used NARClIM 1.0 projections to develop regional climate change snapshots, including snapshots for the Murray, Murrumbidgee and South East and Tablelands regions.⁵² For these snapshots, the 12 models were run using a single, representative emissions scenario defined by the Intergovernmental Panel on Climate Change. The 12 models were run for three time periods: a baseline period (1990 to 2009), a near future (2020 to 2039) and a far future (2060 to 2079). The snapshots present climate projections from all 12 models, spanning the range of likely future changes in climate.

Regional water strategies—climate change datasets

To assess future climate risk, we are using the stochastic datasets representing natural climate variability of rainfall and evapotranspiration, adjusted using monthly factors derived from NARClIM 1.0 modelled results. We have selected the most conservative result from NARClIM 1.0, using the global climate model scenario that represents the greatest reduction in average monthly rainfall.⁵³ While the results of the other scenarios in the current version of NARClIM are arguably equally appropriate and probable, we intend to stress test the water system and understand the worst-case climate scenario for strategic water planning.

51. The NSW and ACT Regional Climate Modelling (NARClIM) Project is a partnership between the ACT and NSW Governments to provide high-resolution climate projections for southeast Australia, including the ACT.
52. Department of Planning and Environment, *Climate projections for your region*, climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region
53. This is the global climate model result that represents the greatest reduction in the mean of the three regional climate models' monthly rainfall for the 2060-2079 period compared to the 1990-2009 period.

Future climate work for the regional strategies

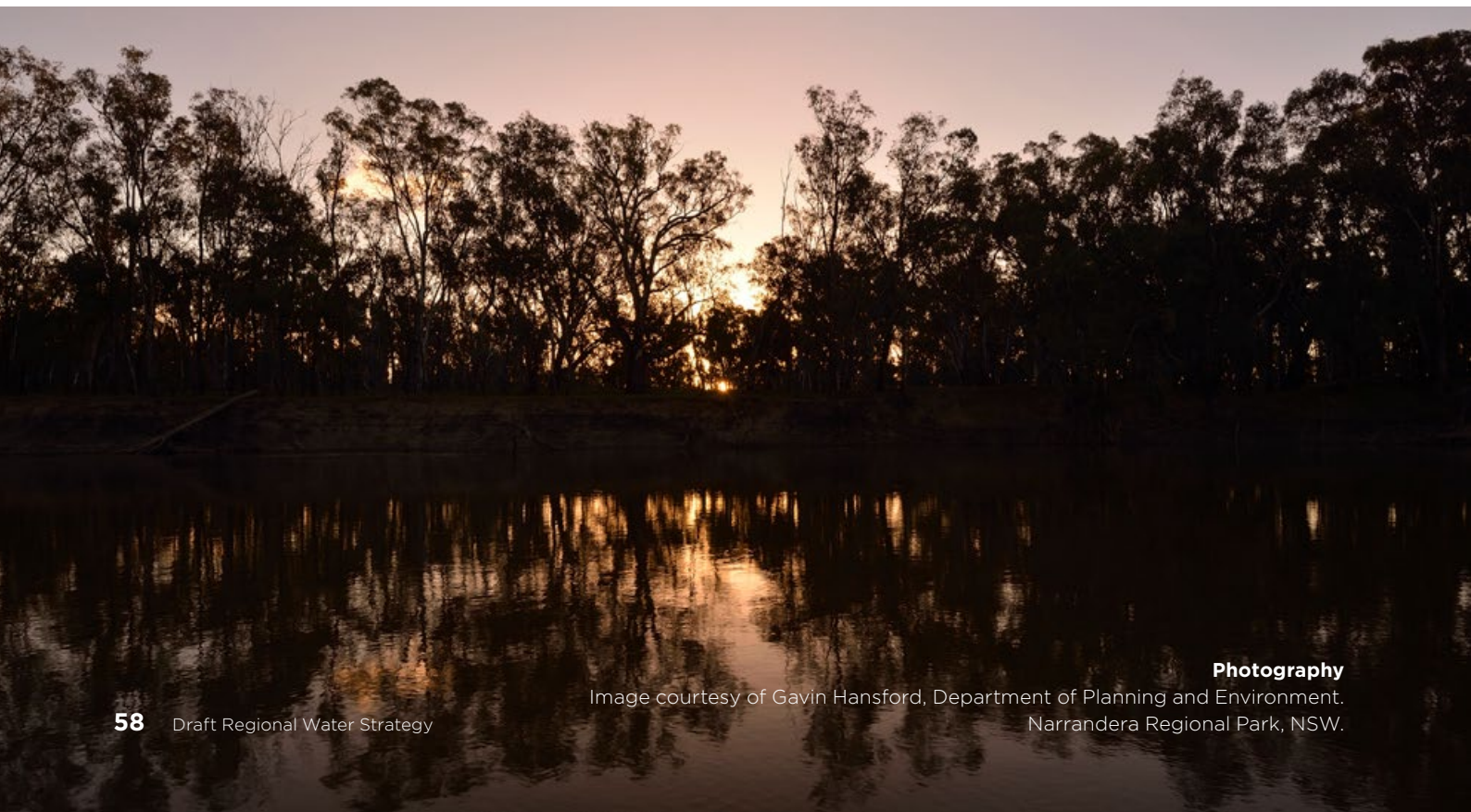
A pilot study is being progressed by Adelaide University to inform the generation of new climate datasets for the Murrumbidgee and Murray regional water strategies.⁵⁴ The aim of the pilot study is to determine whether changes in climate in recent decades affect the estimates of present-day climate risk compared with climate risk based on the whole observed historical record. To date, the study has demonstrated that observed rainfall and temperature records in the southern Basin experienced statistically significant change over time. Trends of decreasing autumn and early winter rainfall of 10–20% in southeast Australia since the mid-1990s, and an accompanying decrease in the number of wet days, were at least partly attributable to climate change.

New climate datasets incorporating these results will improve the representation of natural climate variability and climatic trends, helping us to better assess current and future drought risk.

Updating to NARClIM 1.5

The NARClIM Project completed NARClIM 1.5 datasets in 2020, delivering updated and expanded projections that use more recent global climate models and two emission scenarios to provide projections out to 2100. These improvements will further advance our understanding of plausible future climate conditions and inform future regional water strategies.

54. Devanand, A., Leonard, M., & Westra, S. 2020, *Implications of Non-Stationarity for Stochastic Time Series Generation in the Southern Basins*, Pilot Study undertaken by Adelaide University.



2.2 The landscape and its water

The landscape of the Murrumbidgee region is diverse and ranges from mountainous terrain in the east to open plains in the west. The region's river system—including the large number of unregulated rivers and creeks and extensive groundwater resources—supports towns and communities, industries, the environment, and cultural heritage assets. However, managing such an extensive and long river system and vast groundwater sources is challenging. A variable and changing climate, existing constraints and competing demands for surface water and groundwater will also add further water-related risks and challenges to the region.

2.2.1 Water resources in the region

The region is supported by multiple sources of water (shown in Figure 14 and Figure 17):

- **unregulated rivers and creeks**⁵⁵ including the upper Murrumbidgee, Numeralla, Goobarragandra, Goodradigbee, Yass, Bredbo and Molonglo rivers, and Gilmore, Tarcutta, Jugiong, Houlaghans and Mirrool creeks
- **major regulated rivers** including the Murrumbidgee River and the Tumut River, as well as the Yanco Creek system and Lowbidgee.

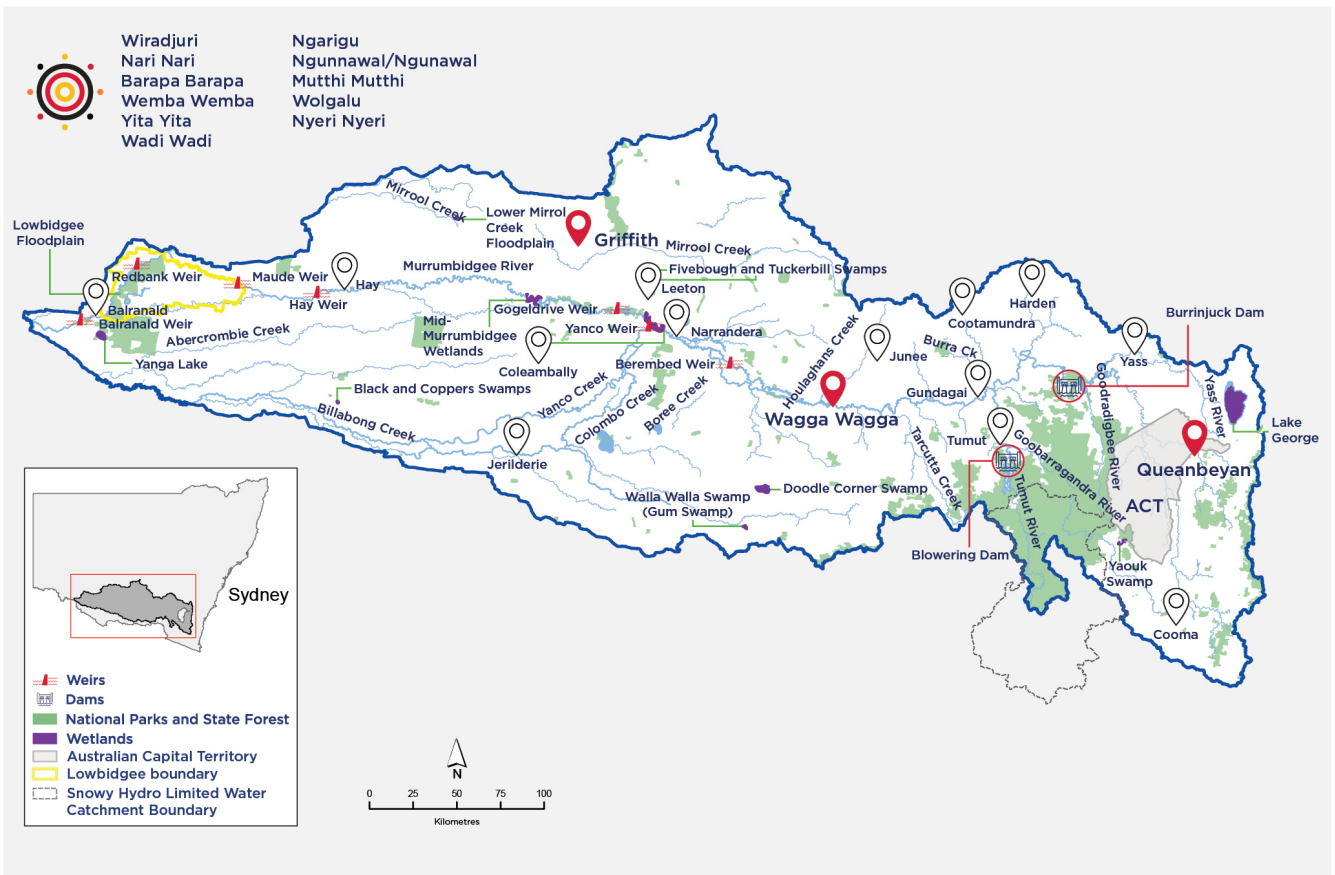
- **groundwater sources** including the Bungendore, Mid-Murrumbidgee Alluvium (comprising Gundagai, Kyeamba, Wagga Wagga and Mid-Murrumbidgee Zone 3), Lower Murrumbidgee Shallow and Deep, Lachlan Fold Belt MDB, Young Granite, Yass Catchment and Billabong Creek Alluvium groundwater sources⁵⁶
- **reuse and recycled water** as used by several councils in the region for non-potable uses.

The Murrumbidgee region has large regional water supply distribution networks, managed by Riverina Water and Goldenfields Water and an extensive network of irrigation channels in and around Coleambally and Griffith.

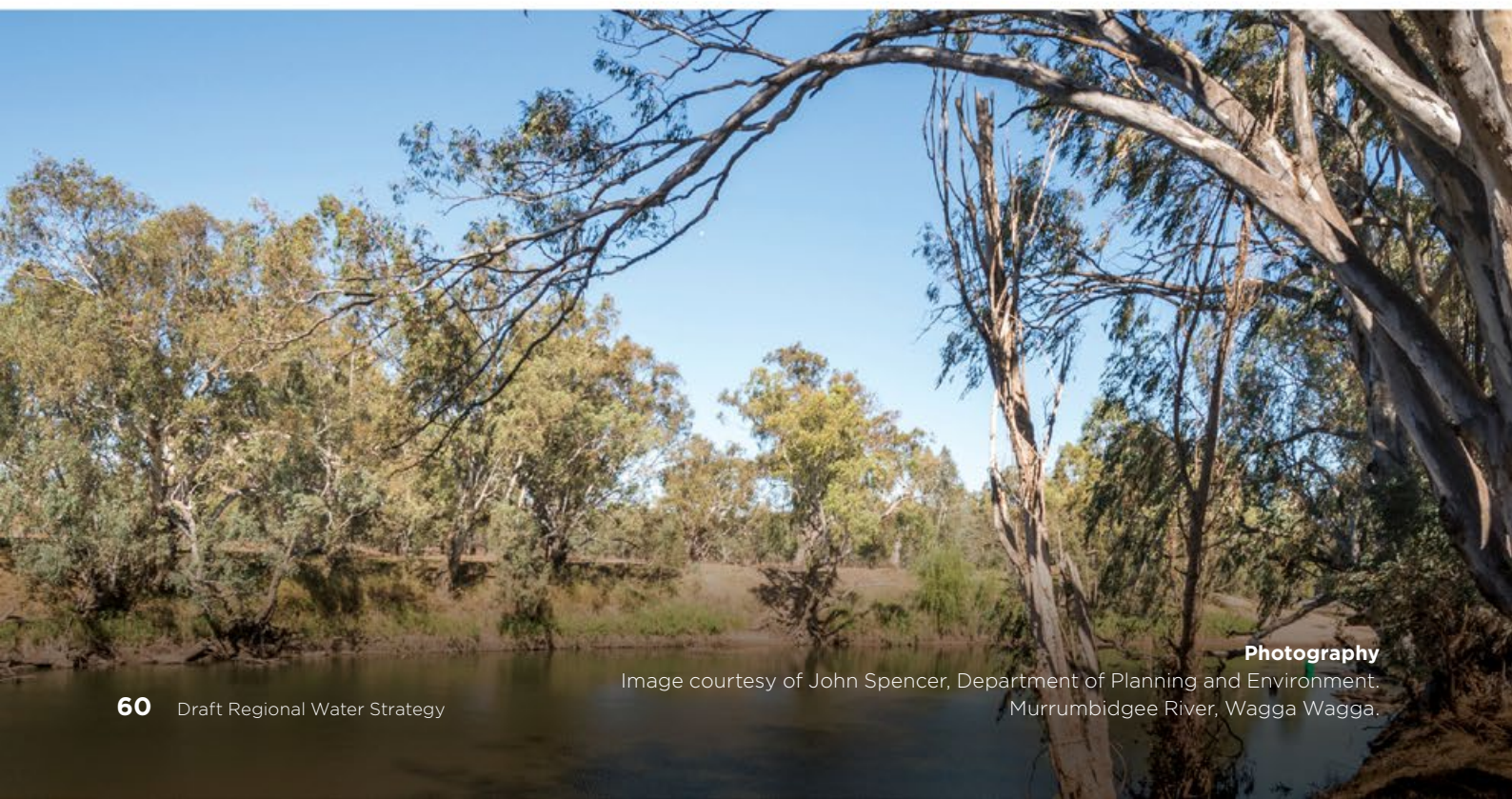
55. An unregulated river or stream is not controlled by releases from a dam or through the use of weirs or gated structures. Water users are reliant on climatic conditions and rainfall.

56. The Billabong Creek Alluvium is hydraulically connected with the unregulated section of the Billabong Creek surface water source in the Murrumbidgee region. However, due to its connectivity with the Lower Murray Alluvium it is part of the Murray region groundwater sources and is included in the Water Sharing Plan for the Murray Alluvial Groundwater Sources 2019.

Figure 14. The Murrumbidgee region: key surface water resources and infrastructure⁵⁷



57. Map excludes storages operated by Snowy Hydro Limited and Icon Water—refer to subsequent sections on Snowy and ACT interlinkages for details.



Photography

Image courtesy of John Spencer, Department of Planning and Environment, Murrumbidgee River, Wagga Wagga.

Unregulated rivers and creeks

There are 43 unregulated surface water sources within the region. Upstream of Burrinjuck Dam, the main unregulated water sources are the upper Murrumbidgee River and the Goodradigbee, Yass, Bredbo, Numeralla and Molonglo rivers.

Based on observed data, the regulated Murrumbidgee River receives on average 750,000 ML per annum from tributaries that join the river downstream of Blowering and Burrinjuck dams. This accounts for around 21% of the total average annual system inflows.⁵⁸ In the area between the region's major dams and Wagga Wagga, several unregulated tributaries flow into the Murrumbidgee River, including the Goobarragandra River, the Adjungbilly, Jugiong, Muttama, Adelong, Tarcutta and Kyeamba creeks. In addition, there are numerous ungauged tributaries.

Below Wagga Wagga there are no significant tributary inflows to the regulated river, with the exception of Houlaghans Creek. The river is influenced by Beavers Creek and Old Man Creek anabranch, which takes off downstream of Wagga Wagga and re-joins the regulated Murrumbidgee River between Berembed Weir and Narrandera.

The region's unregulated water sources are vital for town water supplies, industries and the environment. Cooma, for example, relies solely on unregulated water supply. Cooma accesses town water from a weir pool on the upper Murrumbidgee River, which is prone to water quality issues after storms.

Gilmore Creek and its tributaries provide town water supply for Batlow and water for surrounding orchards. Low flows can result in water restrictions in Batlow and temporary access limitations for other users. The ACT and the towns of Yass and Queanbeyan⁵⁹—where significant growth is expected—also rely heavily on unregulated water sources.⁶⁰

58. Long-term annual inflows—Burrinjuck Dam 1,234,442 ML/year and Blowering Dam 1,633,739 ML/year.

www.watersnsw.com.au/__data/assets/pdf_file/0019/151435/Murrumbidgee-Valley-Annual-Operations-Plan-2019-20.pdf

59. Water supply for the town of Queanbeyan is provided from the ACT water supply scheme by Icon Water

60. Australian Bureau of Statistics, *Quickstats 2016*, www.abs.gov.au/websitedbs/D3310114.nsf/Home/2016%20QuickStats

Snowy Scheme Interlinkages

The Snowy Scheme is an integrated water and hydro-electric power utility located in Australia's Southern Alps, operated and maintained by Snowy Hydro Limited. Completed in 1974, it was designed to collect, store and divert water from east of the Dividing Range to the western river catchments of the Murray and Murrumbidgee rivers for irrigation and industry. However, it is also essential for generation of hydroelectricity, providing around 32% of all renewable energy that is available to the eastern mainland grid of Australia.⁶¹

The Snowy Scheme has a highly variable annual inflow, with average spring runoff and snowmelt contributing around 50% of total scheme inflows.⁶² The total active storage capacity of 5,300 GL enables the Scheme to capture water during wet years, store this water and release it during dry years.

The Snowy Scheme comprises of two major developments: the northern Snowy-Tumut Development and the southern Snowy-Murray Development.

The Snowy Water Licence sets the Scheme's obligations to make annual and environmental releases to the Murrumbidgee, Snowy and Murray rivers:

- required annual releases of a nominal 1,026 GL/year to the Murrumbidgee River via Blowering Dam
- required annual releases of a nominal 1,062 GL/year to the Murray River via Hume Dam
- base passing flows that target release of annual volumes of 9 GL to the Snowy River

- further environmental releases into the Murrumbidgee River catchment
- environmental releases to the Snowy River, Geehi River and the Murray River.

Required annual releases from the Snowy Scheme are re-regulated for extractive and environmental uses by the Murray-Darling Basin Authority in the Murray River and by WaterNSW in the Murrumbidgee River through releases from Blowering Dam.

The most recent review of the Snowy Water Licence⁶³ made a range of recommendations, including some amendments to the licence and further investigating options to better manage environmental flows and improve current water release rules. The Murrumbidgee and Murray regional water strategies will be able to integrate the review's work with other options identified in the strategies. Several provisions in the Snowy Water Licence have rules with hydrologic or operational links to the upper Murrumbidgee, the regulated Murrumbidgee and Murray rivers. For the regional water strategies, this means that hydrologic models for both the Murray and Murrumbidgee regions need to be integrated with the Snowy Scheme hydrologic model.

A pumped hydro expansion of the Snowy Scheme—Snowy 2.0—is currently under development, with expected completion of the power station by 2026. Snowy 2.0 intends to link the existing Tantangara and Talbingo reservoirs via 27 km of new tunnels, along with a new 2,000 MW power station.⁶⁴

61. Snowy Hydro Limited, *The Snowy Scheme*, www.snowyhydro.com.au/our-energy/hydro/the-scheme/

62. Snowy Hydro Limited, *Generation Water*, www.snowyhydro.com.au/generation/water/

63. Department of Industry 2018, *Ten-year review of the Snowy water licence, Final report*.

www.industry.nsw.gov.au/__data/assets/pdf_file/0003/209109/ten-year-review-of-the-snowy-water-licence-final-report.pdf

64. Snowy Hydro Limited, *About*, www.snowyhydro.com.au/snowy-20/about

Figure 15. The Snowy Scheme



Source: www.snowyhydro.com.au/our-energy/hydro/the-scheme/

NSW and ACT inter-jurisdictional water management

While the ACT is a separate jurisdiction, its water supply relies on unregulated water sources within both the ACT and NSW, including the Cotter, Queanbeyan and upper Murrumbidgee rivers.

Icon Water⁶⁵ operates the ACT's sewerage services and water supply scheme. The ACT water network includes four dams, the ACT-owned Corin, Cotter and Bendora dams and the Australian Government-owned Googong Dam, with a total storage of around 278 GL. In addition, Icon Water can extract water from the upper Murrumbidgee River near the Cotter pumping station and via the recently completed Murrumbidgee to Googong pipeline⁶⁶ during drought periods. The ACT water network supplies bulk water to Queanbeyan and the new Googong township in NSW. The ACT, NSW and Australian governments have entered into an Agreement to ensure integrated water supply to the ACT/NSW cross-border regions.

Despite the storage capacity and implementing permanent water conservation measures since the Millennium Drought, the ACT and Queanbeyan could have faced additional water restrictions by the end of 2020 had dry conditions continued.⁶⁷ The ACT also provided emergency water carting to Braidwood in early 2020 when extremely low flows prevented pumping from the Shoalhaven River, prompting a rethink of Braidwood's water security. The ACT combined dam storage levels increased from 55% to 99% between July and November 2020, highlighting how rapidly conditions can change between drought and potential floods in the upper Murrumbidgee.

The ACT and the surrounding region expect to see significant growth over the next decade, including in Googong, South Jerrabomberra and Parkwood. The proposed location of these developments on the border between the ACT and NSW create complexity from a planning, administrative and water supply perspective which will require ongoing inter-jurisdictional collaboration.

65. Icon Water is an unlisted public company owned by the ACT Government

66. Murrumbidgee to Googong Pipeline diverts water from the Murrumbidgee River at Angle Crossing in the ACT into Googong Dam via Burra Creek in NSW. It was commissioned in 2012 to provide additional water supply to the ACT during drought conditions similar to the Millennium Drought. See www.iconwater.com.au/Water-education/Water-and-sewerage-system/Dams/Murrumbidgee-to-Googong-Pipeline.aspx

67. Bladen, L. 2020 15 January, Bushfires and dry conditions have forced Braidwood, Bungendore, Cooma and Yass to implement or strengthen water restrictions. *The Canberra Times*: www.canberratimes.com.au/story/6571241/surrounding-towns-implement-water-restrictions-act-not-yet/

Major regulated rivers

The Murrumbidgee River is the third longest river in Australia.⁶⁸ On average, it takes around one month for water to flow down the Murrumbidgee River (from Burrinjuck Dam) to the confluence with the Murray River downstream of Balranald.

The Tumut River is a key tributary of the Murrumbidgee River and originates in the Snowy Mountains. Along its 182 km length, it is joined by 12 tributaries and meets the Murrumbidgee River near Gundagai. Approximately 70 km of the Tumut River is regulated—from Blowering Dam to the junction with the Murrumbidgee River.

The Murrumbidgee River system has five major dams—Burrinjuck, Blowering, Talbingo, Tantangara and Googong⁶⁹ seven major weirs between Wagga Wagga and Balranald—Berembed, Yanco, Gogeldrie, Hay, Maude, Redbank and Balranald, and strategically located regulators along the length of the river. The Berembed weir and Bundidgerry Creek regulator divert water to the Murrumbidgee Irrigation Area, while the Gogeldrie Weir just upstream of Darlington Point diverts water to the Coleambally and Murrumbidgee Irrigation areas. The structures also regulate flows into numerous effluent streams, including Yanco Creek and Billabong Creek, for water supply and environmental water in the mid-Murrumbidgee wetlands and lower Murrumbidgee floodplain.

Water supply for the Murrumbidgee regulated system comes from two main storages, operated by WaterNSW, and downstream tributaries:

- Burrinjuck Dam on the Murrumbidgee River has a capacity of 1,026 GL.
- Blowering Dam on the Tumut River has a capacity of 1,628 GL.
- Downstream tributaries, including Goobarragandra River and Jugiong, Muttama, Adelong, Tarcutta, Kyeamba and Billabong creeks, contribute on average around 21% of inflows (750 GL).

Other important off-river, re-regulating storages include Barren Box Swamp and Tombullen storage, which is used to capture unregulated tributary inflow and rainfall rejection⁷⁰ flows.

Flows and river heights in the Murrumbidgee River are influenced by rules in the regulated water sharing plan, water user demand (including for environmental uses) and seasonal conditions. There are several challenges in operating and managing the river and balancing the water needs of many different users.

68. Murray-Darling Basin Authority 2019, *Murrumbidgee*, www.mdba.gov.au/discover-basin/catchments/murrumbidgee

69. Talbingo (920,550 ML) and Tantangara (254,080 ML) dams are part of the Snowy Scheme, operated by Snowy Hydro Limited. Googong Dam (125,000 ML), located in NSW, provides water to the ACT and is managed by Icon Water.

70. Rainfall rejections occur when an water licence holder's orders water and operators release these orders from the dam, but it rains in the period between the dam release and the water reaching the irrigator's offtake. The rainfall may reduce the water licence holder's need for water, and they may choose not to take the full amount of water they ordered. This dam release water not taken up by the water licence holders becomes surplus flow in the river.

- **Physical and operational constraints**—the Murrumbidgee River has several physical and operational constraints that limit the volumes of water that can be delivered. These include the Mundarlo Bridge between Gundagai and Wagga Wagga,⁷¹ the channel capacity of the Tumut River near Tumut township,⁷² the Yanco weir,⁷³ and the channel capacity of the Murrumbidgee River near Balranald. In particular, the Tumut River capacity constraint⁷⁴ limits the maximum release from Blowering Dam, placing greater reliance on Burrinjuck Dam to meet peak (summer) demands downstream. This can result in more rapid emptying of Burrinjuck Dam, leading to an imbalance between the storages and the risk of supply shortfalls during extended droughts. In comparison, when Burrinjuck and/or Blowering dams are near full, these constraints can also limit the ability to make releases to provide the required airspace and attenuate floods.⁷⁵
- **Integrated management of the region's two main storages**—system demands are met from Blowering and Burrinjuck dams in proportions that balance the chances of emptying or spilling both storages in the forecast period. However, the very different inflows, storage patterns and release constraints of these dams presents challenges for river operators (Figure 16).
 - Burrinjuck Dam captures the variable runoff from the large upper-Murrumbidgee catchment. Water levels in the storage can frequently be lower than Blowering Dam and take longer to recover. More variable inflow also means that Burrinjuck Dam generally spills more frequently
 - Blowering Dam re-regulates water released from the Snowy Scheme. It receives 32% higher average annual inflows compared with Burrinjuck Dam, mainly due to the required annual releases from the Snowy Scheme, which are adjusted during extreme events.⁷⁶ Spills from Blowering Dam are rare. However, releases are made in most years to maintain required airspace in the dam.⁷⁷

71. A channel capacity constraint of 32,000 ML/day applies in the Murrumbidgee River near Gundagai to avoid overtopping the Mundarlo bridge and inundating surrounding properties. This constraint is being investigated under one of the SDLAM supply measures projects.

72. The Murrumbidgee regulated river Water Sharing Plan limits managed releases from Blowering Dam to 9,000 ML/day to lessen the effect of inundation on low-lying areas and erosion along the Tumut River. In the Tumut River, at Tumut township, managed flows are limited to 9,300 ML/day, so when tributary inflows from the Goobarragandra River exceed 300 ML/day, releases from Blowering Dam are reduced further.

73. The current Yanco weir and regulator on the Murrumbidgee River limits the ability to direct high flows to the mid-Murrumbidgee wetlands. This constraint is being investigated under one of the SDLAM supply measures projects.

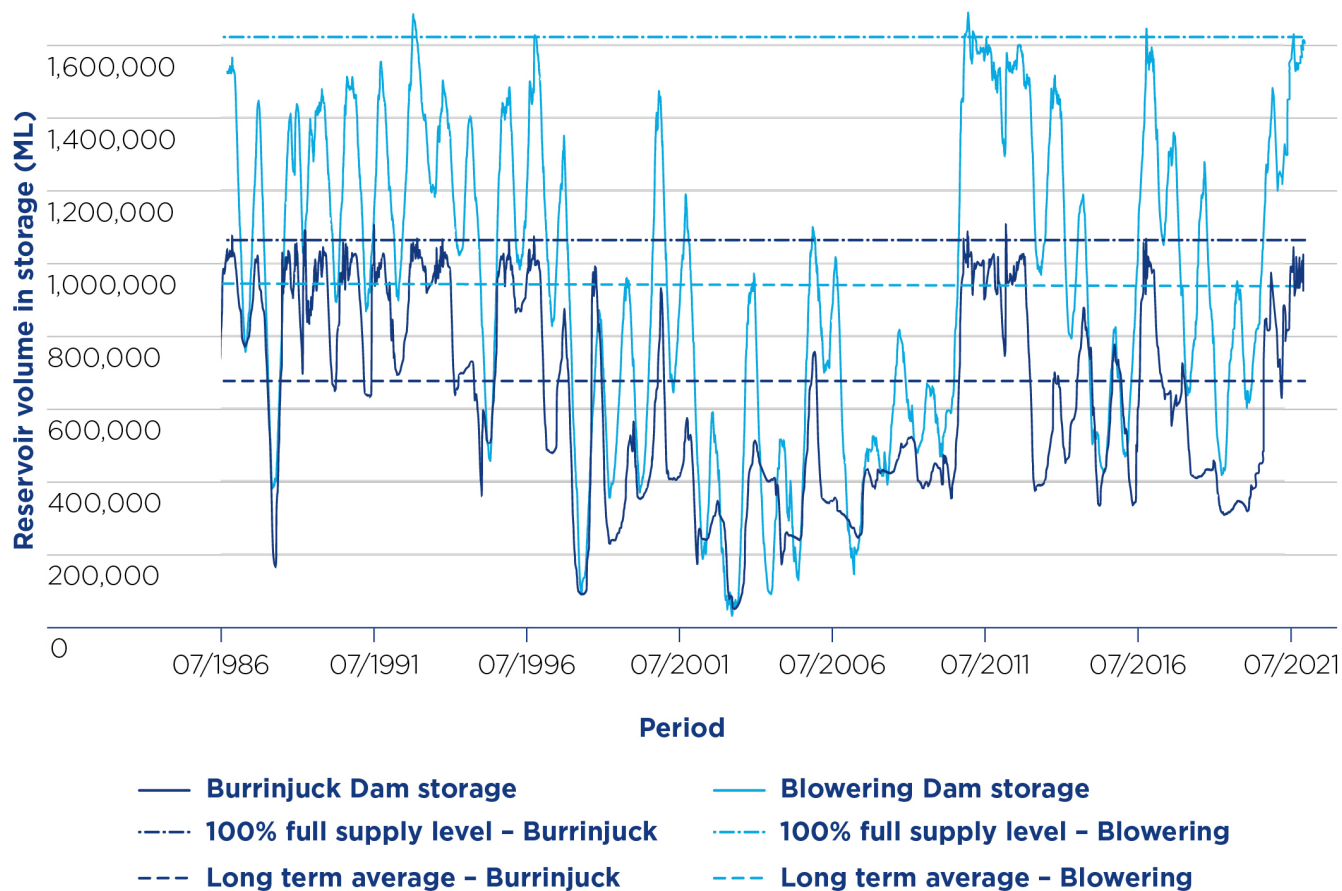
74. Capacity constraints in the Tumut River downstream of Blowering Dam, limit releases to 9,000 ML/day or less to limit flow at Tumut to 9,300 ML/day and avoid flooding and minimise bank erosion.

75. Channel constraints in the Murrumbidgee River at Gundagai, and Tumut River at Tumut limited releases from near full dams prior to extreme wet weather events in December 2010 and March 2012.

76. Under the Snowy Water Licence, during extended dry periods when the Snowy Scheme inflow is worse than the design dry inflow sequence (1936 to 1946), the required annual release is reduced by a volume called the dry inflow sequence volume.

77. Under the provisions of the Blowering Airspace Deed, Blowering Dam is required to maintain up to 190 GL of airspace for emergency power generation by Snowy Hydro Limited, in addition to airspace for flood management purposes.

Figure 16. Storage volume in Burrinjuck and Blowering dams from 1986 to 2021



- Conveyance, losses and travel times**—these can account for more than 30% of the available water during dry periods⁷⁸ however, these ‘losses’ are important for groundwater recharge. Water delivery to the end of the Murrumbidgee and Yanco systems takes around 20 and 28 days respectively.⁷⁹ Delivering water for critical human needs and other water users along the entire length of the Murrumbidgee River will remain a challenge during dry periods.⁸⁰
- Environmental watering**—associated with the physical and operational constraints described above, meeting environmental watering requirements can also be challenging especially when environmental watering requirements coincide with increased water demands from other users during peak spring and summer months.

78. WaterNSW 2019, *Murrumbidgee River Operations Plan*. Losses is the volume required to run the river to meet demands for the water year. This includes storage evaporation, transmission losses and operational loss. Conveyance is the water used by Irrigation Corporations, under access licences, to facilitate delivery of water through their channel systems. Allocation to this category is prescribed in the water sharing plans and is a function of high and general security allocations.

79. Sinclair Knight Merz 2011, *Environmental Water Delivery: Murrumbidgee Valley, Prepared for Commonwealth Environmental Water*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

80. Calculations for conveyance is done at all times but during dry periods, the proportion of water required for conveyance increases significantly and becomes more important as there is limited water available.

Groundwater sources

The Murrumbidgee groundwater sources are extensively used and are an important water source for the region's towns, industries and the environment (Figure 17). These groundwater sources include:

- Bungendore Alluvial Groundwater Source (referred to as Lake George Alluvium in the Basin Plan) supplies the town of Bungendore, stock and domestic uses, and irrigation
- Mid-Murrumbidgee Alluvium—comprising the Gundagai, Kyeamba, Wagga Wagga and Mid-Murrumbidgee Zone 3 Alluvial Groundwater Sources—is the main water source for two regional town water supply schemes operated by Riverina Water and Goldenfields Water, supplying Wagga Wagga and surrounding towns, and Narrandera
- the Lower Murrumbidgee Shallow Groundwater Source—mainly used for stock and domestic supply
- the Lower Murrumbidgee Deep Groundwater Source—mainly used for irrigation, as well as town water supply for Darlington Point and Coleambally
- Lachlan Fold Belt MDB Groundwater Source provides town water supply to Bredbo, Murrumbateman and Woomargama and provides a secondary town water supply to several towns including Tumut and Humula
- Young Granite Groundwater Source supplies stock and domestic bores and irrigation
- Yass Catchment Groundwater Source supplies town water in the Yass Valley and stock and domestic uses
- Billabong Creek Alluvium⁸¹ provides town water supply for Holbrook, Culcairn and Walbundrie, and also supplies water for irrigation.

81. Billabong Creek Alluvium is included in the Water Sharing Plan for the Murray Alluvial Groundwater Sources 2020 and the Murray Regional Water Strategy due to its connectivity with the Lower Murray Alluvium. However, it underlies the Murrumbidgee catchment, is a source for water users in the Murrumbidgee, and is recharged from the Billabong Creek surface water source.



Photography

Image courtesy of Destination NSW.
Cattle, Murrumbidgee Shire.

Figure 17. Map of groundwater sources in the Murrumbidgee region



Alluvial aquifers

The alluvial aquifers are shallow and narrow in the upper catchment in the east, forming the Mid-Murrumbidgee Alluvium groundwater sources. The alluvium becomes wider and deeper as the river travels west and flows across floodplains. The lower Murrumbidgee alluvium is up to 400 m deep. The western edge of the Murrumbidgee alluvium grades into the Western Murray Porous Rock.

Fractured rock aquifers

The groundwater source underlying the alluvial aquifers is the Lachlan Fold Belt MDB Groundwater Source. This is a fractured rock aquifer, meaning the water is stored in fractures (cavities) of the hard rock. The Lachlan Fold

Belt MDB Groundwater Source ranges from fresh to saline. Several towns access the source for primary or secondary town water supply, including Adelong, Murrumbateman, Bowning and Bredbo. Recent approval of a new 1 GL entitlement in the Lachlan Fold Belt MDB Groundwater Source will potentially supplement Bungendore’s existing water supply and support expected future growth. This groundwater source may be considered an alternative or supplementary water source, given the expected growth around the ACT, particularly in Yass and Queanbeyan (see Option 21: Secure and reliable access to groundwater for towns).

Yield from aquifers

The volume of water that can be pumped from a bore in a given time (bore yield) is important for water users. Despite the vast size of the Lachlan Fold Belt MDB Groundwater Source, bore yields can be low because the fractures where the water is stored are often disconnected, restricting the free flow of water through the rock into a bore. In contrast, bore yields in the alluvial aquifers are generally high because the water can easily flow through the spaces in between the unconsolidated sediments. Even within the alluvium, the bore yields can vary due to the presence of clay layers, which can slow down or stop the flow of groundwater. For example, in the Mid-Murrumbidgee Alluvium bore yields range from 40 to 150 L/s, whereas in the Lower Murrumbidgee Deep Groundwater Source, yields can be as high as 350 L/s.

Level of entitlement

Most of the groundwater sources in the Murrumbidgee alluvium are fully allocated, meaning the number of entitlements issued, plus basic landholder rights, equals or exceeds the long-term average annual extraction limit for each source. Exceptions to this are the Lower Murrumbidgee Shallow Groundwater Source,⁸² Billabong Creek Alluvium and the Lachlan Fold Belt MDB Groundwater Source. In addition to being fully allocated, usage in groundwater sources can exceed extraction limits which may trigger reduced allocations in the following water year. Usage in the Wagga Wagga Alluvial Groundwater Source has approached the extraction limit during recent drought years.

Sustainable use of the region's groundwater sources is critical to support existing towns and communities, industries and the environment, and to ensure the region can take full advantage of the NSW Government's investment in the Wagga Wagga Special Activation Precinct. Around 80% of water extracted from the Wagga Wagga Alluvial Groundwater Source is used for town water supply for Wagga Wagga and other towns in the Murrumbidgee and Lachlan regions via Goldenfields Water and Riverina Water supply systems. However, the high concentration of pumping around Wagga Wagga is resulting in declining water levels. A per- and polyfluoroalkyl substances (PFAS) plume in the source poses an additional risk to the safety of future town water supply.

Managing groundwater impacts

The *Water Management Act 2000* and relevant water sharing plans include provisions to manage local impacts by imposing or varying conditions of a water supply approval, limiting the volumes or rates of extraction from existing water supply work approvals, or imposing restrictions on trading groundwater entitlements and allocations.⁸³ The Murrumbidgee Regional Water Strategy provides an opportunity to assess the effectiveness of these provisions for managing groundwater in localised hotspots and identify options to fill any data gaps to ensure sustainable access to groundwater resources by all water users (see Option 12: Provide increased clarity about sustainable groundwater management).

82. The remaining unassigned water in the Lower Murrumbidgee Shallow Groundwater Source is used for shallow water table management in the Murrumbidgee Irrigation area.

83. *Water Management Act 2000*, Sections 102, 107, 331, 342(2) and Access Licence Dealing Principles Order 2004

Managing groundwater salinity

Salinity affects whether groundwater is suitable for drinking water, watering stock, irrigation or whether it needs further treatment. Salinity is a problem for towns and industries because saline water has limited use and treating it, is expensive.

Some groundwater sources in the Murrumbidgee region are affected by salinity, limiting their beneficial use. Some groundwater is naturally saline, and the level of salinity varies between groundwater sources and within the same source. Some activities such as concentrated use, agricultural practices and irrigation can increase salinity risk in certain areas.

The Mid-Murrumbidgee Alluvium is generally fresh, whereas the Lower Murrumbidgee Shallow Groundwater Source varies from fresh near the river to very saline. This salinity is exacerbated by industry water use which can cause the water table to rise and mobilise salts. This salinisation and waterlogging in the shallow alluvium can reduce crop yields, increase soil erosion, elevate salt in rivers and threaten surface and groundwater-dependent ecosystems.

Salinity in the Lower Murrumbidgee Deep Groundwater Source increases from east to west, with high salinity levels west of Hay. There is a long-term trend of increasing salinity in the deep aquifer within the irrigation areas east of Hay, attributed to concentrated groundwater extraction from the deep aquifer that induces leakage from the more saline shallow aquifer.⁸⁴

84. Department of Industry 2018, *Water quality management plan—GW9 Murrumbidgee Alluvium water resource plan area*



Photography

Image courtesy of Department of Primary Industries.
Rice Crop, NSW.

Groundwater sources and regional water strategy boundaries

The boundaries for the surface water sharing plans and water resource plans are generally dictated by the major river catchments in each region; however, aquifers can extend beyond the range of these catchments. Several groundwater sources span the Murrumbidgee, Murray and Lachlan regions and are accessed by communities in multiple regions.

- The Lower Murrumbidgee Shallow and Deep Groundwater Sources cover part of the Lachlan region to the north-west, providing stock and domestic supply. It also extends slightly into the Murray region.
- The Billabong Creek Alluvium lies within the Murrumbidgee region, and provides town water supply to Holbrook, Walla Walla and Culcairn.

- The Mid-Murrumbidgee Alluvium (Wagga Wagga Alluvial and Mid-Murrumbidgee Zone 3 Alluvial Groundwater Sources) supplies several towns within the Murrumbidgee and Lachlan regions via the Goldenfields Water water supply scheme. Towns connected to the scheme within the Lachlan region include Ungarie, West Wyalong, Barmedman, Temora, Aria Park and Young.
- The lower Murray alluvium span a portion of the south-western Murrumbidgee catchment, south of Billabong Creek, between Moulamein and Jerilderie.
- The Lachlan Fold Belt underlies and provides water across the Murrumbidgee, Murray and Lachlan regions, and parts of the south coast.

This highlights the need for the Murrumbidgee and adjacent regions to work together to ensure sustainable management of these shared groundwater sources.

Groundwater opportunities

NSW has a robust groundwater management framework that has undergone significant reform. However, opportunities may still exist to improve how we manage groundwater resources.

A changing climate, increasing population and economic growth may lead to greater demand for groundwater in the future. The ability of groundwater sources to meet this demand may be limited, as most of the good quality, easily accessible groundwater sources in the Murrumbidgee region are fully committed and highly used.

Managed aquifer recharge may be feasible in the Murrumbidgee region. Managed aquifer recharge is the intentional recharge of water into aquifers (through infiltration or direct injection) for later use or environmental benefit. It could improve the drought resilience of groundwater resources and improve water security, as it offers a water storage solution during wet years and increases groundwater availability during dry periods. It can improve storage efficiency, as it reduces the amount of water lost to evaporation.

Managed aquifer recharge can be an efficient way to manage and store treated wastewater but there are significant technical, economic, policy and regulatory challenges that need to be addressed if managed aquifer recharge is to be considered as a realistic water security solution in NSW. Option 20: Managed aquifer recharge investigations and policy, proposes the development of a policy and regulatory framework to enable the storage and recovery of this water.

Groundwater opportunities in the Murrumbidgee region rely on better understanding the resource, improving industry and local council understanding of groundwater systems and providing greater transparency around how regulators and government will make groundwater management decisions.

Given the ongoing demand on groundwater, enhancing our understanding of the interaction between surface water and groundwater resources in the Murrumbidgee region will help to improve our management of connected water sources. We need to better understand where a change in groundwater use can influence flows to rivers and vice versa.

We also need to understand how a changing climate is impacting the replenishment of groundwater resources. Generally, the larger groundwater resources are resilient and respond more slowly to changes in climate, but this means the impact of present-day activities on groundwater may not be realised for decades. Under a future dry climate change scenario, lower rainfall will likely result in less recharge to groundwater resources. Recharge from rivers is also likely to be reduced if surface flows are lower and there are less floods.

This draft regional water strategy includes options to improve our understanding of groundwater processes (Option 45: Improve the understanding of groundwater sources and processes, risks and impacts) and provide training opportunities on groundwater and the likely impact of climate change on groundwater sources (Option 47: Develop targeted education and capacity building programs).

Options are also proposed to protect ecosystems that depend on groundwater resources (Option 23: Improve protection of groundwater dependent ecosystems) and integrate Aboriginal peoples' knowledge into groundwater decision making.

An extensive groundwater monitoring network exists across regional NSW, with data going back to the 1970s. In the Murrumbidgee region there are over 1,000 monitoring bores, however, many of these bores are old and need maintenance or replacement. We need to ensure ongoing investment in the groundwater monitoring network, so we have the information we need to manage the resource into the future.

Catchments and key watersheds

The way in which rainfall interacts with the region's diverse landscapes varies significantly. When rain falls onto land it can either be absorbed and held in the soil, taken up by plants, evaporated back to the air, infiltrate deeper into the ground, or it can pool on the surface and run off into gullies, creeks and rivers. Factors influencing where the water goes include rainfall intensity and amount, snowfall, temperature, wind, ground slope, soil moisture conditions, soil permeability, vegetation cover and maturity, leaf litter cover and soil surface properties.

Changes to catchment conditions and land use have contributed to runoff and water quality issues in the region. Runoff from cropping and grazing areas, erosion of soil and nutrients from stream banks and discharge from localised saline areas have led to increased turbidity, salinity, sedimentation, nutrient loads and chemical residues. In turn, these impacts can degrade aquatic ecosystem health. Major catchment-scale issues in the Murrumbidgee region are outlined below.

Intense bushfires can reduce the quality and volume of run-off

Shortly after an intense bushfire, loose soil, ash, debris and nutrients often wash into watercourses that can cause short-term but serious impacts such as fish deaths and contamination of town water supplies.⁸⁵ Over periods lasting up to and exceeding a century, there can be significant declines in run-off volumes as forests regrow. The 2019/2020 bushfire season burnt around 5.6 million ha within NSW, including over 450,000 ha across the Snowy Valleys and Snowy Monaro local government areas and led to declines in water quality and conditions for native fish (Section 3.2.2).

The impacts of each fire are different, depending on the location and intensity of the burn, as well as the type of vegetation burnt and other factors. As such, each fire will have a different impact on run-off rates over time.

Furthermore, given a warming climate and an increase in severe fire weather (Section 2.1.2), bushfire risk is expected to worsen over the coming decades.

As such, we need to better manage our key catchments and watersheds to avoid adverse fire regimes and associated water-quantity and water-quality impacts. Option 53: Consider hydrologic processes in bushfire management, seeks to investigate how bushfire management can be strengthened in priority areas by including protection of rainfall run-off processes as a key bushfire management priority.

Improving soil carbon content provides local and downstream benefits

Carbon or organic matter in the soil is a very important factor in how a landscape functions to retain moisture, carry it through drought, and release water to our creeks and rivers. Soil carbon is typically related to the amount of vegetation material both above and below the land surface. When a landscape has experienced poor management, such as grazing or cropping regimes beyond its capacity, vegetation and soil carbon is depleted. Soils that have had their carbon levels depleted do not hold moisture or cycle nutrients well, leading to reduced drought tolerance and reduced productivity for farms. Depleted soils can also create faster rainfall run-off, which results in localised erosion, high sediment loads running through watercourses, poor water quality and reductions in baseflows. This can cause watercourses to flow for shorter time periods and cease to flow more frequently.

As such, we can simultaneously improve the productivity of farmlands, the health of our waterways and the quality of water for downstream water users by improving riparian vegetation and soil carbon levels in our landscapes. Refer to option 26: Develop a river and catchment recovery program for the Murrumbidgee region.

85. ewater.org.au. 2020, Bushfire Impacts on Hydrology. Retrieved from www.ewater.org.au/bushfire-impacts-on-hydrology/

Improving riparian and aquatic condition provides whole-of-catchment benefits

This is a key priority for areas in the mid and upper parts of the catchment, where there has been degradation of vulnerable riparian areas and waterways through uncontrolled stock access; clearing for agriculture or urban development; invasion by pests and feral animals such as rabbits, and weeds such as privet; or overuse from recreational activities.

Clearing riparian vegetation and reducing large woody debris deposits into waterways has led to loss of riffles, channel bed erosion, reduced in-channel water storage, and downstream water quality issues including excessive nutrients leading to algal blooms and high turbidity.

The erosion of soils, bank slumping and high concentration of soil nutrients (nitrogen and phosphorus) in tributary catchments are key drivers for nutrients entering the waterways of the Murrumbidgee region.

High turbidity in the mid-Murrumbidgee⁸⁶ originates from suspended sediment delivery via the tributaries downstream of Burrinjuck Dam, including Tarcutta Creek. The Yanko, Colombo and Billabong creek catchments can also contribute to high turbidity.

Recent actions to improve land management and rehabilitate riparian zones in the Murrumbidgee region include *Riverspace* projects and three pilot projects under the *River Connections Program*: Riverina Highlands, South West Slopes and Lower Billabong Creek.⁸⁷ In addition, Option 26: Develop a river and catchment recovery program for the Murrumbidgee region, seeks to improve riparian and aquatic conditions.

Salinity causes a range of local and downstream impacts on land and water resources

Mobilisation of salt in the landscape can impact land, in-stream water quality and salt load via streams and rivers.

Dryland salinity occurs when rising groundwater mobilises salt in the landscape and redistributes it closer to the soil surface and into waterways. Groundwater levels can rise under dryland farming because of increasing rates of leakage and groundwater recharge; replacing deep-rooted perennial species such as native trees, shrubs and pasture with shallow-rooted, annual species; and incorporating long fallows into a cropping rotation. It can have negative effects on agricultural productivity, infrastructure, vegetation and ecosystem functions. The most significant areas of dryland salinity in the region occur in the Jugiong Creek, Muttama Creek and upper Yass River catchments and to a lesser extent in the upper Billabong Creek catchment. This poses a low risk in the local Jugiong, Muttama and Yass River catchments where grazing is the main land use and there is limited irrigation.

In-stream salinity occurs when salt in the landscape is mobilised as soluble salts into creeks and rivers. High in-stream salinity occurs along Jugiong and Muttama Creeks, mid-Murrumbidgee tributaries including Kyeamba and Hillas creeks, and in irrigation areas along Yanco Creek and in the Murrumbidgee Irrigation area. This in-stream salinity is diluted by water released from Burrinjuck and Blowering dams and poses a medium risk for many plants and animals, drinking water supplies and suitability of water for irrigation.

86. The mid-Murrumbidgee refers to the Murrumbidgee catchment downstream of Burrinjuck and Blowering dams and upstream to Narrandera

87. Information about Riverspace projects is at www.riverspace.com.au. Information about the River Connections grants program is at www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/grants-available/river-connections/refreshing-river-management-to-improve-river-health

Valley-scale salt load export refers to the transport of salt out of the Murrumbidgee. The sub-catchments in the mid-Murrumbidgee yield some of the highest salt loads in NSW. From 2010 to 2012, high flows and salt loads from upland and mid-catchment tributaries resulted in the end-of-valley salt load target for the Murrumbidgee being exceeded.⁸⁸

Urban salinity is a significant land degradation problem around Wagga Wagga. The salt build-up in upper soil layers is caused by rising groundwater due to vegetation clearing and changes in land use. This can damage buildings, infrastructure and surface water quality.

Current measures to address salinity hazards and risks, including the Billabong Creek Salt Interception Scheme, are discussed in Section 2.3.3. Wagga Wagga City Council is implementing monitoring, planning guidelines, public education programs, replanting, and dewatering bores to address the urban salinity problem. The NSW Government is also completing a Hydrogeological Landscapes Project for the upper Murrumbidgee to assess salinity risk above the ACT, and undertaking a Basin Salinity Management Strategy Project in the Jugiong and Muttama catchments to profile salinity risk. This will extend to the Kyeamba and Tarcutta catchments later this year.

Improved land and vegetation management can help mitigate the region's nutrient, turbidity and salinity issues, as proposed by Option 26: Develop a river and catchment recovery program for the Murrumbidgee.

Re-use and recycled wastewater

Two thirds of local water utilities in the Murrumbidgee region produce recycled water for re-use. In 2018/19, around 3,800 ML of the recycled water was supplied for agricultural, industrial and municipal purposes using 20% of the total wastewater collected by the region.

Around 60% of recycled water is produced by the Griffith, Wagga Wagga and Snowy Valleys councils.

Several councils are considering the introduction and expansion of recycled water use including:

- The Googong Integrated Water Cycle Management Strategy Project is providing reticulated water, wastewater and recycled water to a new 800 ha township in the Queanbeyan-Palerang Regional Council area. Developed over the next 20 years, the new township is expected to house around 18,000 people and reduce potable water consumption by around 60%.
- Narrandera Shire Council has developed an effluent re-use scheme under the Strengthening Basin Communities Program. To date, it is being used to deliver raw water for non-potable use, pending the upgrade of sewage treatment processes.
- The Wagga Wagga Special Activation Precinct, including the Bomen Business Park, provides an opportunity to implement sustainable industrial water use. The concurrent development of a new integrated water cycle management strategy by Riverina Water County Council will include an assessment of water source options for the Special Activation Precinct, including the use of recycled water for non-potable use, which would reduce additional demand for potable supply.

The Murrumbidgee Regional Water Strategy provides an opportunity to gauge community views on the use of treated wastewater. See Option 18: Review impediments to water recycling projects and Option 19: Assess potable re-use for towns.

88. The Murrumbidgee end-of valley salt load target is 169,000 t/year under the Basin Salinity Management Strategy 2030.

2.2.2 Impacts of climate variability on water resources

Our new modelling will provide another line of evidence to understand how our observed climate and hydrology compares with historical long-term and worst-case climate change scenarios. It will also highlight potential risks to future water availability in the region. In the interim, climate variability based on observed historical data, modelling over the instrumental period, and trends from new hydrological modelling in other inland regions have been used to infer potential impacts in the Murrumbidgee region.

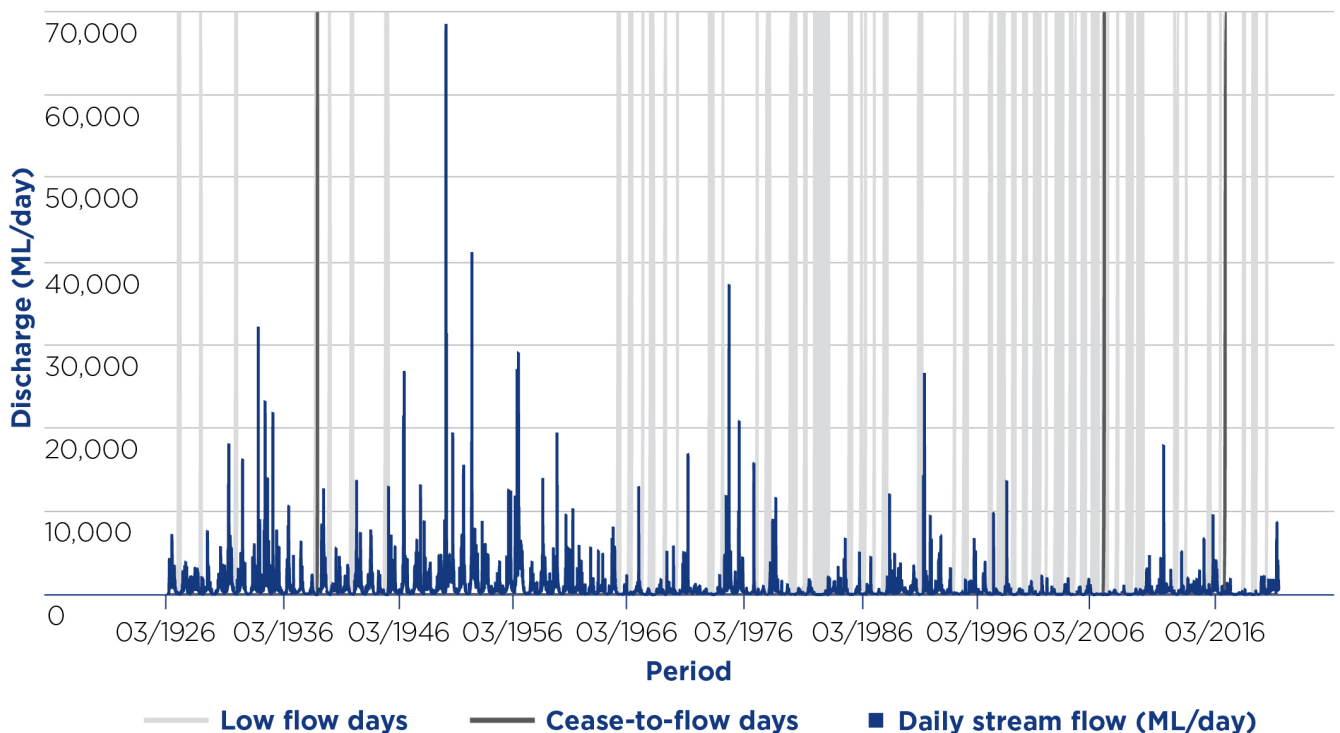
Streamflow variability in the upper Murrumbidgee

Fluctuations in streamflow in the unregulated rivers and creeks of the upper Murrumbidgee are closely linked to the variability of rainfall

and temperature, and this part of the catchment is more susceptible to short intense droughts. This variability in water availability poses risks to water users, particularly those reliant on the unregulated rivers as a sole source of water supply.⁸⁹

Several locations along the upper Murrumbidgee show a trend of declining annual streamflow over the historical record. Since 1960, streamflows in the upper Murrumbidgee experience less frequent large flows and more frequent low flows. At Mittagang Crossing near Cooma, streamflow was below the low flow threshold (95th percentile) for around 25% of the time before 1960, approximately 50% of the time between 1960 and 2000, and around 86% of the time since 2000. There has also been an increase in the occurrence of cease-to-flow conditions (Figure 18).

Figure 18. Observed daily streamflow in upper Murrumbidgee River at Mittagang Crossing



Source: www.waternsw.com.au/waterinsights/real-time-data

89. This includes towns such as Cooma, Batlow, Queanbeyan and Yass.

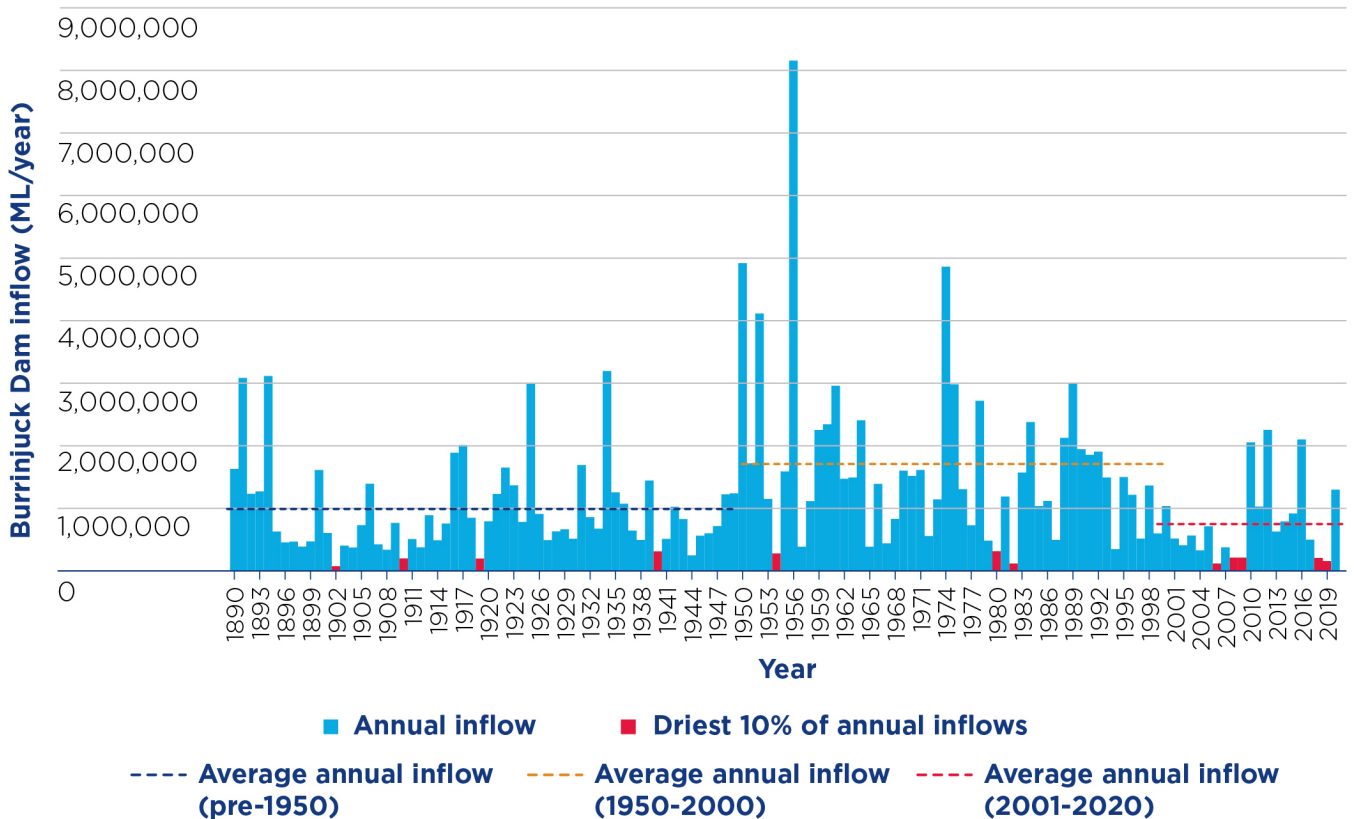
Variability of inflows to Blowering Dam and Burrinjuck Dam

Burrinjuck Dam’s lowest historical 10-year inflow sequence on record occurred during the Millennium Drought. The average annual inflow over the ten years from 2001 and 2010 (463 GL/yr) was around 37% of the long-term average. Subsequent intense rainfall in winter 2010 increased storage from 33% to full capacity and led to spilling within three months, resulting in major flooding along the regulated Murrumbidgee River. The region’s longest, but less severe, back-to-back droughts occurred from 1895 to 1915 (average annual inflow of 593 GL/yr), separated by two single years of moderate inflows (Figure 19 and Table 3).

Following below average rainfall from 2015 to mid-2016, an intense wet period increased Burrinjuck Dam’s storage to full capacity within three months. At the same time, Blowering Dam’s storage increased from 29% to full in seven months. This resulted in moderate to major flooding downstream.

In the 24 months to the end of January 2020, Burrinjuck Dam received the lowest two-year inflow sequence on record (390 GL), due to the absence of the critical winter-spring inflow. From June to November 2020, the change to wet conditions resulted in above average dam inflows. The combined storage in Burrinjuck and Blowering dams increased from 46% to 92% of capacity, altering conditions significantly from prolonged drought to the threat of potential flooding. In July 2021, Burrinjuck Dam spilled.

Figure 19. Modelled average annual inflows to Burrinjuck Dam over the instrumental period based on current conditions⁹⁰



90. Burrinjuck Dam was completed in 1928, with a capacity of 804 GL. Between 1937 and 1956, the dam was raised to its current capacity of 1,026 GL. The Snowy Scheme was completed in 1974. Hydrological modelling undertaken for the regional water strategies adopts current conditions as the baseline, with simulations undertaken for the period of instrumental record. Therefore, the simulation assumes the current Burrinjuck Dam capacity and current Snowy Scheme operations are in place throughout the entire simulation period.

Inflows into Burrinjuck Dam can vary significantly within any given year (Figure 20). Average monthly inflows can vary from 43 GL in February to around 174 GL in July, with a strong bias towards winter and spring inflows in the past. Before the Millennium Drought, there was a pattern of winter inflows in most years with Burrinjuck typically spilling

between September and December. Since 1996, Burrinjuck Dam has only filled and spilled in four years: 2010, 2012, 2016 and 2021. The dry conditions from 2017 to 2020 resulted in dam inflows that were well below average during 2018 and 2019, with no distinct winter or spring inflow.

Figure 20. Burrinjuck Dam catchment runoff in 2018 and 2019 compared to average

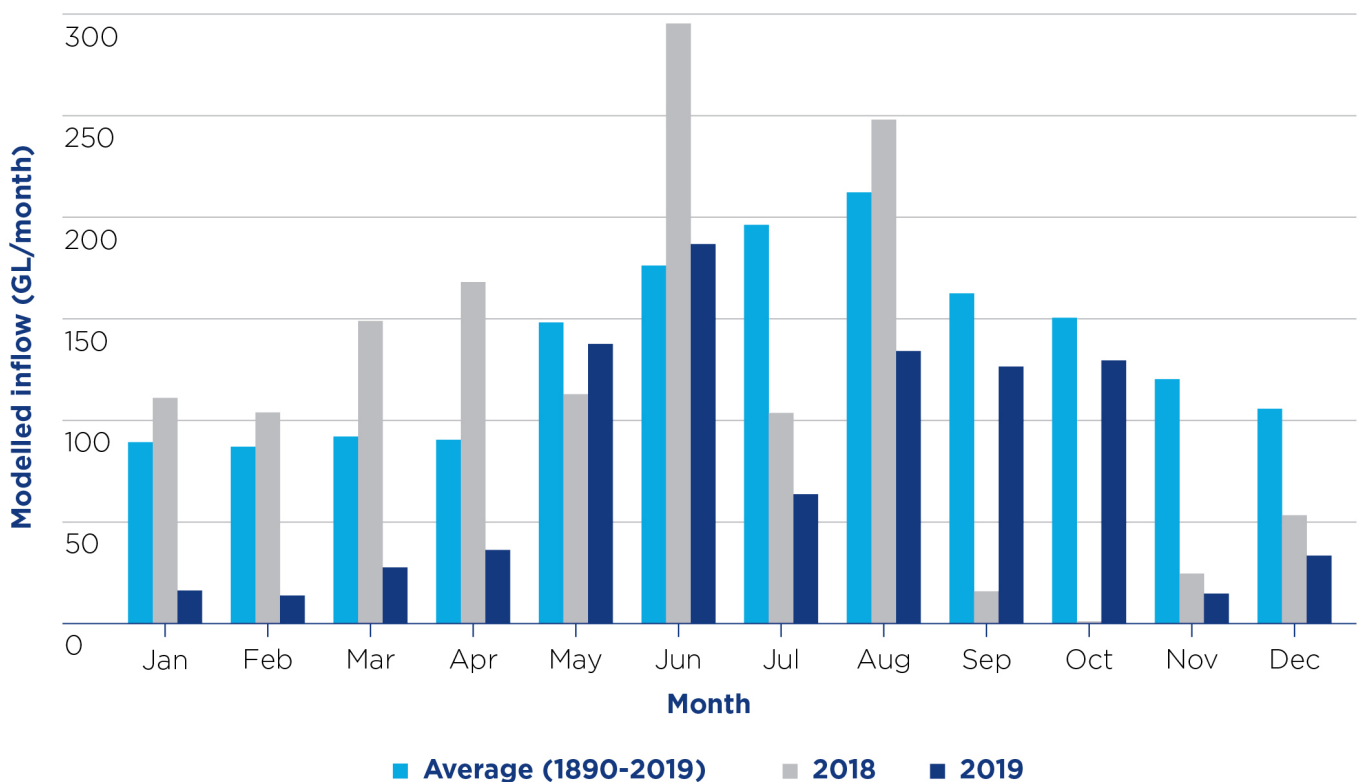


Table 3. Burrinjuck Dam minimum inflow sequences from observed historical records

Burrinjuck Dam minimum inflow sequence	Total inflow volume (GL)	When did it occur in the observed historical record?
24-month	390	2018–2020
36-month	756	July 2006 to June 2009
10-year	4,637	2000–2010
20-year	11,872	1895–1915

Hydrological modelling for the Murrumbidgee region, based on the new climate datasets, is still underway and will contribute to the final Murrumbidgee Regional Water Strategy. Based on the hydrological modelling for other nearby regional water strategy areas (the Lachlan and Macquarie), we can infer that the Murrumbidgee may experience similar results as it is affected by the same key climate drivers. Under the worst-case dry climate change scenario, projections indicate a decline in annual rainfall, a seasonal shift in rainfall pattern with the most significant reduction in winter and spring rainfall, and an increase in evapotranspiration. Modelling for other inland regions indicated that winter dam inflows for these regions could be significantly lower than under observed and long term historical records. It also indicated that dams could sit at lower levels for longer.

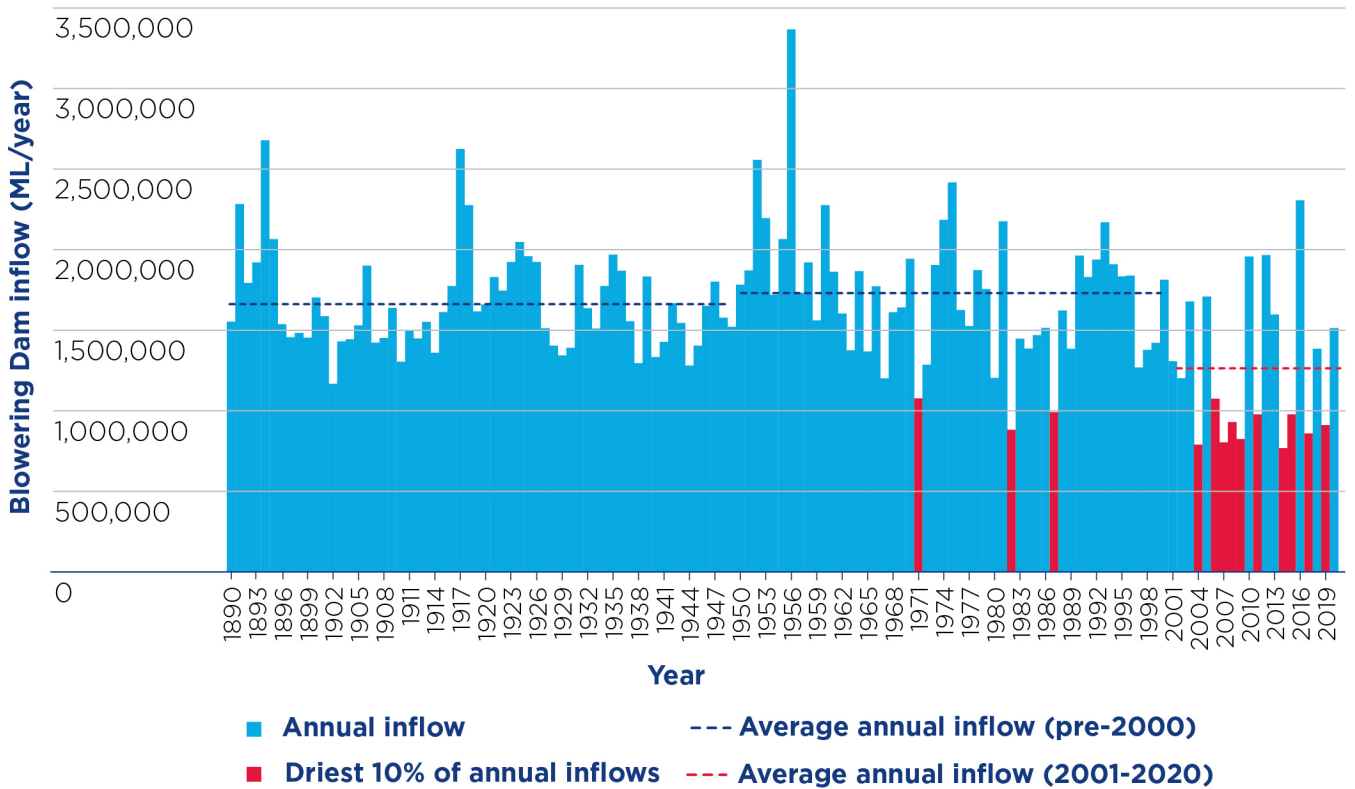
While annual inflows into Burrinjuck Dam are highly variable, inflows to Blowering Dam are more constant due to the required annual release from the Snowy Scheme⁹¹ (Figure 21).

Hydrological modelling of current system conditions over the period of instrumental records show that there has been a significant reduction in Blowering Dam inflows since the start of the Millennium Drought, which is partially due to reduced Snowy Scheme releases under low inflow conditions in the Snowy Water Licence.⁹² Blowering Dam inflow over the last three years (2017 to 2020) has been the second lowest 36-month inflow sequence on record (1,055 GL) and 64% of the long term average annual inflow.

Inflows into Blowering Dam are strongly influenced by adjustments to the required annual release and discretionary timing of releases from the Snowy Scheme. In particular, monthly inflows during 2018 were still high despite the dry conditions due to a pre-release⁹³ and the release of surplus water⁹⁴ to Blowering Dam, which did not occur in 2019 (Figure 22).

91. The required annual release for the Snowy–Tumut development is a nominal volume of 1,026 GL/yr. This volume can be adjusted downwards if the dry inflow sequence volume is triggered or upwards if Snowy Hydro Limited releases above-target water or makes pre-releases.
92. The Snowy Water Licence was issued to Snowy Hydro Limited in 2002 under Part 5 of the *Snowy Corporation Act 1997* (NSW) for a period of 75 years. The Snowy Water Licence is the primary legal document defining how Snowy Hydro is to account for and release water. It defines the rules for releases into the Murray and Murrumbidgee rivers and other montane rivers.
93. Under certain conditions, Snowy Hydro can release up to, and exceeding 200 GL/year in pre-releases. The maximum volume depends on the extent of the dry inflow sequence volumes and the recovery volume.
94. The volume of inflows that occur when Snowy Scheme storages are above the defined target storage is called 'above target storage'. This water is not required to make current and future years' required annual release and can be discharged at the discretion of Snowy Hydro.

Figure 21. Modelled average annual inflows to Blowering Dam over the instrumental period based on current conditions⁹⁵



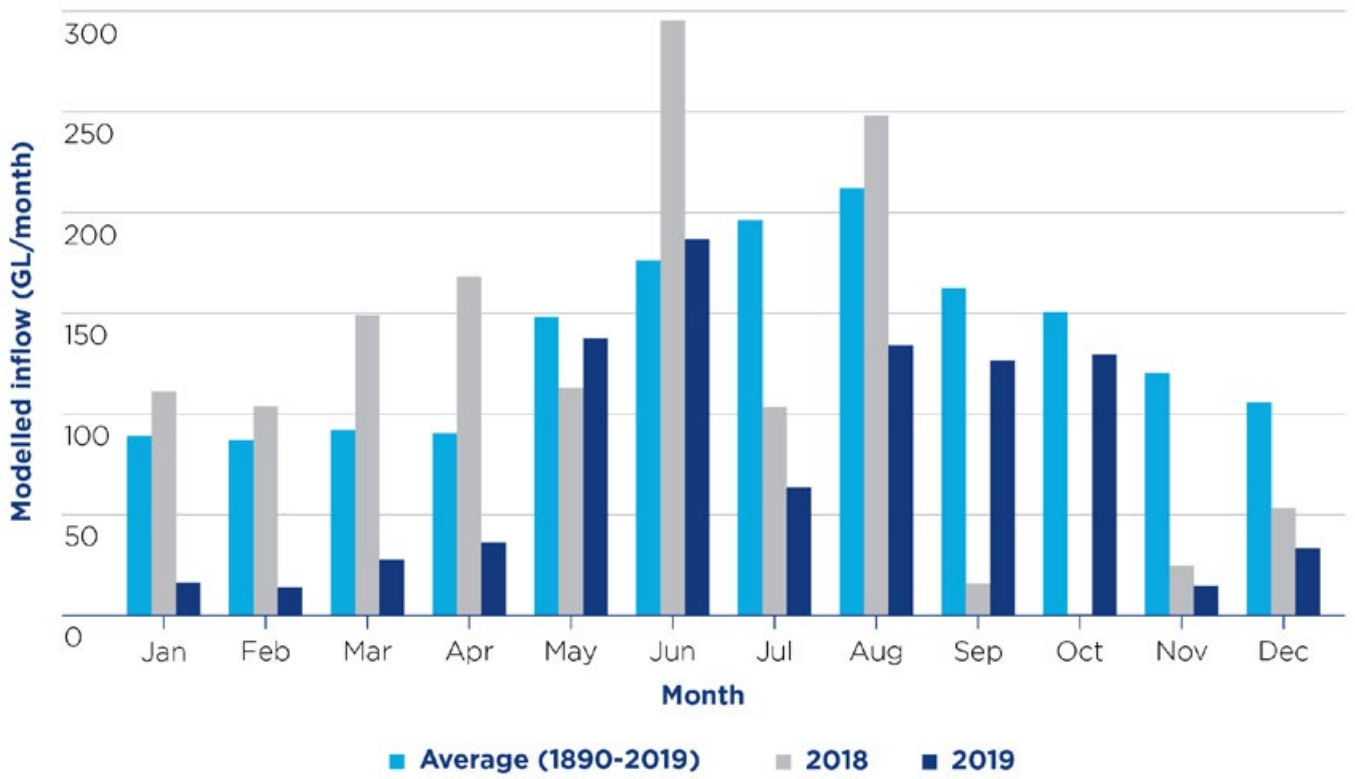
95. Blowering Dam was completed in 1968, with a capacity of 1,628 GL. The Snowy Scheme was completed in 1974. Hydrological modelling was undertaken for the regional water strategies current conditions as the baseline, with simulations undertaken for the period of instrumental record. Therefore, the simulation assumes the current Blowering Dam capacity and the current Snowy Scheme operations are in place throughout the entire simulation period.



Photography

Image courtesy of Destination NSW.
Sunset, Yass River.

Figure 22. Blowering Dam catchment runoff in 2018 and 2019 compared to average



In summary, the new climate data and historical records show that:

- Burrinjuck Dam has had highly variable inflows over the observed historical record. Inflows could be even more variable under a worst-case dry climate change scenario.
- Although Blowering Dam inflow has been less variable over the instrumental climate records, the region’s overall water security could be impacted due to potential significant reductions in low inflows into Blowering Dam under a drier, hotter future climate.
- Water users reliant on the unregulated rivers could be more susceptible to short intense droughts.



A note of caution about modelling

The scenarios that will be modelled will not necessarily eventuate. They are potential scenarios with a level of uncertainty.

This type of modelling is complex and has a number of limitations and uncertainties which need to be taken into account as part of the water planning and decision making processes.

In some instances, this may mean managing risks to our water security by being fully prepared and resilient to all possibilities, rather than relying on firm predictions and hard numbers.

Further information about the new climate risk modelling is provided in the Regional Water Strategy Guide and at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/climate-data-and-modelling

Photography

Image courtesy of Matt Herring.
Wetlands, Yanga National Park.

Floods are a feature of the past, and the future

Flooding is a vital, natural process that supports the region's ecological and agricultural productivity and facilitates longitudinal and lateral connectivity along river systems. Floods form part of the flows required to keep the environment healthy by connecting wetlands and floodplains with the river. Floods distribute nutrient-rich deposits that form the highly productive soils of the region's floodplains. Flood pulses also flush floodplains of any build-up of organic matter, salinity and nutrients that accumulate during the time between floods. They are important reproductive cues for many fish, waterbirds, amphibians and invertebrates, and assist groundwater recharge. These environmental benefits provide financial and economic benefits for some businesses and communities in the valley.

However, floods can also have significant detrimental impacts on people and businesses, damaging infrastructure, creating safety risks and causing financial and economic loss. In addition, floods following long dry periods can impact water quality and heighten the risk of hypoxic blackwater events,⁹⁶ which pose a risk to the environment and aquatic ecosystems, including to threatened species.

The Murrumbidgee region has experienced significant flood events over the past 129 years of observed historical records, notably in 1891, 1900, 1925, 1950, 1974, 2010, 2012 and 2016. Historically, major floods have occurred between July and October, when dam levels are typically already high. Inundation downstream in the catchment can be extensive and last

for several weeks. Due to the magnitude of runoff generated in the catchment, even the large dams in the region can be insufficient to significantly reduce flood peaks at the extreme end. There were several large floods prior to both gauging records and dam construction. These include the 1853 event, which is considered the largest historical flood for many towns along the river.⁹⁷

Flooding patterns are often sporadic. Several severe floods can occur in short succession, like the major floods in December 2010 and March 2012. Conversely, there have been long periods without significant flooding. Most of the Murrumbidgee region experienced a 19-year period, from 1991 to 2010, without any moderate or major floods.⁹⁸

Five of the ten largest floods on record have occurred since the 1980s; three of these have occurred since 2010 (Figure 23). The most significant recent flood event was in March 2012, which resulted in the largest extent of floodplain inundation since the 1974 flood. Homes, businesses and land were inundated from Jugiong to Darlington Point.⁹⁹ Wagga Wagga was declared a disaster zone and almost 9,000 people were evacuated from their homes. Estimated damages resulting from the March 2012 floods in Wagga Wagga were over \$37 million.¹⁰⁰ As the 2012 flood peaked, hypoxic blackwater generated from the Murrumbidgee River floodplains reduced dissolved oxygen sharply from Hay to downstream of Balranald. This resulted in large-scale fish deaths in some sections of the lower Murrumbidgee, prompting subsequent releases of environmental water.

96. Hypoxic 'blackwater' is a term used when high levels of organic material and tannins in a river discolour the water making it appear black. The water can become hypoxic when the material decomposes, reducing the oxygen in the water. Blackwater events can occur after flooding, when organic material is washed off river banks and floodplains into the river system.

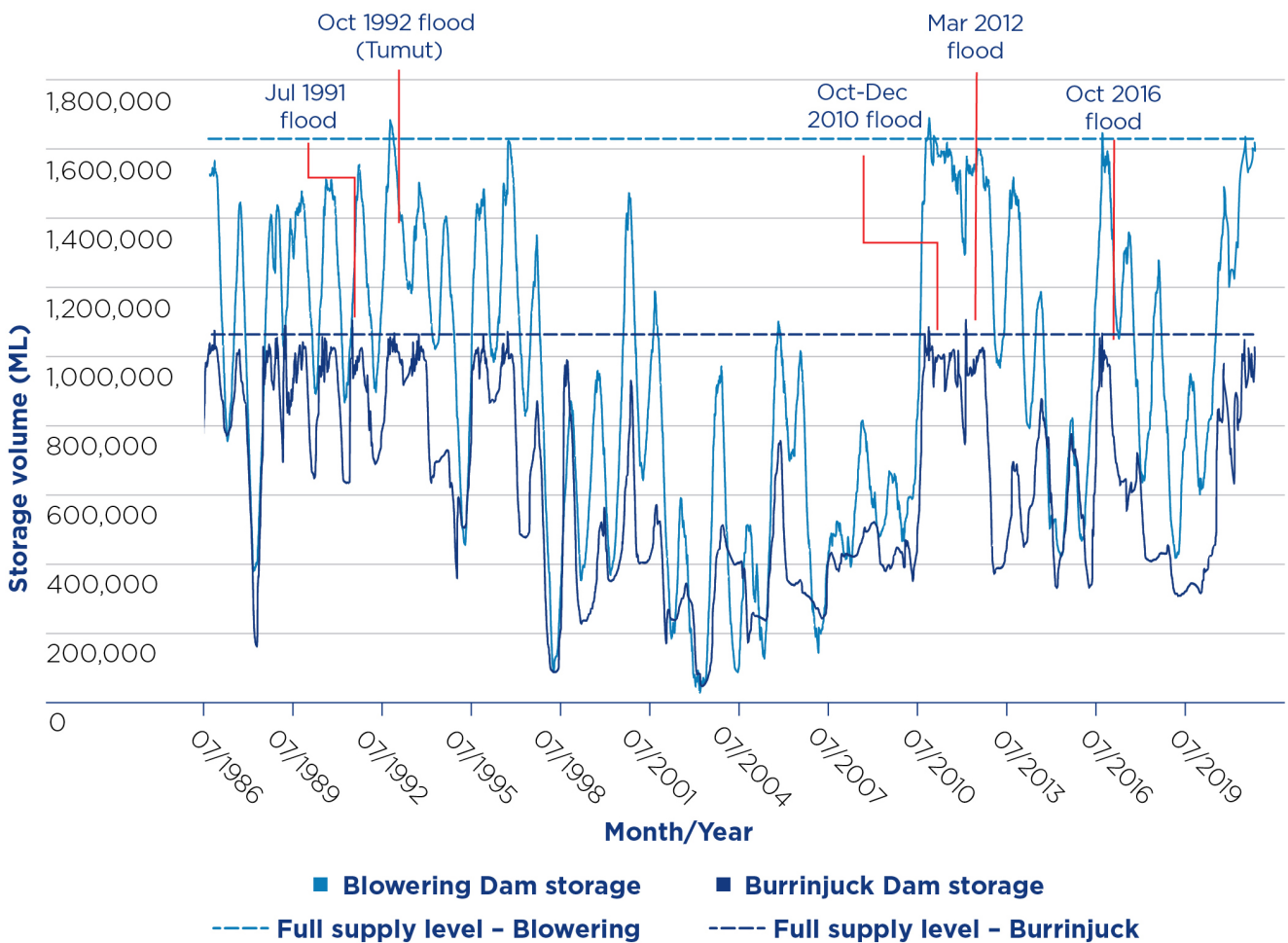
97. Cootamundra Gundagai Regional Council 2018, *Gundagai Floodplain Risk Management Study and Plan*.

98. Wagga Wagga City Council 2018, *Wagga Wagga Revised Murrumbidgee River Floodplain Risk Management Study and Plan*.

99. Bureau of Meteorology 2012, *Special Climate Statement 39 - Exceptional heavy rainfall across southeast Australia*.

100. Wagga Wagga City Council 2018, *Wagga Wagga Revised Murrumbidgee River Floodplain Risk Management Study and Plan*.

Figure 23. Burrinjuck and Blowering dams-storage and major floods



Source: WaterNSW Real-time data, www.watnsw.com.au/waterinsights/real-time-data

Note: FSL denotes full supply level of each dam

More recently, the smaller but longer duration October 2016 flood also caused hypoxic blackwater events in the lower Murrumbidgee. However, both the 2012 and 2016 events provided flow to the floodplains of the mid-Murrumbidgee and Lowbidgee wetlands, enabling the establishment of waterbird nesting areas, including the first significant pelican rookery in the Lowbidgee area and supporting other species of conservation significance.

NSW's hydrological models are being developed to understand long-term inflows into rivers and extraction from rivers. While the models are not specifically designed for flood analysis, they can give some indication of the trends of flood behaviour with climate change. It is important to note that projections for change in annual rainfall span both drying and wetting scenarios. For the regional water strategies, we will model a dry climate change scenario.

Based on modelling in other inland regions, under the worst-case dry climate scenario, large winter flow events could be significantly reduced compared to what we have seen in the observed historical climate. This is likely to reduce the frequency of winter floods and may also reduce the frequency of dam refilling events and groundwater recharge. However, overall flow variability is expected to increase.

Under a wet climate change scenario, the flood projections would look quite different. Significant increases in summer and autumn rainfall could lead to corresponding increases in the frequency and magnitude of large flow events and flooding.

Existing flood and floodplain management, flood operation provisions and procedures and potential options for improvement are discussed in Section 2.3.2.

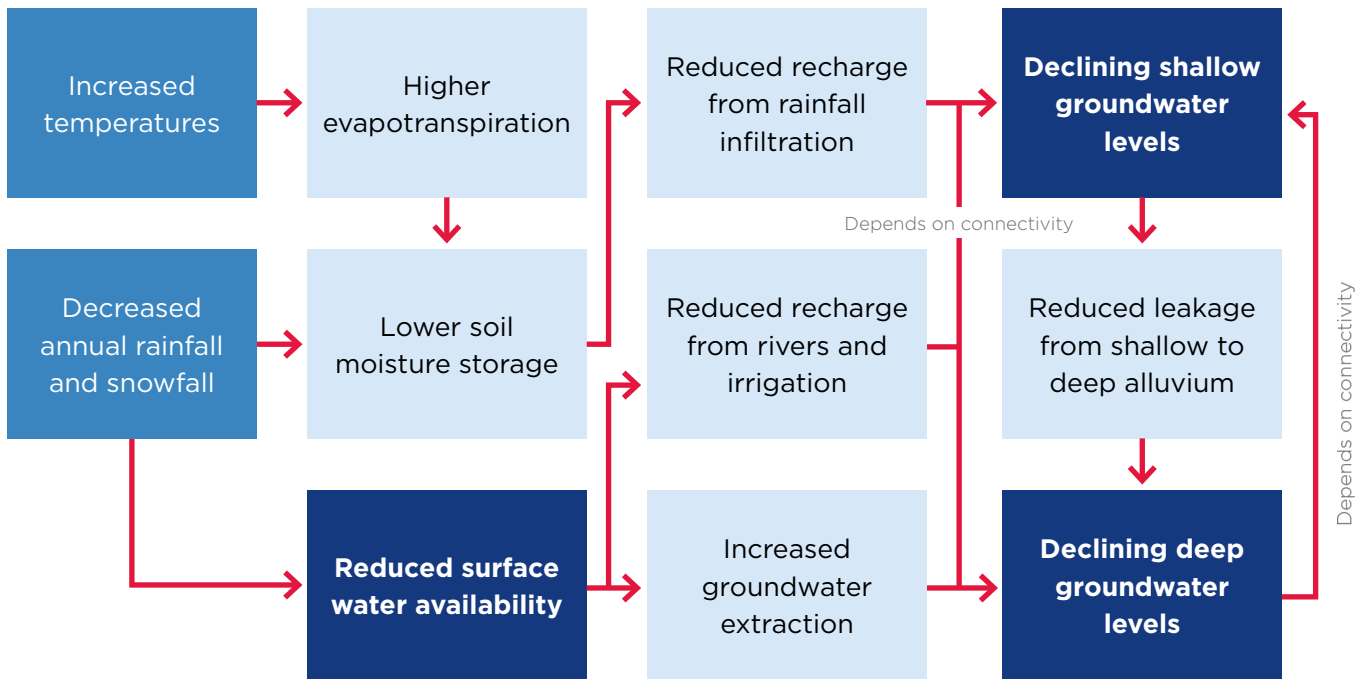
Climate variability impacts on the region's groundwater sources

The surface water models we are developing and using for the regional water strategies do not directly represent the interactions between surface water and groundwater. This limits our current ability to apply the new climate datasets to estimate the risks to future groundwater availability and access. However, we know that groundwater is both directly and indirectly affected by climate variability and further work will be progressed to ensure the new climate datasets can be used to assess future groundwater availability and access risks.

More rainfall means that there is more water infiltrating through the ground and riverbeds to refill the aquifers. More rainfall also means that surface water is more abundant so there may be less reliance on groundwater for those water users that hold both surface water and groundwater entitlements. This may vary depending on specific circumstances, such as variable surface water quality and the capacity to adequately treat poor quality surface water. Conversely, the relationship between rainfall, recharge, surface water availability and reliance on groundwater is generally reversed during drier conditions (Figure 24). There are communities and industries that rely solely on groundwater, irrespective of the prevalent climate conditions.

The degree to which climate variability affects groundwater depends on how connected the aquifer is to the surface, the size and properties of the aquifer storage, and its use.

Figure 24. Factors affecting groundwater recharge and levels during extreme dry periods



Mid-Murrumbidgee

The Mid-Murrumbidgee Alluvium is directly and indirectly affected by climate variability. The narrow and shallow aquifer has variable connectivity with the Murrumbidgee River and is recharged by leakage from the river, rainfall infiltration and irrigation. Declining groundwater level trends from the late 1990s to the end of the Millennium Drought coincided with relatively constant usage of groundwater.

The declining groundwater trend is most obvious in the Wagga Wagga Alluvium from around 1976, largely in response to increasing groundwater extraction for town water supplies. Extended dry periods and concentrated pumping around Wagga Wagga have changed the direction of flow between the Murrumbidgee River and the alluvium. Before development, the water from the alluvium was flowing towards the river, whereas now the river is leaking water to the underlying aquifer.¹⁰¹ Lower surface water availability in recent years has caused a sharp rise in groundwater pumping,

approaching the five-year average extraction limit in all four groundwater sources in the Mid-Murrumbidgee Alluvium.

Under a future dry-climate scenario we could see reduced rainfall, reduced winter streamflow and reduced frequency of large winter flood events. This is likely to reduce groundwater recharge from infiltration, rivers and floodplains in the mid-Murrumbidgee. The coinciding lower surface water availability could increase groundwater extraction and increase pressure on groundwater systems.

If extraction exceeds the extraction limit, future groundwater access by towns and industries may be reduced, potentially constraining regional growth. Increased groundwater extraction could also exacerbate the loss of river flows to groundwater, which could potentially impact groundwater dependent ecosystems. There is also a small risk that concentrated extraction could affect the structural integrity of aquifers leading to reduced groundwater storage and lower long-term bore yields.

101. CSIRO 2008, Water availability in the Murrumbidgee. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Commonwealth of Australia.

Lower Murrumbidgee

The Lower Murrumbidgee Shallow Groundwater Source is also directly affected by climate variability through reduced recharge from the river, irrigation runoff and through flow from the Mid-Murrumbidgee Alluvium. However, where the shallow aquifer is connected to the deep alluvium in the east, there are also localised declines in levels because of high pumping of the deep aquifer during dry periods. This downwards leakage is increasing salinity in the deep aquifer east of Hay.¹⁰²

The Lower Murrumbidgee Deep Groundwater Source is less affected in the short term by climate variability because it is mainly recharged by leakage from the shallow aquifer. However, it is indirectly affected by climate variability because of increased groundwater pumping during dry periods.¹⁰³ This trend could be exacerbated under future climate change.

Groundwater pumping has significantly increased in the Lower Murrumbidgee Deep Groundwater Source since records began in the early 1970s, with most of the bores used for irrigation in the east.¹⁰⁴ Historically, policy decisions led to a large number of licences being granted and as the region became more developed, the associated groundwater extraction was beyond what was sustainable. This ultimately led to the Achieving Sustainable Groundwater Extraction Program.

The volume of groundwater use increased significantly from the 1980s. Groundwater use stayed high during the Millennium Drought until the Water Sharing Plan for the Lower Murrumbidgee Groundwater Source started in 2006. In the wet years of 2010 and 2011, use fell to between 56 and 120 GL/year. The recent drop in general security surface water allocations to under 10% for the years 2018/19 and 2019/20, resulted in a sharp rise in groundwater use to over 377 GL in 2018/19 and around 326 GL in 2019/20.¹⁰⁵

Groundwater levels declined up to 12 m in the Lower Murrumbidgee Deep Groundwater Source around the high use area between Hay, Darlington Point and Coleambally. In the west, where groundwater use is low, groundwater levels have only slightly declined since the Millennium Drought. These extraction patterns are reflected by distinct seasonal drawdowns and a gradual decline in groundwater levels in the eastern part of the aquifer since the late 1990s, as shown in Figure 25. Reduced groundwater pumping when there were high rainfall and flood events in 2010/11 allowed some recovery of groundwater, but not to pre-Millennium Drought levels.

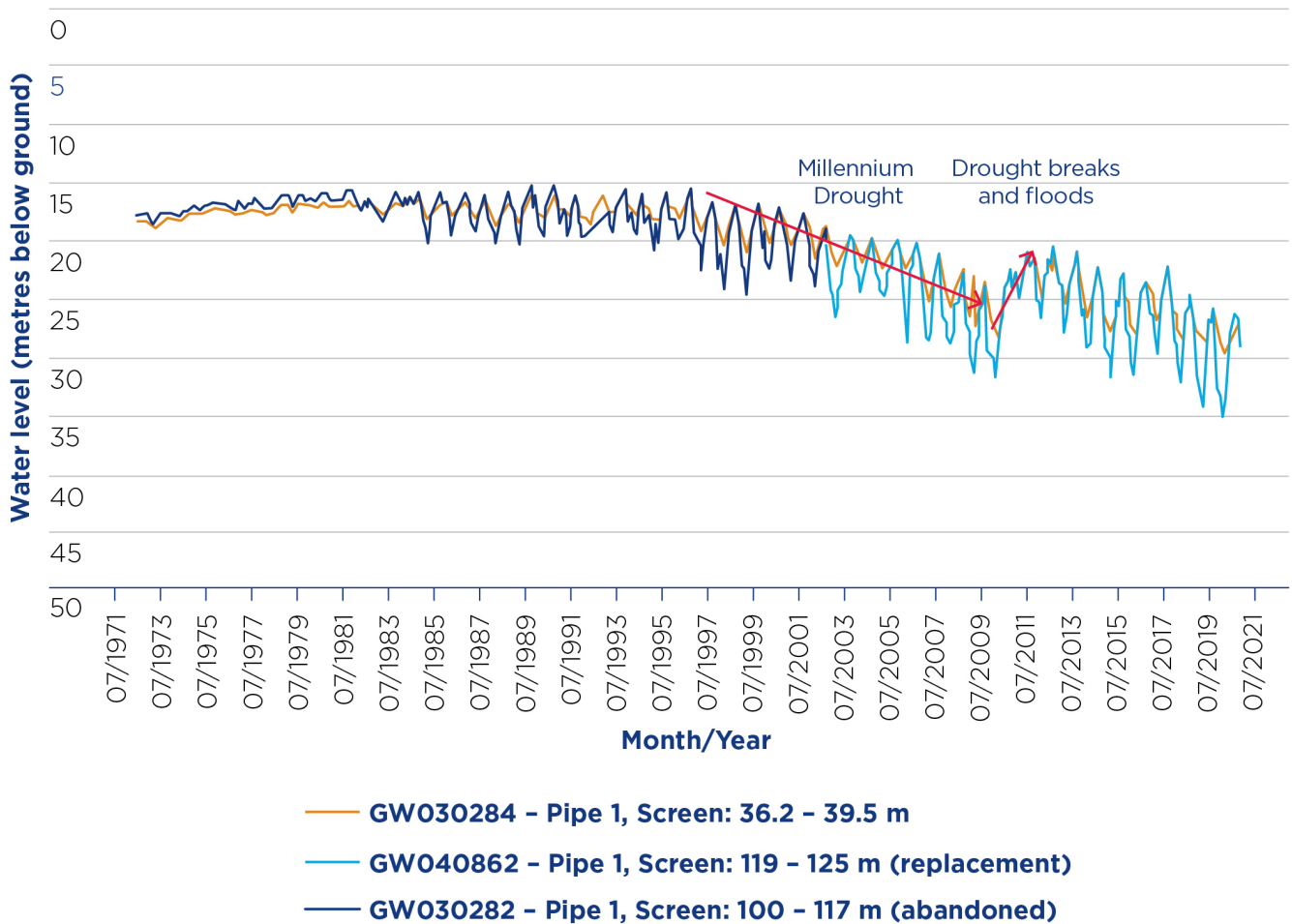
102. Department of Industry 2018, *Water quality management plan—GW9 Murrumbidgee Alluvium water resource plan area*.

103. Greater extraction by existing licence holders.

104. Department of Planning, Industry and Environment 2019, *Murrumbidgee Alluvium Water Resource Plan Resource Description, Appendix A*.

105. Department of Planning, Industry and Environment 2020, *Groundwater Annual Report—Lower Murrumbidgee Groundwater Sources 2020*.

Figure 25. Hydrograph for the Belvedere monitoring bores in the lower Murrumbidgee alluvial groundwater sources, showing declining groundwater levels during the Millennium Drought and increasing groundwater levels when the drought breaks



Source: Department of Planning, Industry and Environment 2020, Groundwater Annual Report—Lower Murrumbidgee Groundwater Sources 2020.

The Murrumbidgee Regional Water Strategy provides an opportunity to progress and update past work on how groundwater resources respond to climate variability and to identify options that increase our knowledge about groundwater sources, use, water quality

and recharge to inform more sustainable management of groundwater resources in the region (see Option 45: Improve the understanding of groundwater sources and processes, risks and impacts).

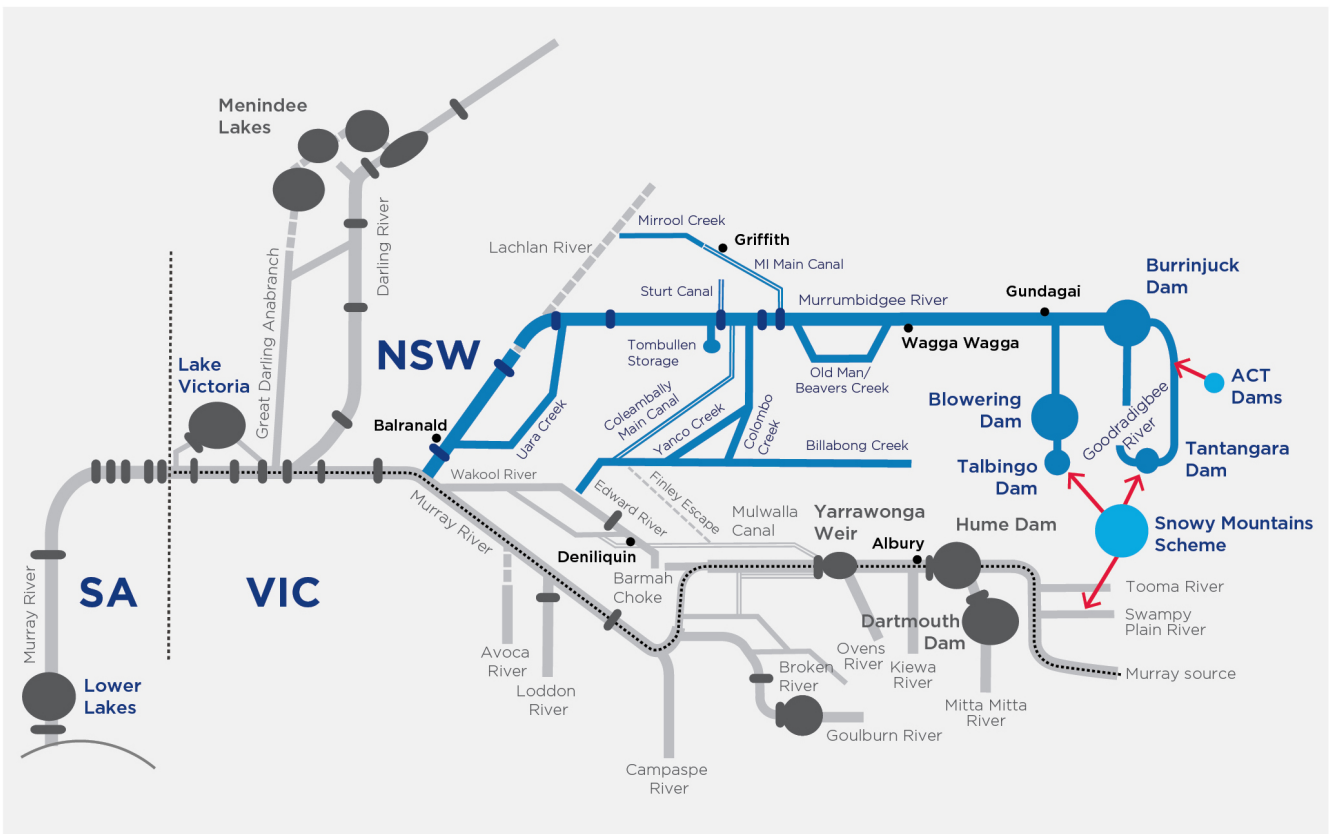
2.3 Managing water in the Murrumbidgee region

The Murrumbidgee region is part of the southern connected basin (Figure 26), a network of rivers that feed into the Murray River between Hume Dam and the border to South Australia. Interstate agreements and rules govern how water in the Murray River catchment is shared between NSW, Victoria and South Australia. For the Murrumbidgee, there are also other relevant rules that govern

water sharing arrangements between NSW and the Australian Capital Territory and water releases from the Snowy Scheme.

Within NSW, water is managed and shared under the *Water Management Act 2000*, with specific water sharing rules set out in the respective NSW surface water and groundwater water sharing plans.¹⁰⁶

Figure 26. The Murrumbidgee region as part of the southern connected basin



106. More information about water policy and planning is provided in the *Regional Water Strategies Guide*.

High level water sharing arrangements under the Murray-Darling Basin Agreement

The Murray-Darling Basin Agreement is a legal instrument that embodies the long-standing agreement between NSW, Victoria and South Australia to share the water of the Murray River and many of the rivers that flow into it. Schedule 1 of the *Water Act 2007* sets out rules and provides a framework of powers and responsibilities. This includes:

- NSW tributary inflows into the Murray River downstream of Albury, including the Murrumbidgee River and Billabong Creek belong to NSW
- a definition of the water available from the Snowy Scheme to the Murrumbidgee, as water of the Eucumbene River, the Tooma River, the upper Murrumbidgee and the upper Tumut River regulated by the Snowy Scheme
- rules for interstate water trading between South Australia, Victoria and NSW within the southern connected system
- requirements for implementation of Basin Salinity Management 2030 (BSM2030)—including end-of-valley salinity targets for each valley in the southern connected system—to manage salinity throughout the system.

There is a long history of collaboration between state and federal agencies to manage the southern connected basin. However, cross-border water management at such a large scale can be challenging at times and particularly so given that changes to the Murray-Darling Basin Agreement must be agreed (by consensus) by the Murray-Darling Basin Ministerial Council.

The broad water-sharing arrangements of the Agreement have remained the same since the original agreement was established in 1914. Apart from changes made in 2011 to address issues identified during the Millennium drought, the last substantive change occurred in 1970 after ten years of negotiations and led to the construction of Dartmouth Dam and an increase to South Australia's water entitlement.

The impacts of a drier climate and lower inflows into the Murray and Murrumbidgee systems have been evident since 2000.

Given the observed decline in inflows over the last two decades (see Section 2.2.1) and future climate change projections (see Section 2.1.2), the pressures on water users and the environment is likely to increase.

With a potential decline in water availability, the ability to meet the ever-changing water needs of communities, Aboriginal people, industries and the environment will become increasingly challenging, in particular in the context of future growth aspirations in the region.

Considering such aspirations and risks, there is a need for inter-jurisdictional discussion about the current settings of the Agreement and how current river operations can be improved or optimised to ensure that our river systems can be adaptively managed.

2.3.1 Sustainable Diversion Limits and Water Sharing Plan extraction limits

The *Basin Plan 2012* sets the limit on the amount of water that can be extracted (on average) from the region's water sources located in the Murrumbidgee catchment.

The current estimates of the sustainable diversion limits for water sources located in the Murrumbidgee region are 2,048.9 GL for surface water¹⁰⁷ and 355.3 GL for groundwater, excluding fractured and porous rock groundwater sources.

These limits are implemented through water sharing plans for the:

- *Murrumbidgee Regulated River Water Source 2016*

- *Murrumbidgee Unregulated River Water Sources 2012*
- *Murrumbidgee Alluvial Groundwater Sources 2020.*

The following plans also operate in the Murrumbidgee Region:

- *NSW Murray-Darling Basin Porous Rock Groundwater Sources (2020)*
- *NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2020).*

Extractions in the Murrumbidgee region are managed so that they remain within these limits, irrespective of the licensed entitlement volume.

107. Murray-Darling Basin Authority 2020, *Current diversion limits for the Basin*, as calculated at 26 November 2020, from www.mdba.gov.au/basin-plan/sustainable-diversion-limits/current-diversion-limits-basin



Sustainable Diversion Limit Adjustment Mechanism

The Basin Plan includes a Sustainable Diversion Limit Adjustment Mechanism (SDLAM) that allows the SDLs to be adjusted by a maximum of 5% through the implementation of a suite of supply or efficiency measures.

Supply Measures are projects that improve the way we manage the Basin's rivers to more efficiently deliver water for the environment. Projects include environmental works, such as building or improving river or water management structures and changes to river operating rules, which achieve environmental outcomes with less water.¹⁰⁸

Included within Supply Measures is the Reconnecting River Country Program (formally known as the Constraints Measures Program) that aims to achieve a balance of economic, social, cultural and environmental outcomes across southern NSW by improving wetland and floodplain connectivity.

There are a range of constraints or barriers limiting flows along our river system, including physical structures (e.g. low-lying bridges and roads), river management practices and operational flow limits. Removing or 'relaxing' constraints by addressing issues in collaboration with affected landholders will allow water for the environment to be delivered at higher levels and at more appropriate times. This will enhance the outcomes achievable with water for the environment.

Efficiency Measures are activities that change water use practices and save water for the environment. Projects can include upgrading irrigation systems, lining water delivery channels or installing water meters, along with water productivity improvements in manufacturing or irrigated agriculture, or changes to urban water management practices to reduce water use. It should be noted that NSW has not nominated any efficiency measures for inclusion in SDLAM Program.

SDLAM projects in the Murrumbidgee

In 2017, the Basin states and the federal government agreed on a package of 36 SDLAM projects across the southern connected Murray–Darling Basin with NSW leading or partnering in 21 projects.

Twelve SDLAM projects are complete or almost complete, including two in the Murrumbidgee region:

- Nimmie-Caira Enhanced Environmental Water Delivery Project, which is reconfiguring water delivery infrastructure to more effectively deliver environmental flows to the Gayini Nimmie-Caira floodplain and other parts of the Lowbidgee
- Computer Aided River Management (CARM) system, which aims to assist operators to more accurately make releases to meet downstream orders through better metering, models and more accurate loss estimates.

108. The SDLAM assumes that Pre-requisite Policy Measures are implemented in the southern NSW regions. These measures ensure more flexible water management arrangements to maximise the beneficial outcomes of proposed supply projects for the SDLAM.

The NSW Government is accelerating five of the remaining SDLAM projects through the \$320 million NSW SDLAM Acceleration Program, removing barriers and streamlining construction funding to deliver these projects by June 2024. The program includes two Murrumbidgee projects:

- **Yanco Creek Modernisation Project**, which aims to reduce water losses and improve outcomes for water users and the environment. The project includes the replacement of fixed crest weirs with automated regulators, the establishment of alternate supply arrangements, changes to operating rules and improved flow monitoring
- **Yanga National Park Project**, which is part of a package of works and measures under the SDLAM Murray and Murrumbidgee National Parks Project. The project aims to improve the movement of environmental flows into and through these water-dependent national parks by reducing the unnecessary watering of areas caused by inadequate and obsolete infrastructure that releases or holds water within the parks. This will decrease both the volume of water required and water lost to evaporation by reducing the inundation area. Other water savings are achieved by increasing the capacity of structures to manage environmental water, which will reduce the need too 'overtop' banks.

The separate Yanco Creek Offtake SDLAM Project has caused some concern in the community. The NSW Government recognises the unique sensitivities of this project and acknowledges that it cannot be delivered in its current form by 2024. The project is currently being re-scoped to develop options that achieve the project's objectives and have broad community support. Rescoping the project has the potential to deliver significant benefits to ecosystems, communities, landholders and water managers in the region.

The NSW Government recently launched the Better Bidgee Program to incorporate the rescoped Yanco Creek Offtake Project and other measures that will improve connectivity, environmental, cultural and community outcomes. Additional initiatives are in the early planning stages and will be shaped by community feedback.

The Murrumbidgee River is one of three focus areas of the new Reconnecting River Country Program. This program will investigate removing or 'relaxing' constraints in the river system to allow water for the environment to be delivered at higher levels and at more appropriate times, in a way that balances economic, social, cultural and environmental outcomes. Alongside this, the Enhanced Environmental Water Delivery Project seeks to improve the forecasting, planning and coordination of environmental water by increasing the ability to synchronise delivery of environmental water with natural flows.

2.3.2 Managing floods

In NSW, a risk management approach is taken to reduce the impact of flooding on flood prone land and reduce private and public losses resulting from floods. For inland regulated river systems such as the Murrumbidgee, a range of agencies have roles in flood management.

Floodplain risk management

The *NSW Flood Prone Land Policy*¹⁰⁹ outlines the government partnership for flood risk management in NSW. It identifies that local councils are primarily responsible for managing urban flood risk in their communities, while the Department of Planning and Environment is primarily responsible for rural floodplain management in the Basin.

The *Floodplain Development Manual*¹¹⁰ outlines the roles and responsibilities of local councils, including:

- developing and implementing floodplain risk management plans to better understand and manage flood risk to the community
- providing information to, and improving the awareness of flooding in, the community
- operating and maintaining their flood mitigation assets (for example, drainage and levees)
- considering flooding in development and infrastructure decisions
- supporting NSW State Emergency Service (NSW SES) in emergency management and planning.

The Environment and Heritage division of the Department of Planning and Environment (DPE—Environment and Heritage) leads the implementation of the *NSW Flood Prone Land Policy* and provides support to councils through the *Floodplain Development Manual* and associated policies, guidelines and tools. DPE—Environment and Heritage is currently reviewing the Manual and its associated guidance. DPE—Environment and Heritage also influences the planning and management of flood prone land through state environmental planning policies, regional strategies and plans.

Councils receive specialist technical support from DPE—Environment and Heritage flood risk management experts and financial assistance through the NSW Floodplain Management Program. This program supports the development and implementation of floodplain risk management studies and plans consistent with the Manual. Funding provided through the program to local government authorities to manage flood risk is generally at a rate of \$2 for every \$1 provided by the council.¹¹¹

Floodplain Risk Management Studies have been completed or updated in recent years for most large towns along the Murrumbidgee. These studies identify a preferred mix of local options to reduce the impact of flooding, including property modifications, response measures and flood modification measures such as levees and bypass channels. Several towns within the Murrumbidgee region's floodplains, such as Wagga Wagga, Darlington Point, Hay and Urana, are partly protected by levees.

109. The policy is incorporated in the *Floodplain Development Manual: the management of flood liable land*, NSW Government 2015, www.environment.nsw.gov.au/topics/water/floodplains//floodplain-management-program/

110. Department of Planning, Industry and Natural Resources 2005, *Floodplain Development Manual: the management of flood liable land*, NSW Government, www.environment.nsw.gov.au/topics/water/floodplains//floodplain-management-program/

111. Department of Planning, Industry and Environment 2018, *Floodplain Management Program*, accessed 26 August from www.environment.nsw.gov.au/topics/water/floodplains/floodplain-management-program

The NSW SES leads flood emergency management, planning and response. The Bureau of Meteorology provides flood forecasting to the SES to inform flood warnings and flood response operations. The NSW SES and councils are responsible for developing Local Flood Plans for flood-affected communities across the state, establishing

flood warning systems and coordinating evacuation and initial recovery from flooding. In the Murrumbidgee region, the SES issues local flood warnings and coordinates with the Bureau of Meteorology and WaterNSW when flood operations are active for Blowering and Burrinjuck dams.



Photography

Image courtesy of iStock.
Murrumbidgee River, Cotter Crossing.

Rural floodplain management plans

The Department of Planning and Environment—Water prepares rural floodplain management plans under the *Water Management Act 2000*. These plans coordinate flood work on a valley-wide basis to maintain the natural pattern of flood flows and protect ecological and cultural floodplain assets.

WaterNSW implements these plans through the assessment, granting or refusal and conditioning of flood work approvals. The Natural Resources Access Regulator is responsible for ensuring compliance with flood work approvals and enforcement of unauthorised flood works.

The Natural Resources Commission recently audited the implementation of existing rural floodplain management plans for the Lachlan, Murray and Murrumbidgee.¹¹² This included two rural floodplain management plans (Hay to Maude and Billabong creek) in the Murrumbidgee region. The audit found that the provisions in the plans have not been given full effect in accordance with the Act. These shortcomings could increase the risks to life and property from floods, adversely impact the health of riverine and floodplain ecosystems, and increase the likelihood of non-compliant flood works.

Similarly, a review under Section 43 of the *Water Management Act 2000*¹¹³ found that the plans:

- are not adequate and appropriate to effectively implement the water management principles under the Act
- should be replaced with valley-based plans
- should be expanded so their boundaries include the local ecosystems, flood fringe areas and upstream extents to be consistent with the Act.

The regional water strategies provide an opportunity to progress this evolution in NSW floodplain management planning (see Option 17: Enhance southern inland floodplain management plan replacement).

112. Natural Resources Commission 2020, *Audit of the implementation of the Floodplain Management Plans for the Lachlan, Murray and Murrumbidgee. Final Report*, www.nrc.nsw.gov.au/wsp-audits

113. Alluvium Consulting Australia Pty Ltd 2021, *Section 43 Review of 10 Southern Floodplain Management Plans. Final Report*. Prepared for Department of Planning, Industry and the Environment. www.industry.nsw.gov.au/water/plans-programs/healthy-floodplains-project/plans/review-process

Flood operations

Major floods along the regulated Murrumbidgee River typically occur when either or both Blowering Dam and Burrinjuck Dam are full and spilling. Minor and moderate flooding can also occur during periods of pre-release from the dams in advance of forecast heavy rain.¹¹⁴

WaterNSW is responsible for operating Burrinjuck and Blowering dams to maintain the safety of dam infrastructure and achieve a full supply level after flood events. The flood mitigation requirements, channel capacity constraints and dam airspace¹¹⁵ requirements set out in the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* and WaterNSW's operating licence¹¹⁶ influence how the dams are operated in the lead-up to and during floods:

- Burrinjuck Dam is operated to maintain a volume of airspace that is sufficient for it to refill based on the minimum predicted inflows.
- The Blowering Dam Airspace Deed gives Snowy Hydro the right to specify the airspace required in the dam for power generation purposes that is to be targeted by WaterNSW.
- For both dams, downstream impacts due to channel capacity constraints in the Tumut River at Tumut (9,300 ML/day) and Murrumbidgee River at Wagga Wagga (32,000 ML/day) must be considered before making dam releases to obtain airspace.

WaterNSW obtains guidance on weather forecasts from the Bureau of Meteorology and Snowy Hydro Limited to estimate dam inflows and downstream tributary flows to inform decisions about dam releases.

Better data and information on floods in the Murrumbidgee region is critical to understand how floodplains are connected, how groundwater reserves are replenished and the flood risk of towns and villages. Flood studies that analyse the characteristics and movements of floods will help to protect rural properties and vital infrastructure, while ensuring that environmental and cultural assets are not negatively affected.

The State Infrastructure Strategy (2014) identified flood management risk as a key issue, based on the limited capacity of major dams to provide flood mitigation.

In addition to WaterNSW's operating requirements for Burrinjuck and Blowering dams, the Snowy Water Licence and the Annual Water Operating Plan guide the operation of storages within the Snowy Scheme by Snowy Hydro Limited. The Snowy Water Licence contains specific operational requirements to mitigate further downstream flooding.

The 10-year review of the Snowy Water Licence¹¹⁷ identified 23 actions to improve coordination of water management between the Snowy Scheme and downstream water supply systems. Options are currently being investigated to improve the effectiveness of provisions that may influence flood management, including flood mitigation arrangements, and rules around the timing of releases.

114. Flows from downstream tributaries are often a major contributing factor to flooding.

115. Airspace is defined as the gross storage capacity of the dam at the spillway crest minus the actual gross storage volume.

116. WaterNSW. Operating Licence, www.watarnsw.com.au/about/legislation/operating-licence

117. Department of Industry 2018, *Ten-year review of the Snowy water licence—final report*



Photography

Image courtesy of Department of Planning and Environment.
Crown lands, Griffith.

2.3.3 Managing water quality

Water quality is managed through several legislative and regulatory instruments and agencies. The NSW Government adopted the *National Water Quality Management Strategy*¹¹⁸ as its policy to manage the quality of waterways in NSW and protect water resources. It includes guidelines to support state and local governments, water authorities and industry to maintain and improve water quality according to local community environmental values and uses as outlined in the NSW Water Quality Objectives.¹¹⁹

The NSW Environment Protection Agency is responsible for managing water pollution—diffuse and point source—in NSW under the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (General) Regulation 2009*.

The NSW Government has developed the *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions*¹²⁰ to provide an evidence-based tool to assist regional planners to integrate water quality into strategic land-use planning decisions and assist councils to reduce the impacts of land-use developments on waterways.

For all inland NSW regions, water quality management plans have been developed to support the development of the water resource plans and meet the relevant requirements of the Basin Plan. These plans provide a framework to protect, enhance and restore surface water and groundwater quality to:

- provide essential and recreational amenity for rural communities

- protect and improve ecological processes and healthy aquatic ecosystems
- support Aboriginal people's spiritual, cultural, customary and economic values
- assist industry to be productive and profitable.

The water quality management plans are supplemented by NSW incident response guides,¹²¹ developed under the NSW Extreme Events Policy. Incident response guides outline management responses—in accordance with provisions of the *Water Management Act 2000*—for water use during extreme water quality events. Extreme water quality events include the occurrence of hypoxic blackwater, low dissolved oxygen, salinity or blue-green algae outbreaks. Under an extreme water quality event,¹²² water quality may be insufficient to meet critical human needs or may impact aquatic ecosystem health. Potential management responses in the Murrumbidgee include temporary restricting take, reviewing release of operational water or using environmental water for critical ecological needs like maintaining fish refuges.

Water sharing plans do not contain rules directly concerning water quality in the Murrumbidgee region. However, the plans provide mechanisms and tools (including extraction limits, cease to pump rules, supplementary access rules and environmental water allowances) to help ensure sufficient flow is available to meet water quality objectives and targets (refer to Section 3.2.2).

118. Water Quality Australia, *Guidelines for water quality management*, www.waterquality.gov.au/guidelines

119. NSW Government, *NSW Water Quality and River Flow Objectives*, www.environment.nsw.gov.au/ieo/index.htm

120. Office of Environment and Heritage 2017, www.environment.nsw.gov.au/research-and-publications/publications-search/risk-based-framework-for-considering-waterway-health-outcomes-in-strategic-land-use-planning

121. Department of Industry 2019, *Draft Incident Response Guide for the Murrumbidgee Surface Water Resource Plan Area*, www.industry.nsw.gov.au/__data/assets/pdf_file/0014/230315/schedule-g-murrumbidgee-sw-incident-response-guide.pdf

122. An extreme event is defined in the NSW Extreme Events Policy and in section 10.51 of the Basin Plan 2012.

The Murray–Darling Basin Agreement and the Basin Plan outline the salinity management obligations for Basin states that are party to the Murray–Darling Basin Agreement. The Basin Plan incorporates a water quality and salinity management plan, which includes end-of-valley salinity targets for various locations in the southern connected basin.¹²³ These salinity targets provide guidance for operational decisions that will assist in maintaining salinity at acceptable levels. The *Basin Salinity Management Strategy 2030* builds on over 30 years of salinity management in the Basin and provides a framework for governments to work individually and collectively to meet the Basin Plan obligations. The strategy includes maintaining a salinity register, responsible management of salt interception schemes, knowledge building and flow management guidance.

There is only one salt interception scheme in the Murrumbidgee region. The Billabong Creek Salt Interception Scheme pumps freshwater from the deep aquifer of the Billabong Creek Alluvium directly into the creek to reduce upward pressure of the deep aquifer. This upward pressure was previously forcing saline water from the shallow aquifer into the creek, increasing salinity. The scheme prevents around 3,000 t of salt each year from entering Billabong Creek and the Murray River.¹²⁴ The Department of Planning and Environment is undertaking a proof-of-concept study to determine whether the scheme will remain operational beyond 2026, and to address potential short and long-term risks to local surface water users and fish communities.

The quality of water resources is also affected by land-use activities (Section 2.2.1), many of which are outside the influence of flow management and therefore cannot be addressed through water planning alone.

The process used to assess and manage the impacts of land use activities and water extraction on water quality is outlined in the *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions*.¹²⁵ This framework helps local councils to support healthy waterways through regional and local planning instruments, environmental regulation, integrated water cycle management plans, or other catchment management plans for restoring and protecting the health of waterways.

Managing catchment water quality also helps local water utilities meet drinking water quality standards set out in the Australian Drinking Water Guidelines.¹²⁶ The Guidelines detail a preventative management approach that manages and monitors water quality from the catchment to the consumer. They are used by NSW Health, the Department of Planning and Environment and local water utilities to assure safe, good quality drinking water for NSW communities.

Water supplies in regional NSW are monitored for microbiological and chemical quality through the NSW Health Drinking Water Monitoring Program. NSW Health also publicly reports water quality incidents. The Department of Planning and Environment's Water division monitors the performance of local water utilities in providing drinking water.

123. The Basin is required to include a Water Quality and Salinity Management Plan under the Australian *Water Act 2007*. The End-of-Valley salinity target set for the Murrumbidgee River is a salt load of 169,000 t/year.

124. Billabong Creek Alluvium is part of the Murray Alluvial sources. Billabong Creek is a surface water source within the Murrumbidgee region. See www.industry.nsw.gov.au/water/science/groundwater/interception-schemes/billabong-creek

125. Dela-Cruz, J., et al. 2017, *Risk-based framework for considering waterway health outcomes in strategic land-use planning decisions*, NSW Office of Environment and Heritage and Environment Protection Authority.

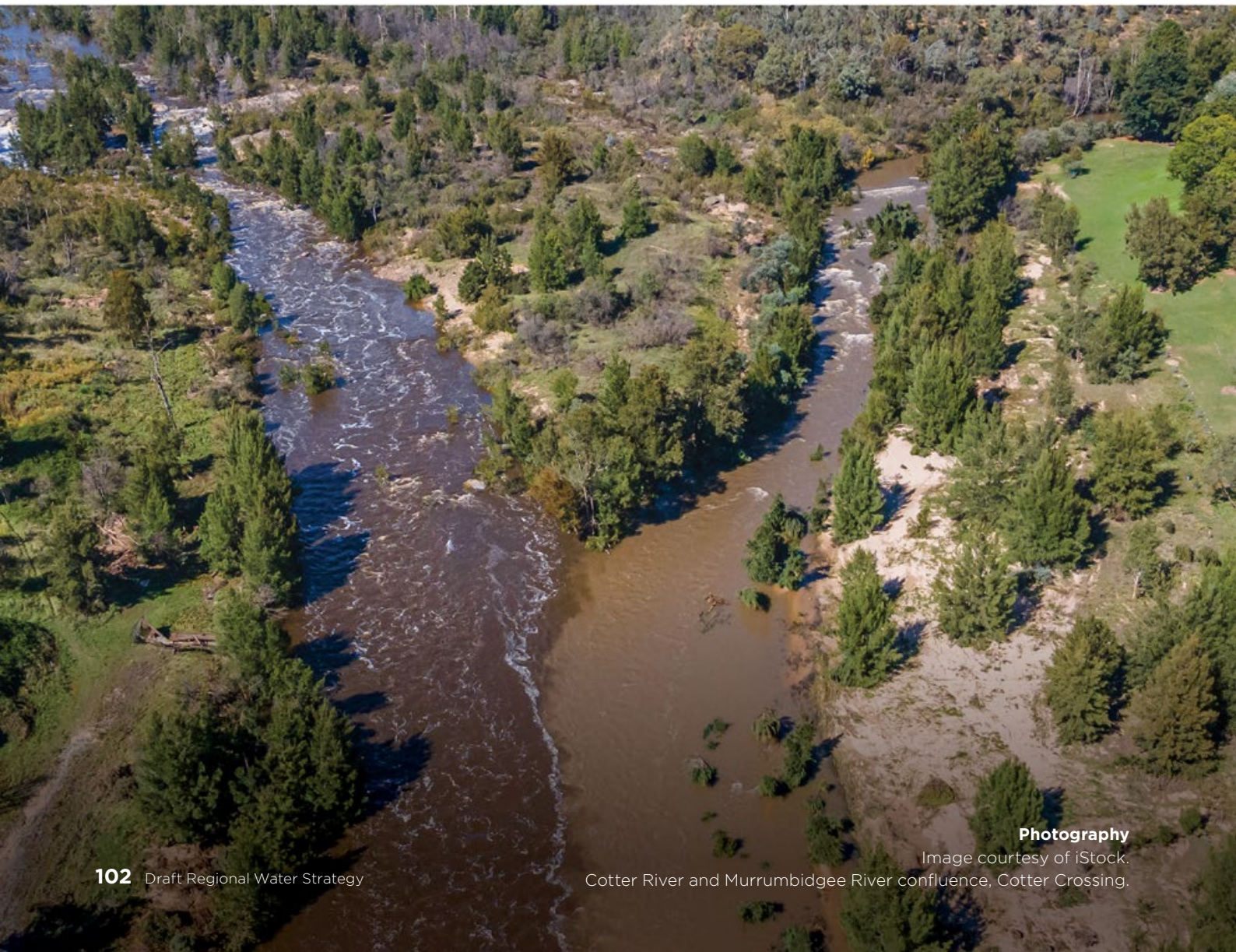
126. National Health and Medical Research Council, National Resource Management Ministerial Council 2018, *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*, Canberra: NHMRC.

Abandoned mines—a potential risk to water quality in the Murrumbidgee

Abandoned and disused mines present a yet to be quantified water quality risk for the Murrumbidgee region. There are numerous sites within the region that pose a potential risk to the Murrumbidgee River, and rivers and associated creeks, from contaminated run-off and increased sediment loads. The Captains Flat (Lake George) is being rehabilitated by the NSW Government, with the major soil remediation beginning soon and the plan progressing with ongoing works to treat residual acid mine drainage and heavy metals, including zinc, seeping from the site to the Molonglo River.¹²⁷ Refer to Option 29: Assess pollution from disused mines and minerals concurrences, for an option that could address the issue.

Additional measures that address water quality issues affecting specific water users, including the environment, are discussed in Section 3.

127. Regional NSW, *Captains flat*, www.nsw.gov.au/regional-nsw/captains-flat



Photography

Image courtesy of iStock.

Cotter River and Murrumbidgee River confluence, Cotter Crossing.

2.3.4 Entitlements to water in the region

Most water access licences¹²⁸ in the region have been issued for the Murrumbidgee regulated river source, with just over half of the volume of these being general security water access licences (Figure 27).

General security water access licences are less reliable than high security water access licences due to the priority of how water is allocated in NSW. However, the water sharing plan allows unused general security allocations of up to 30% of the entitlement volume to be carried over from one-year to the next. The long list of options in this draft strategy proposes several options concerning high security and general security water access licences to address water security challenges in the Murrumbidgee region—see Option 10: Review the allocation and accounting framework in the Murrumbidgee (surface water) and Option 13: Investigate Water Access Licence conversion.

In addition to high security and general security water access licences, 43,585 ML is set aside for local water utilities in the regulated river water source, of which 19,769 ML is regulated river (high security) (Town water supply).¹²⁹ Another 4,940 ML is set aside for local water utilities in the Murrumbidgee's unregulated water sources and 28,492 ML in groundwater sources.

In addition to these volumes set aside in the respective water sharing plans, some local water utilities have purchased additional water access licences to meet their water needs. These additional water access licences have the same characteristics as other entitlements of the same category.

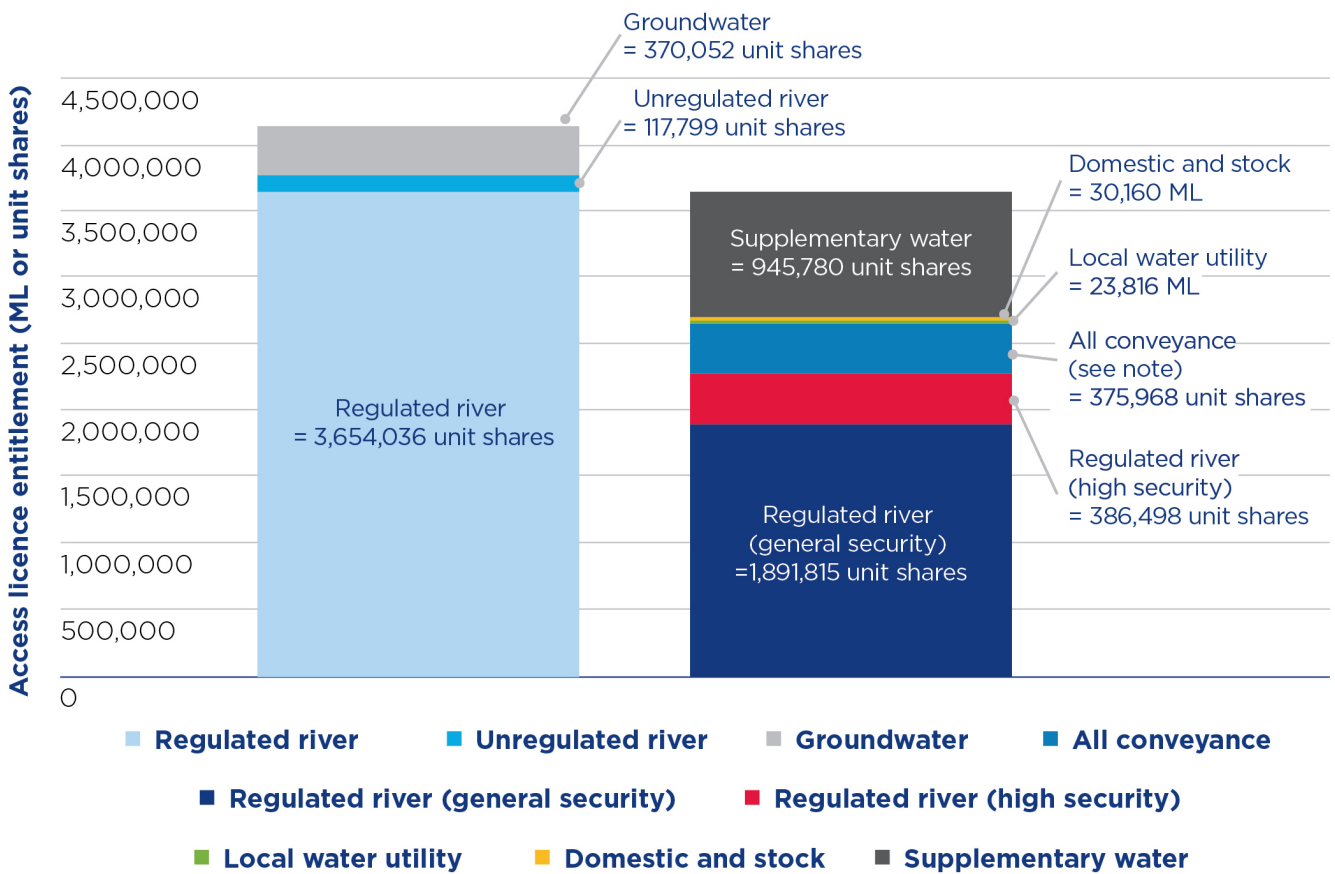
Supplementary water access licences account for 26% of the regulated share components, with the majority held by the environmental managers in the Lowbidgee. This water is accessed opportunistically when a surplus river flow is announced.

Conveyance water licences make up around 10% of regulated entitlement with the majority providing for conveyance losses within the main irrigation areas. Option 10 in this draft strategy proposes to further investigate conveyance and transmission losses across the Murrumbidgee catchment with the help of the new climate datasets and updated modelling.

128. A licence entitles its holder to shares in the available water within an area or water source. For surface water, licences also dictate when water can be taken at specified times, in specified areas or from specified locations. For groundwater licences, these conditions are managed through conditions on the water supply works approvals.

129. Regulated River (High Security) (Town Water Supply) entitlements held by Murrumbidgee Irrigation Ltd and Coleambally Irrigation Co-operative Limited to supply town water to Leeton Shire, Griffith City and Murrumbidgee Councils.

Figure 27. Murrumbidgee region water access licence shares



Notes:

- Entitlement is based on licensed share components only and this figure does not include environmental water allowances or basic landholder rights.
- Groundwater entitlements only include the share components for the Lower Murrumbidgee Shallow and Deep groundwater sources and Mid-Murrumbidgee Alluvium.
- All conveyance access licences include regulated river [conveyance] (2,968 unit shares), Coleambally Irrigation [conveyance] (130,000 unit shares) and Murrumbidgee Irrigation [conveyance] (243,000 unit shares).

Source: Department of Planning, Industry and Environment 2018, Murrumbidgee Water Resource Plan: Surface water resource description and WaterNSW water licence database and internal Department of Planning, Industry and Environment—Water data

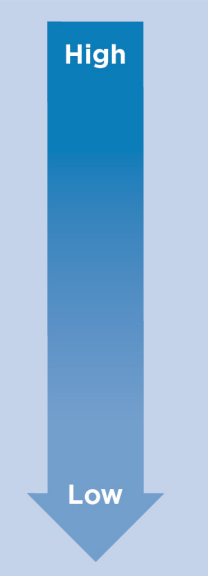
2.3.5 Setting priorities for water sharing

The *Water Management Act 2000* sets out how we prioritise water sharing during normal operations, with the highest priority being for the environment, followed by basic landholder rights (Table 4).

During extreme events, such as prolonged droughts or severe water shortages,¹³⁰ the priority changes. Critical human water needs become the highest priority, followed by the environment.

This change in priorities is triggered when a NSW water sharing plan—or part of a plan—is suspended.¹³¹ The aim is to operate within the plan rules for as long as possible, as they provide certainty for all users of these water sources. The Murrumbidgee Regional Water Strategy is an opportunity to consider whether the triggers should be reviewed (see Option 9: Review drought rules for the Murrumbidgee).

Table 4. Priorities for water sharing¹³²

Priority	Extreme events	Normal circumstances
Highest	<ul style="list-style-type: none"> Critical human water needs 	<ul style="list-style-type: none"> Needs of the environment
	<ul style="list-style-type: none"> Needs of the environment 	<ul style="list-style-type: none"> Basic landholder rights
	<ul style="list-style-type: none"> Stock High security licences Commercial and industrial activities authorised by local water utility Water for electricity generation on a major utility licence Conveyance in supplying water for any priority 3 take 	<ul style="list-style-type: none"> Local water utility access licences Major utility access licences Stock and domestic access licences
	<ul style="list-style-type: none"> General security licences 	<ul style="list-style-type: none"> Regulated river (high security) access licences
	<ul style="list-style-type: none"> Supplementary licences 	<ul style="list-style-type: none"> All other forms of access licences Supplementary access licences

Source: Based on priorities table in Murrumbidgee Surface Water Resource Plan Schedule G—Incident Response Guide for the Murrumbidgee Surface Water Resource Plan

130. *Water Management Act 2000*, Section 60(3)

131. *Water Management Act 2000*, Section 49B

132. Department of Industry 2019, *Draft Incident Response Guide For the Murrumbidgee Surface Water Resource Plan Area*, www.industry.nsw.gov.au/__data/assets/pdf_file/0014/230315/schedule-g-murrumbidgee-sw-incident-response-guide.pdf

Sharing and allocating water in the regulated river

In the Murrumbidgee regulated river water source, the process for assessing water availability and announcing available water determinations—typically referred to as ‘allocations’—involves regular resource assessments.

An opening allocation is announced at the start of each water year (1 July) based on the minimum volume of water that can be confidently made available and delivered across the entire year to licensed users. The NSW Government operates the system on a 12 to 24-month planning horizon. This includes an assessment of:

- how much water is available in the storages, plus:
 - a minimum natural inflow into storages expected during the year that can be allocated for regulated use, including setting aside sufficient volumes of water in storage to ensure supply can be maintained to basic landholder rights, domestic and stock, local water utility and high security access licences through a repeat of the pre-July 2004 minimum inflow sequence prescribed in the water sharing plans.
- required annual releases by Snowy Hydro Limited into Blowering Dam, minus:
 - the volume required to run the river, including end of system flows, transmission losses and evaporation losses, minus
 - other water sharing plan requirements, including storage reserves and credits to environmental water allowances, minus

- the forecasts volume of carryover¹³³ and conveyance volumes.

Additional allocation announcements are often made throughout the water year depending on the ongoing resource assessments.

Future climate conditions are often hard to predict, which means that allocation decisions have to be made in the context of uncertainties. For example, if conditions drier than those expected occur or if system losses exceed historical volumes, there is a residual risk that there is insufficient water available to meet all water needs. When these unexpected conditions occur, it is critical that adequate drought management actions are enacted to ensure critical needs are protected as efficiently as possible.

Making allocation announcements is a careful balancing act between making water available for communities, the environment and productive use. The more conservative our allocation process is, the less water can be made available for productive and (licensed) environmental use. Conversely, the less conservative we are in allocating water, the greater is the risk that insufficient water is available to meet critical human and high priority needs—particularly if conditions are drier than expected.

The new climate datasets and updated modelling being prepared for the Draft Murrumbidgee Regional Water Strategy will provide an opportunity to review the current assumptions and processes that are used to make allocation announcements. We will have much more comprehensive datasets that allow us to test the existing water allocation framework and analyse the merits and risks of adjusting it (see Option 10: Review the allocation and accounting framework in the Murrumbidgee (surface water)).

133. Carryover is the unused account water that is brought forward into the new water year, from 30 June to 1 July. Currently in the Murrumbidgee, carryover is only available for general security or conveyance access licences.



Photography

Image courtesy of Amanda Ind.
Murrumbidgee River, Jugiong.

Sharing and allocating groundwater

Each groundwater source has a long term average annual extraction limit (LTAAEL) defined by the NSW water sharing plans. The LTAAEL is the volume of water that can be sustainably extracted each year from the groundwater source. The method for calculating the LTAAEL varies between groundwater sources and can be based on a percentage of recharge—for example, in the Lachlan Fold Belt—or the level of development prior to the introduction of water sharing plans—in the Mid-Murrumbidgee Alluvium.

Sometimes the amount of groundwater extracted annually is higher than the LTAAEL. This can happen if the number of entitlements plus basic landholder rights are higher than the LTAAEL or if licence holders use their full entitlement and some unused water in their account carried over from the previous year (carryover).

Since the introduction of the Achievable Sustainable Groundwater Entitlements Program,¹³⁴ allocations against groundwater licences in the Murrumbidgee groundwater sources, at the start of the water year have generally been 100%. However, if the five-year

average annual extraction by all water users exceeds the LTAAEL compliance trigger (5% or 10% exceedance level above the extraction limit) in any groundwater source, the Department of Planning and Environment may need to limit the volume of water available in the following year to return average extraction to within the limit. This can be done by reducing the available water determination.¹³⁵ The number of entitlements remains the same, but the volume of water allocated to each entitlement changes.¹³⁶

In the Gundagai Alluvial Groundwater Source, which is highly connected to the Tumut and Murrumbidgee rivers, available water determinations for high security aquifer access are linked to high security regulated river access (Table 5).

For some groundwater sources, such as the Lachlan Fold Belt MDB Groundwater Source, the volume of entitlements plus basic landholder rights is less than the LTAAEL. This means that there is opportunity for the NSW Government to grant more entitlements through a process called ‘controlled allocations’.

134. The Achievable Sustainable Groundwater Entitlements Program started with the commencement of the water sharing plans and aimed to reduce the use of groundwater in six groundwater sources in NSW to a sustainable level. This included the Lower Murrumbidgee Deep Groundwater Source, where entitlements were reduced by around 48%. CSIRO Murray-Darling Basin Sustainable Yields Project, 2005/06.

135. Maximum water account debit is another method to return average extraction to the LTAAEL by reducing the amount of water that can be taken or traded from accounts. This method can also be used to manage localised significant drawdown causing negative impacts. In this case, temporary restrictions can be applied to limit the access to groundwater in accounts for a period while water levels recover.

136. For example, if a licence holder has an entitlement of 1,000 unit shares for the Lower Murrumbidgee Deep Groundwater Source, in July 2019 the available water determination was 1 ML so the licence holder could extract their 1,000 ML allocation. In July 2020, the available water determination was reduced to 0.65 ML to bring the average extraction below the compliance trigger; this meant that the licence holder could extract 650 ML over the 2020/21 water year.

Table 5. Limits to the extraction of groundwater in the Murrumbidgee

Groundwater source	Entitlements (ML or unit share)	BLR (ML/year)	LTAEL (ML/year)	AWD limit (ML/unit share)	Carryover limit (ML/unit share)	Account limit (ML/unit share)
Lower Murrumbidgee Deep	275,402	3,625	273,625*	1.0	2.0	2.0
Lower Murrumbidgee Shallow	11,201	10,875	26,875	1.0	2.0	2.0
Wagga Wagga Alluvial	20,200 (LWU) 7,961 (Aquifer)	135	16,998 for LWU access licences 3,650 for others	1.0	0.4	1.4
Mid-Murrumbidgee Zone 3 Alluvial	47,969	496	30,176	1.0	0.3	1.3
Kyeamba Alluvial	2,070	12	723	1.0	0.4	1.4
Gundagai Alluvial	4,305	156	1,926	Aquifer – 1.0 Aquifer (high security) – 0.68 ML/unit share plus 32% of the AWD for regulated river (high security) access licences	0.3	1.3
Bungendore Alluvial	1,238	25	1,268	1.0	Not permitted	1.0

Note:

* The LTAEL for the Lower Murrumbidgee Deep Groundwater Source excludes one aquifer access licence held by the Australian Government with a share component totalling 5,048 ML/year. This licence is not identified as licensed environmental water but is intended to be used for environmental purposes.

Source: Water Sharing Plan for the Murrumbidgee Alluvial Groundwater Sources 2019

The Murrumbidgee Regional Water Strategy is an opportunity to consider whether the groundwater extraction limit compliance settings are appropriate, particularly in relation to the new climate data, water use trends and other regional developments.

2.3.6 Water trade

Both water access licence entitlements and water allocations can be traded between water access licence holders, subject to specific legislated rules and licence conditions. Many different water holders participate in the water market, including irrigators, irrigation infrastructure operators, local water utilities, environmental water managers, water brokers and exchanges, investors, Aboriginal people and others.

Of these groups, Aboriginal people hold the least amount of water access licence entitlements and are largely absent from the water market. However, Aboriginal people have expressed an aspiration to increase their access to water to allow them to generate cultural, environmental and economic benefits for their communities. Some have noted that treating water as a property right can be at odds with many traditional beliefs, however water markets are considered a potential pathway to increase access to water for Aboriginal people.¹³⁷

For businesses, environmental water managers and local water utilities, water markets are an important tool to manage their water needs and access water in systems that are fully allocated. For example, water markets allow businesses to supplement their water supply to expand production, free up capital that can be invested elsewhere, or access carryover opportunities to shore up water supplies for the next season. Water access licence entitlements are also a significant asset for many businesses, often equating to, or exceeding the value of land assets.¹³⁸

Since mid-2012, water market participants traded a total value of approximately \$12.7 billion (2019/20, constant terms) in water access licence entitlements across the Murray–Darling Basin water markets.

In contrast, the total value of water allocation trades equated to around \$2.7 billion (in 2019/20, constant terms).¹³⁹ Most trading activities in the Murray–Darling Basin occurred in surface water basin across the southern connected system.

The volume of surface water trade strongly correlates to climate conditions and water availability. There are indications that the volume traded relative to the total water allocated to water access licence entitlements has grown over the years.¹⁴⁰ This indicates that water markets are developing and more water holders are utilising the market to meet their needs. Groundwater markets are also developing, with increased trading activities in some groundwater systems. In the context of a variable and changing climate, groundwater markets are likely to become more important.

Significant regulatory, policy, investment, water use and climatic changes have occurred in the southern connected basin over the last two decades which has led water markets to continue to evolve, increase in size, value and complexity. In recent years, changes in land use and the expansion of permanent horticulture in the Murray River below the Barmah Choke have influenced water markets and trading across the southern connected basin. This has resulted in several investigations and inquiries, including the Australian Competition and Consumer Commission's inquiry into Murray–Darling Basin water markets and the independent expert panel's work to understand and manage shortfall risk for the Murray River system.¹⁴¹

Future changes in the region's climate, together with ongoing land use and population changes are likely to influence surface water and groundwater markets and trading activities in the southern connected basin over the next few decades.

137. Australian Competition and Consumer Commission 2021, *Murray–Darling Basin water market inquiry—Final report*

138. Australian Competition and Consumer Commission 2021, *Murray–Darling Basin water market inquiry—Final report*

139. Australian Competition and Consumer Commission 2021, *Murray–Darling Basin water market inquiry—Final report*

140. Australian Competition and Consumer Commission 2021, *Murray–Darling Basin water market inquiry—Final report*

141. Murray–Darling Basin Ministerial Council 27 November 2020, www.mdba.gov.au/media/mr/murray-darling-basin-ministerial-council-27-nov-2020

ACCC water markets inquiry

Recently, the Australian Competition and Consumer Commission (ACCC) undertook an inquiry into water markets in the Murray Darling Basin. The review highlighted that Basin water markets are critical to the efficiency and productivity of Australian agriculture, and that water trading delivers substantial benefits to both water users and the economy. However, it also highlighted significant deficiencies and recommended major reforms across four key areas:

- market governance needs comprehensive reform
- stronger market integrity and conduct regulations are needed
- trade processes and information need to improve
- market architecture (trade rules and system design) needs to better reflect the physical river system.

Full details can be found in the final report from the inquiry.¹⁴²

In May 2021, the Australian Government committed \$3.5 million to establish an expert panel to address the ACCC recommendations.¹⁴³ A principal advisor has been appointed and work is underway to find actions that can be agreed by 'Basin States'. The draft implementation roadmap is expected to be released by June 2022.¹⁴⁴

The NSW Government is currently considering further reforms to the water market following the release of the ACCC's

final report, including the opportunities to introduce 'unique common identifiers' for each market participant. These unique common identifiers would enable trades to be traced and the conduct of traders to be more easily scrutinised across regions and multiple accounts in order to strengthen the transparency of water markets in NSW.

Transparency in the operation of the water markets is critical to ensure trust and accountability for all market participants. To improve transparency around water markets, the NSW Government has already implemented:

- publishing a trade price dashboard
- collecting new information on NSW trade in relation to strike dates and the purpose and price of the trade
- identifying broker and environmental trades
- increasing the scrutiny of \$0 trade price reporting
- adding an environmental water portal to the public water register.

In late 2020, the NSW Government also invited community feedback on all of NSW's water market information platforms to understand what information should be shared and how the various platforms could be improved. Submissions on the *Transparency in the NSW water markets (Discussion paper)* will feed into future considerations around water market reforms in NSW.¹⁴⁵

142. Australian Competition and Consumer Commission 2021, *Murray-Darling Basin water market inquiry—Final report*

143. The Hon Keith Pitt MO, *Budget begin process of water market reform* 13 May 2021, minister.ave.gov.au/pitt/media-releases/budget-water-market-reform

144. Department of Agriculture, Water and the Environment, *Water market reform roadmap*, www.ave.gov.au/water/policy/markets/reform

145. NSW Government will consider the potential socio-economic impacts of future water market reforms

Inter-valley and interstate water trade in the southern connected system

There are 15 unique trading zones where water allocations can be traded in the Murrumbidgee, NSW Murray, Lower Darling, Victorian and South Australian regulated river water sources. Trade between zones is subject to inter-zone trading rules, sometimes also referred to as 'inter-valley trading rules' or 'interstate trading rules', which impose restrictions on trade.¹⁴⁶

The four major allocation trade restrictions in the southern connected basin are:

- Murrumbidgee Inter-Valley Trade Limit (Murrumbidgee IVT)
- Goulburn to Murray Trade Limit (Goulburn IVT)
- New South Wales to Victoria spill risk Trade Limit¹⁴⁷
- Barmah Choke trade restrictions.

The Murrumbidgee IVT operates between the Murrumbidgee and NSW Murray regulated river water sources. It reflects the net balance of surface water volume that has been traded out of the Murrumbidgee regulated river water source to the Murray system at any point in time and that is therefore still owed to the Murray in a physical sense as a result of those trades.¹⁴⁸

The Murrumbidgee IVT is an important mechanism to partially overcome constraints in the mid-Murray, including the Barmah Choke. Since 2011/12, the Murrumbidgee IVT has switched regularly between being opened and closed, however during 2016/17 and 2018/19, there were regular and extensive closure periods.

WaterNSW is responsible for the administration and management of the trade processes that facilitate the Murrumbidgee IVT. Due to changes in water use patterns and trading behaviours, WaterNSW is conducting a review of the current arrangements for receiving and processing trade applications for access to the Murrumbidgee IVT capacity.¹⁴⁹

The Goulburn IVT is operated by the Victorian Government. This IVT does not allow trade from the Goulburn, Campaspe, Broken and Loddon systems to the Murray if more than 200 GL of water is owed to the Murray at any one time.¹⁵⁰ Since 2012/13, there has been extended periods when the Goulburn IVT has been closed, including most of the 2019/20 water year.

The Victorian Government has consulted on changes to the Goulburn IVT to address impacts on the environment and other water access entitlement holders. Should trades via the Goulburn IVT be further restricted, this will likely place increased pressure on the Murrumbidgee IVT.

146. Australian Competition and Consumer Commission 2021, *Murray-Darling Basin water market inquiry—Final report*

147. The New South Wales to Victoria spill risk trade limit is implemented by the Victorian Government. It limits allocation trade from NSW to Victoria to the lesser of a net annual volume of 200 GL or a volume that keeps the risk of spill in Victoria's share in the Murray system below 50%. Since 2012, this trade limit mostly did not apply, except during late 2015/16 and 2016/17.

148. The Murrumbidgee IVT account is operated between a lower limit of 0 GL and an upper limit of 100 GL. If the balance reaches 0 GL, trade into the Murrumbidgee is closed, whilst if the balance reaches 100GL, trade out of the Murrumbidgee is closed. These volumetric limits are in place to address physical system constraints and to minimise impacts on the water available to other water users.

149. WaterNSW, *Review of the Murrumbidgee inter-valley transfer (IVT) application and assessment approach*. Issues and options paper for public comment 2021, www.watarnsw.com.au/__data/assets/pdf_file/0009/168669/Murrumbidgee-IVT-review-issues-and-options-paper.pdf

150. If the 200 GL is exceeded, trade out of the Goulburn system is closed and cannot open again until the Goulburn IVT account balance falls below 200 GL.

Murray–Darling Basin Authority’s (MDBA) River Murray Operations use the Goulburn and Murrumbidgee IVT accounts to meet Murray River system demands efficiently, when needed. This occurs when the Murray–Darling Basin Authority calls on the operators of these two systems to release water to the Murray in a bulk delivery and essentially ‘pays back’ an amount owing to the Murray.

The Barmah Choke trade limit is implemented by the MDBA and reflects the physical constraint on the Murray River running through the Barmah-Millewa Forest. The Barmah Choke restricts the flow of the Murray River to 9,200 ML per day.

The Barmah Choke trade limit ensures that water allocation trade downstream through the Barmah Choke can only occur when there is sufficient matching prior trade upstream. Since 2014/15, the Barmah Choke trade balance has varied, however during recent years, the balance has generally been 0 GL with small periods when water allocation trade downstream could occur.

Due to the increasing demand in downstream regions and other factors, inter-regional and inter-valley trade restrictions are becoming more binding and we will likely see continuous price differentials between regions, especially during dry periods. It may also increase the risks of supply shortfalls within a year, particularly under a drier future climate or if trade constraints are further tightened.

The climate datasets and updated modelling being developed for the Murrumbidgee and Murray regional water strategies will provide further important information to analyse potential impacts of climate variability and climate change on water markets and trading activities.



Photography

Image courtesy of iStock.
Gogeldrie Weir, Murrumbidgee River.

2.3.7 Compliance

An effective compliance regime is important to ensure that:

- our water resources are effectively managed
- water users and the communities can have confidence that everyone ‘plays by the rules’ and if they do not, then they are held to account.

Following the 2017 independent investigation into NSW water management and compliance—final report (the Matthews Report),¹⁵¹ the NSW Government established and continues to build an effective, efficient, transparent and accountable compliance and enforcement framework, supported by fair and consistent procedures for the management of the state’s water resources. Leading this work is the independent Natural Resources Access Regulator, established in 2017.

The Natural Resources Access Regulator is moving from reactive to proactive, preventative compliance framework to get ahead of emerging issues, better understand the regulated environment and support the rollout of new initiatives such as the new non-urban metering policy.

This policy, announced by the NSW Government as part of the 2017 Water Reform Action Plan, will significantly improve water management and compliance. Under the framework, large surface water pumps—500 mm and above—were required to be fitted with compliant metering and telemetry equipment by 1 December 2020. All remaining NSW inland surface and groundwater works covered by the rules must be fitted with compliant metering equipment by 1 December 2022. An estimated 2,241 water supply works in the Murrumbidgee region will be subject to the metering rules: 1,205 in the regulated system, 429 in the unregulated rivers, and 607 in the alluvial groundwater systems.

In June 2021, the NSW Government announced new funding of \$23.6 million to assist water users in transitioning to telemetry-based metering—of which \$9 million will fund rebates for water users switching to telemetry and \$14.6 million will support the upgrade of government-owned meters.¹⁵²

151. Matthews, K. 2017, *Independent investigation into NSW water management and compliance*, www.industry.nsw.gov.au/___data/assets/pdf_file/0019/131905/Matthews-final-report-NSW-water-management-and-compliance.pdf

152. In Murray and Murrumbidgee regions, around 1,900 works captured by the new metering rules are fitted with meters owned by WaterNSW, as a legacy of previous Commonwealth funded programs. [www.dpie.nsw.gov.au/news-and-events/articles/2021/\\$23.6m-to-support-modernisation-of-non-urban-water-meters-in-nsw](http://www.dpie.nsw.gov.au/news-and-events/articles/2021/$23.6m-to-support-modernisation-of-non-urban-water-meters-in-nsw)

2.3.8 Knowledge and information are essential to manage water resources

To efficiently and effectively manage NSW surface water and groundwater resources and protect them into the future, we need to continuously improve our understanding of these resources and how they are used across the Murrumbidgee region.

Gathering and analysing data about how water is used in the catchment and how changes in population and land uses may affect water resources, water demands and usage behaviours will help:

- inform NSW water management decisions
- better protect the region's water resources
- address water-related risks earlier and thereby support our local communities, industries and the environment.

As a highly regulated system, there is a range of information available about storage levels, regulated river heights and flows rates in the Murrumbidgee. In addition, the southern NSW valleys were part of an early Southern Valleys Metering Project, which commenced in 2015 and aimed to ensure 95% of total extraction in the region's regulated, unregulated and groundwater systems was metered. Through the new non-urban metering policy, remaining gaps in metering will be addressed¹⁵³ (see Section 2.3.7).

The regional water strategies provide an opportunity to undertake further work to better understand water user behaviour in the southern NSW regions, in particular industry water use, to determine whether extractions track at equal or below the sustainable diversion limit (see Option 44: Better understand water use with data collection and analytics). We also need to better understand growth in NSW town water needs over the next 20 years, including the proportion of non-residential water users reliant on town water supplies.

Data and information is also important to better manage the water needs of communities, industries and the environment, and any water-related risks to these uses. We acknowledge that a lot of information is already available, but it is often dispersed and not easily accessible. The regional water strategies provide an opportunity to consider how we share the data we have with water users in the region, and how we tailor our data analytics and information products to meet the needs of different water users. Option 47: Develop targeted education and capacity building programs, has been informed by our past conversations with communities in the Murrumbidgee and suggests areas where we could target our initial efforts and build on past initiatives.

153. As of 1 December 2021, 83% of pumps 500 mm or greater in the Murrumbidgee and 75% of pumps 500 mm or greater in the Murray were fully compliant with the new metering rules.

Given the continuing demands on groundwater, enhancing our understanding of the interaction between surface water and groundwater resources in the Murrumbidgee will improve our management of these resources. We need to understand where a change in groundwater use can influence flows to rivers and vice versa. We also need to understand how a changing climate is impacting the replenishment of groundwater resources. More broadly, we need to ensure ongoing investment in the groundwater monitoring network so we have the water level and quality information we need to manage the resource into the future (see Option 32: Monitor sediment compaction over the long term). Additionally, we need to investigate how the new climate datasets and improved representation of surface water–groundwater interaction can be integrated into the NSW groundwater models (see Option 45: Improve the understanding of groundwater sources and processes, risks and impacts).

To build community confidence in water management, there is a need for government to provide more transparent and accessible information. The NSW Government has released the NSW Water Strategy which includes a key action to increase the amount and quality of publicly available information about water in NSW. The department has also recently released a range of videos that explain how water is managed in NSW.¹⁵⁴

Within NSW, there have been a number of improvements in communicating water information to stakeholders, including the:

- **NSW Water Register**,¹⁵⁵ which provides information about water licences,

approvals, water trading, water dealings, environmental water and other matters related to water entitlements in NSW

- **WaterInsights Portal**,¹⁵⁶ which provides meaningful information and real-time data to support WaterNSW customers and communities
- **NSW Allocations Dashboard**,¹⁵⁷ which brings greater transparency to the water users and market participants in relation to water availability announcements
- **Trade Dashboard**,¹⁵⁸ which brings greater transparency to water market participants in relation to information on dealings in the water markets
- **Environmental Water Hub**,¹⁵⁹ which collates relevant data and information about environmental watering activities in NSW
- The Natural Resource Access Regulator's **Public Register**,¹⁶⁰ where the public can find out about convictions under water legislation in NSW.

In addition, the Bureau of Meteorology has recently released the Murray–Darling Basin Water Information Portal as an online portal to access storage levels, water allocations and trading information across the Basin.

These information tools are expected to lead to improvements in water market participation, in the ability of water users to make business plans and decisions, and in the level of engagement in NSW water resource management planning initiatives and reforms.

154. Department of Planning and Environment, *Resource assessment process*, www.industry.nsw.gov.au/water/allocations-availability/allocations/how-water-is-allocated/resource-assessment-process?_hsmi=144879880&_hsenc=p2ANqtz-8U-3IQaR_N3guwjmq6D84WTS2Hdgj87I5K5J9U60XhpFTKJgwb9ghBxiolYTqzmWISlhPP3OqSaHTEAKDFxWY1zyb9N9xabUxEOR7-TgVhR6Y7fQo

155. NSW Water Register, www.waternsw.com.au/waterinsights/water-insights

156. WaterNSW WaterInsights, www.waternsw.com.au/waterinsights/water-insights

157. Allocations Dashboard, www.industry.nsw.gov.au/water/allocations-availability/allocations/dashboard

158. The Trade Dashboard, www.industry.nsw.gov.au/water/licensing-trade/trade/dashboard

159. Environmental Water Hub, www.industry.nsw.gov.au/water/environmental-water-hub

160. NRAR Public Register, www.dpie.nsw.gov.au/nrar/progress-and-outcomes/public-register

Enhanced Drought Information System

As a result of a national review of drought policy and state review of seasonal condition reporting, the NSW Government initiated the Enhanced Drought Information System Project to track all phases of drought onset and recovery. The system aims to build drought risk awareness, emphasise drought preparedness and improve confidence in drought monitoring and early warning, to enable more proactive drought management.

A key feature of system is the Department of Primary Industries Combined Drought Indicator, which provides complex data in a format that is useful for decision makers. The indicator integrates meteorological, hydrological, agronomic, and drought direction indexes for drought to indicate the five phases of drought—non drought, recovering, drought affected, drought and intense drought.

The Future Ready Regions Strategy 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.

The Combined Drought Indicator map portal is located at edis.dpi.nsw.gov.au

Photography

Image courtesy of Destination NSW.
Murrumbidgee River, Gundagai.



Chapter 3

More resilient water resources for the Murrumbidgee

Photography

Image courtesy of Destination NSW.
Murrumbidgee River Bridge, Narrandera.

Snapshot

Water is essential for Aboriginal peoples' health, wellbeing and connection to Country.

- The current provisions in the *Water Management Act 2000* are not meeting the spiritual, cultural, social and economic needs of Aboriginal people.
- Water is deeply entwined with Aboriginal culture and Aboriginal people's connection to Country. The health of the region's waterways impacts Aboriginal people's cultural connection to water and Country, and affects their health, wellbeing and way of life.
- In our conversations with Aboriginal people, there was a strong sentiment that Aboriginal people want to be represented in the decision-making process and have a say in how water is managed in the region.
- We also heard that Aboriginal people seek ownership of water and that any water licences and water entitlements owned by Aboriginal people should allow for economic benefits and enable employment opportunities to be created.
- The NSW Government recognises there are systemic issues that need to be addressed at a state-wide and regional level to better enable Aboriginal people to exercise their rights and to access water.

We need to improve river and floodplain flows and make sure water reaches vital environmental assets.

- The Murrumbidgee region contains a rich and diverse range of riverine and aquatic habitats, including internationally and nationally significant wetlands and swamps. These habitats support iconic native wildlife and threatened and endangered species and ecological communities.
- River regulation, structural and operational barriers, land clearing and changes in land use have altered flow regimes in the region's river systems. This has resulted in the loss of native vegetation and wetlands, and a decline in the conditions of fish communities and waterbird habitat.
- Poor water quality and extreme water quality events in parts of the region affect the ecology and survival of aquatic organisms. These problems are mostly caused by changes to natural flow regimes and land use changes.
- Higher temperatures, changes to rainfall patterns and associated flows, more intense dry and wet periods, and increased bushfire risk have the potential to significantly exacerbate existing threats to ecological health and make it more difficult to manage the landscape and ecosystems.

Regional town water supplies are under increasing pressure.

- Towns that are reliant on the region’s unregulated rivers or those that have access to only one water source are exposed to water security risks. However, further climate variability and climate change will also increase the water security risks to other towns and communities in the region—including those with access to multiple sources of water.
- Significant growth is expected in some regional centres and towns, where surface water and groundwater sources are fully allocated and heavily used, particularly around the Wagga Wagga Special Activation Precinct and the Queanbeyan, Yass and Snowy Monaro local government areas.
- The quality and conservation of green spaces and water-dependent amenity is a key factor in maintaining liveability and the wellbeing of communities. Data and knowledge gaps, and potential deficiencies in policy and regulations are impediments to shifting to non-climate dependent water sources and ensuring that adequate water is reserved for town amenity.

Water security and reliability are essential for industry and economic development.

- The Murrumbidgee region is the most diverse agricultural region in NSW, producing citrus, wine, almonds, cotton, rice, vegetables, winter cereal and annual pastures. The recent growth in permanent plantings, with year-round water demand, and the growth in cotton production, which competes with other annual crops like rice for water, is changing water demand in the region.
- Industrial and commercial growth in key regional centres is expected to be driven by increased agricultural outputs, diversification of agribusiness, and new value-added processing and manufacturing opportunities. Increased reliability and improved access to water (within extraction limits) are critical to the region’s existing and emerging industries.
- Our water management framework needs to account for these changes and build the resilience of the region’s industry to future climate variability. This includes finding water-smart ways to support expected growth in the region stimulated by the Wagga Wagga Special Activation Precinct, the Inland Rail Project and other government investments.

Greater alignment between strategic land and water planning will protect water resources in the region.

- Water resources are finite, and most water sources are fully allocated. Future population growth and urban development in the region, coupled with the ongoing pressures of drought and climate change, mean that the integration of long-term planning for land and water resources is critical.
- The Murrumbidgee Regional Water Strategy and the schedules review of the *Riverina-Murray and South East and Tablelands regional plans* provide an opportunity to explore more collaborative planning. We also need to consider inter-jurisdictional issues between NSW and the ACT to effectively enable a cross-border approach to water supply.
- Integrated planning offers opportunities to share available water more effectively, use water more efficiently, and secure water supplies for growing towns and industries, including through the water market and via new climate-independent water sources.

Existing water infrastructure and operations could be enhanced to support the region.

- The lack of storage capacity in the mid-Murrumbidgee and channel capacity constraints affect the delivery of both productive and environmental water during the peak spring and summer periods.
- Physical constraints in the Tumut River and Murrumbidgee River limit the flows that can be released from the region's main storages.

3.1 Recognise and protect Aboriginal water rights, interests and access to water

3.1.1 Water, culture and Country

Aboriginal people have lived in the Murrumbidgee region for over 45,000 years and have experienced major climate, environmental and land use changes. The Murrumbidgee region lies within the lands of 11 First Nations.

Barapa Barapa	Nari Nari	Wiradjuri	Ngunnawal/ Ngunawal
Mutthi Mutthi	Wadi Wadi	Yita Yita	Ngarigu
Nyeri Nyeri	Wemba Wemba	Wolgalu	



Photography

Image courtesy of Destination NSW.
Wiradjuri Aboriginal Cultural Tour, Tumut.

Water is deeply entwined with Aboriginal culture and Aboriginal people's connection to Country. As the first managers and carers of this natural resource, Aboriginal people have rights and a moral obligation to care for water under their law and customs. These obligations connect across communities, and connected surface water and groundwater systems.

Similar to the veins in a human body, waterways are often likened to the 'veins of the country',¹⁶¹ carrying water to sustain people and all parts of the landscape. Wetlands are often likened to human 'kidneys', as they filter water as it passes through the land. This understanding of water as a life source shows the deep connection Aboriginal people have to Country and their sense of cultural responsibility to look after all water sources so that in turn, water will look after people and all living beings.

For Aboriginal people, the Murrumbidgee region contains places of deep significance that are central to their spiritual and religious belief system and are often celebrated in ritual, ceremony, story, dance and artwork. Water supports kinship, connection, stories, songlines and healing through medicine and food. Healthy waterways and groundwater systems are critical to sustaining these aspects of Aboriginal life and to ensuring the wellbeing of Aboriginal people.

The Murrumbidgee region has important cultural sites that are registered under the Aboriginal Heritage Information System¹⁶² and are included in the NSW State Heritage Register and the Register of Aboriginal Place Names.¹⁶³ Through their registration, these sites are protected from harm and desecration under section 86(4) of the *New South Wales National Parks and Wildlife Act 1974*.

The Murrumbidgee Long-Term Water Plan recognises seven cultural sites as water-dependent assets, including Coolamatong (Lambie Gorge); the Wiradjuri Reserve and Gobba Beach, Koonadan; Dippo Ceremonial Ground; Toogimbie Indigenous Protected Area; and Gayini Nimmie-Caira.¹⁶⁴ The Murrumbidgee Long-Term Water Plan also identifies water management strategies to maintain and improve the long-term health of these and other sites in the Murrumbidgee region.¹⁶⁵ To nourish these important sites, genuine and ongoing consultation with Aboriginal people is vital.

161. Department of Planning, Industry and Environment 2020, *Murrumbidgee Long-Term Water Plan, Part A: Murrumbidgee catchment*; Murray-Darling Basin Authority 2021, *Rivers—the veins of our Country*

162. Heritage NSW, *Aboriginal Heritage Information Management System*, www.heritage.nsw.gov.au/search-for-heritage/aboriginal-heritage-information-management-system/

163. Department of Planning, Industry and Environment 2020, *Murrumbidgee Long-Term Water Plan, Part A: Murrumbidgee catchment*

164. Department of Planning, Industry and Environment 2020, *Murrumbidgee Long-Term Water Plan, Part A: Murrumbidgee catchment*

165. Department of Planning, Industry and Environment 2020, *Murrumbidgee Long-Term Water Plan, Part A: Murrumbidgee catchment*

Gayini Nimmie-Caira Project—improving environmental and cultural outcomes in the Lowbidgee

The Gayini Nimmie-Caira Project was completed in 2019 and represents a key partnership between the NSW Government and a consortium led by the Nature Conservancy to sustainably manage 86,000 ha of nationally significant Murrumbidgee floodplain.¹⁶⁶ The consortium includes the Nari Nari Tribal Council, the Murray Darling Wetland Working Group and the Centre for Ecosystem Science at the University of NSW.¹⁶⁷ This collaborative approach to managing the land and water resources at Gayini Nimmie-Caira focuses on striking a balance between three main areas:

- environmental protection
- Aboriginal engagement and participation
- sustainable development.

The five major components to the project included:

- the project purchased 19 properties on the Gayini Nimmie-Caira floodplain, together with their share of the Lowbidgee Supplementary Water Entitlement (381,000 shares)
- water entitlements were purchased and transferred from landholders to the Commonwealth Environmental Water Holder to help meet sustainable diversion limits

- an environmental watering plan that documents the demand for environmental water within and beyond the project area
- a *Long-Term Land Management and Water Management Plan*, which outlines how the area will be managed into the future with some land managed for Aboriginal cultural heritage and environmental values and other land managed for commercial use
- reconfiguring the water delivery infrastructure and enhancing the delivery of environmental water to lands identified as having high ecological value.

The arrangement aims to enhance ecological outcomes by providing an appropriate watering regime for environmental assets and values including existing lignum, red gum and black box communities, rehabilitation of some lignum areas that have been lost through irrigation development; and the protection and conservation of small and medium sized native fish, colonial nesting waterbirds and the threatened Southern Bell Frog.

As part of the project, the land was transferred back to its traditional custodians, the Nari Nari people, in 2019. This transfer recognises Aboriginal culture and heritage in the lower Murrumbidgee and the important role of Aboriginal people in managing land and water.

166. Department of Planning, Industry and Environment, *Nimmie-Caira Project*, www.industry.nsw.gov.au/water/plans-programs/state-significant-projects/nimmie-caira

167. The Nature Conservancy Australia, *Exploring Gayini—Nari Nari Country*, www.natureaustralia.org.au/what-we-do/our-priorities/land-and-freshwater/land-freshwater-stories/gayini/

Water for Aboriginal people

Aboriginal peoples' legal rights as they apply to water management have been recognised in international human rights treaties and conventions, in Australia and NSW Native Title and land rights laws, and in national and state-based water plans. These instruments recognise the importance of maintaining the knowledge and practices of Aboriginal people, promoting their full participation in decisions about water resources and acknowledging Aboriginal cultural values and uses in water planning.

In addition, First Nations prepared the 2007 Echuca Declaration which defines cultural flows as '*water entitlements that are legally and beneficially owned by the Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, natural, environmental, social and economic conditions of those Nations*'.¹⁶⁸

While there are some ways of accessing water for cultural purposes, we heard from Aboriginal people in inland regions across the state that the current provisions in the *Water Management Act 2000* are not meeting their spiritual, cultural, social and economic needs. We are committed to having an ongoing dialogue with Aboriginal people to find ways to improve this.

Native Title claims

Australia's Native Title laws recognise the traditional rights and interests to land and water for Aboriginal people, established by the *Native Title Act 1993*. The NSW *Water Management Act 2000* specifically recognises Native Title water rights, stating that 'a Native Title holder is entitled, without the need for an access licence, water supply works approval or water use approval, to take and use water in the exercise of Native Title rights' (section 55(1)). Anyone who holds Native Title with respect to water can take and use water in accordance with the laws and customs by which the title is held.

As stated in section 211(2) of the *Native Title Act 1993* '(...) the law does not prohibit or restrict the Native Title holders from carrying on the class of activity, or from gaining access to the land or waters for the purpose of carrying on the class of activity, where they do so for a) the purpose of satisfying their personal, domestic or non-commercial communal needs; and b) in exercise or enjoyment of their native title rights and interest.' Native Title holders often have water-related aspirations, from protecting waterways and aquatic ecosystems to giving advice on water management practices within a determinations area and seeking water allocations.

Several Native Title applications have been made in the Murrumbidgee region, three of which are active.¹⁶⁹ All water planning processes should engage with Native Title holders or registered claimants, and account for the possible existence of Native Title rights to water in any given area.

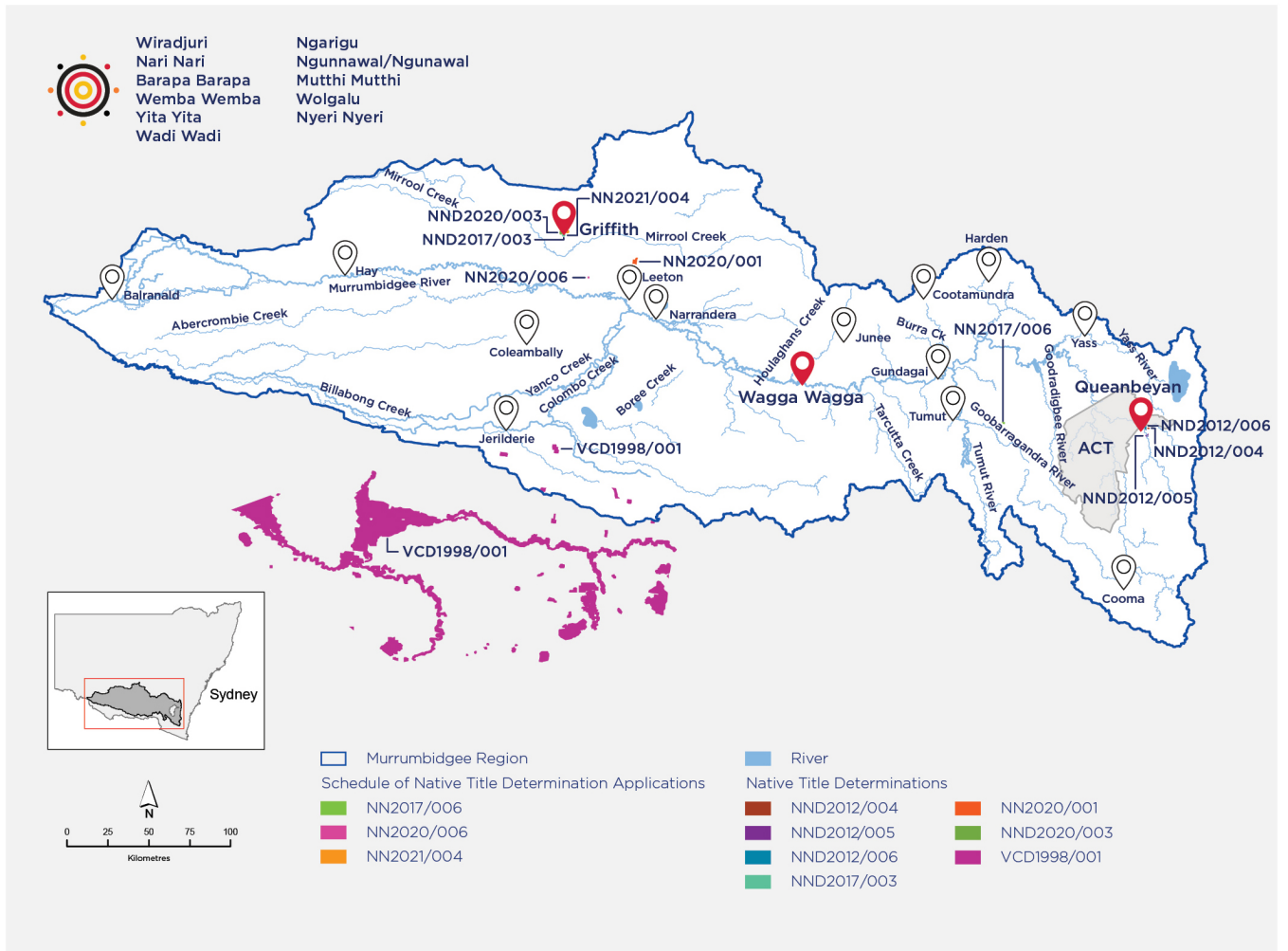
168. Murray Lower Darling Rivers Indigenous Nations (MLDRN) 2007, *Echuca Declaration*

169. Native Title Tribunal, accessed February 2022, www.nntt.gov.au/nativetitleapplications/Pages/default.aspx

Table 6. Native Title applications in the Murrumbidgee region

Application name	Tribunal file number	Status	Native Title claim overview
Daniel James Reakes	NN2017/006	Active	The claim is a small parcel of land (0.0566 km ²) on the corner of Argalong Rd and Jumpers Rd, to the east of the Tumut Plains
Griffith Local Aboriginal Land Council	NN2021/004	Active	The claim is a parcel of land (0.4975 km ²) on Rifle Range Rd, Griffith
Attorney General of New South Wales	NN2020/006	Active	The claim is a small parcel of land (0.0101 km ²) on Gogeldrie St, Whitton
Leeton and District Local Aboriginal Land Council	NN2020/001	Determined	Native Title does not exist
Ngambri Local Aboriginal Land Council #1	NND2012/004	Determined	Native Title does not exist
Ngambri Local Aboriginal Land Council #2	NND2012/005	Determined	Native Title does not exist
Ngambri Local Aboriginal Land Council #3	NND2012/006	Determined	Native Title does not exist
Griffith Local Aboriginal Land Council	NND2017/003	Determined	Native Title does not exist
Griffith Local Aboriginal Land Council	NND2020/003	Determined	Native Title does not exist
Yorta Yorta	VCD1998/001	Determined	Native Title does not exist

Figure 28. Murrumbidgee region Native Title applications and determinations



3.1.2 Water issues raised by Aboriginal people in the region

The Murrumbidgee region is the only region that has a dedicated Aboriginal Cultural Licence codified in its Water Sharing Plan for the Murrumbidgee Regulated River Water Source.¹⁷⁰ The licence is available for use each water year (1 July to 30 June) and the combined volume used under this licence cannot exceed 2,150 ML per water year.¹⁷¹ The licence is administered by the Riverina Local Land Service.

In our conversations with Aboriginal people in the Murrumbidgee, we heard that there are several issues with the use of this Aboriginal Cultural Licence. For example, the licence can only be accessed at four specific locations in the Murrumbidgee and the costs associated with using it at other locations can be extremely high. These constraints make it very difficult to achieve broader benefits for Aboriginal people in the region.

Aboriginal people can also apply for individual cultural water access licenses.¹⁷² If granted, this licence can provide up to 10 ML/year for cultural purposes such as cultural teaching or ceremonial purposes. However, the Water Sharing Plan for the Murrumbidgee Regulated Water Source constrains the granting of this type of licence by stating that 'applications may not be made (...) if it would cause the sum of access licence share components of all high security (Aboriginal cultural) access licences in this water source to exceed 2,150 ML (section 67(3)). The Murrumbidgee Regional Water Strategy is an opportunity to review this clause and to consider opportunities to simplify the application process and provide clearer and

better targeted information on how Aboriginal people can apply for these licences (see Option 2: Review Aboriginal Cultural Water Access Licence framework).

We also heard that licences and water entitlements owned by Aboriginal people should allow for economic benefits and enable employment opportunities to be created. While some groups and Aboriginal Land Councils own water licences, the licensing framework and costs of purchasing water on the market create significant barriers for Aboriginal people to buy and own water entitlements and allocations.

In our conversation with Aboriginal people, we also heard there are concerns with river operations and access to Country. There have been questions about existing river operations causing bank erosion in the upper Murrumbidgee catchment, which can have significant effects on the environment and native species. We also heard concerns about access to water and Country, which often relies on existing relationships with resident landholders. In cases where these relationships aren't established, Aboriginal people felt shut out of places that are of deep cultural significance to them. Land clearance and disturbance of important sites is another major concern, resulting in loss of native plants and other resources used for food and medicine.

Collectively, these constraints prevent Aboriginal people from adequate access to water and Country to fulfil their rights and moral obligations under their law and customs, and to protect important Aboriginal sites.

170. NSW water sharing plans set out a number of Aboriginal cultural objectives and outcomes. In groundwater water sharing plans, groundwater-dependent culturally significant areas are identified, and rules applied to ensure they are protected from any impacts associated with the construction or use of water supply works.

171. *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016*, section 67

172. In NSW, the Water Management (General) Regulation 2018 allows for applications to be made for any category of specific purpose access licence, subcategory Aboriginal Cultural, for Aboriginal cultural purposes. This ensures that applications can be made for an Aboriginal Cultural licence throughout NSW, in both surface water and groundwater. These licences allow the take of water independent of Native Title rights.

3.1.3 Opportunities and potential options

The NSW Government recognises there are systemic issues that need to be addressed at a state-wide level, as well as at a regional level, to better enable Aboriginal people to exercise their rights and access to water. These issues include access to cultural flows, self-determination and decision-making regarding water policy, increasing Aboriginal peoples'

understanding of the water management framework and incorporating Aboriginal people's knowledge and science about water systems into water planning, management and policy development.

The strategy will also consider how water-related solutions can help to deliver NSW's commitments under the National Agreement on Closing the Gap.¹⁷³

Taking state-wide action

The NSW Government recognises Aboriginal peoples' rights to water and we aim to secure a future where water for Aboriginal people is embedded within the water planning and management regime in NSW and delivers cultural, spiritual, social, environmental and economic benefits to communities.

Actions are proposed in the NSW Water Strategy to:

- strengthen the role of Aboriginal people in water planning and management

- develop a state-wide Aboriginal Water Strategy
- provide Aboriginal ownership of and access to water for cultural and economic purposes
- work with Aboriginal people to improve shared water knowledge
- work with Aboriginal people to maintain and preserve water-related cultural sites and landscapes.

173. National Agreement on Closing the Gap 2020, www.closingthegap.gov.au



Photography

Image courtesy of Destination NSW. Wiradjuri Trail, Wagga Wagga.

There are also opportunities to advance the rights, interests and aspirations of Aboriginal people in the region. These include improvements to the provisions of the 2,150 ML Aboriginal Cultural Licence (Option 2: Review the Aboriginal Cultural Water Access Licence framework), changes to enable access to water and Country (Option 3: Assess access arrangements for the Murrumbidgee Aboriginal Cultural Water Access Licence), and simplifications to cultural fishing rules and processes. There may also be opportunities to build on recent funding commitments by the Australian Government to establish River Ranger positions to help improve waterway health, manage Country and ensure more Aboriginal people are involved in water management (Option 7: Support long-term participation of local Aboriginal people in water-related matters).

Based on the learnings from the limited engagement that was undertaken, the following options have also been included for the Draft Murrumbidgee Regional Water Strategy and we are interested in feedback from Aboriginal people on these draft options:

- Option 1: Improve access to culturally significant areas and waterways for Aboriginal people
- Option 2: Review the Aboriginal Cultural Water Access Licence framework
- Option 3: Assess access arrangements for the Murrumbidgee Aboriginal Cultural Access Licence

- Option 4: Fund water entitlements for Aboriginal communities
- Option 5: Secure flows for water dependent cultural sites
- Option 6: Shared benefit project (environment and cultural outcomes)
- Option 7: Support long-term participation of local Aboriginal people in water-related matters
- Option 8: Incorporate Aboriginal history of water and culture in the southern Basin into water data.

There are several other options on the draft strategy long list, including environmental restoration works and options related to groundwater that may be able to advance the rights, interests and aspirations of Aboriginal people in the Murrumbidgee region.

Due to the COVID-19 pandemic, our engagement with Aboriginal people was significantly hindered. Accordingly, the options presented in this draft strategy to recognise and protect Aboriginal rights, interests and access to water are limited. We are committed to continuing our conversation with Aboriginal people throughout the development of the Murrumbidgee Regional Water Strategy to ensure that their rights, interests and concerns related to water are heard and included in the final strategy. We will continue this dialogue into the future to keep the Murrumbidgee Regional Water Strategy up to date with the needs and aspirations of Aboriginal people.¹⁷⁴

174. More information about our Aboriginal engagement approach is in the *Regional Water Strategies Guide*.

3.2 Protect and enhance the environment

3.2.1 Key environmental assets in the region

The Murrumbidgee region contains a rich and diverse range of riverine and aquatic habitats, including internationally and nationally significant wetlands. These habitats support native and threatened plant and animal species.

The Murrumbidgee is home to the lower Murrumbidgee floodplain (known as the Lowbidgee), which includes the Redbank, North Redbank systems and Gayini Nimmie-Caira Project area. Located between Maude and Balranald, the Lowbidgee covers over 2,000 km² and supports the second largest red gum forest and one of the largest remaining semi-permanent wetland systems and colonial waterbird breeding sites in Australia.¹⁷⁵ The extensive floodplains in the broader region support a range of water-dependent ecosystems, including instream aquatic habitats, significant black box, lignum and reed-bed communities, woodlands and permanent and temporary wetlands.

Key water-dependent environmental assets in the Murrumbidgee region are:

- two internationally important wetlands/Ramsar sites, including the permanent Fivebough swamp and seasonally flooded Tuckerbil swamp, located near Leeton and the Ginini Flats Wetland Complex Ramsar site—a series of interconnected wetlands located within the ACT. These are of national and international significance because of the abundance and diversity of waterbirds they support, including migratory shorebirds and threatened species¹⁷⁶
- there are other nationally important wetlands and swamps in the region, including Monaro Lakes, Micalong Swamp and the mid-Murrumbidgee wetlands. The mid-Murrumbidgee wetlands are a network of around 45,000 ha of river red gum wetlands, riverine lagoons and billabong formations along the Murrumbidgee River between Wagga Wagga and Hay. As these wetlands rarely dry out, they provide drought refuge for a wide range of fish and bird species, including several listed as endangered or threatened.¹⁷⁷
- threatened and iconic species, including a diverse range of native fish such as the Murray cod, trout cod and Macquarie perch, Murray crayfish, vegetation communities of black box, river red gum, lignum and spike rush, waterbirds such as the Australasian bittern and Australian painted snipe, and six threatened and vulnerable species of frogs, including the endangered Southern Bell Frog. The region contains two of four remaining natural populations of Macquarie perch and Tantangara Creek contains the only known population of Stocky galaxias.
- endangered ecological communities, which are naturally occurring groups of native plants, animals and other organisms living in a unique habitat. The natural drainage system of the lowland Murrumbidgee¹⁷⁸ and the Montane peatland swamps of the upper Tumut and upper Murrumbidgee rivers and tributaries are listed as Threatened Ecological Communities in NSW.¹⁷⁹

175. NSW Office of Environment and Heritage 2019, *Murrumbidgee Long-Term Water Plan, Part A: Murrumbidgee catchment*

176. Green D., Petrovic J., Moss P., Burrell M 2011, *Water resources and management overview: Murrumbidgee catchment*, NSW Office of Water, Sydney.

177. Department of Industry 2019, *Murrumbidgee Surface Water Resource Description*

178. The lowland Murrumbidgee River below Burrinjuck Dam lies within the Lower Murray Endangered Ecological Community.

179. Threatened Ecological Communities are listed and protected under the Australian *Environmental Protection and Biodiversity Act 1999*.

Resilient water sources are essential to support these environmental assets and species. A healthy environment contributes to the region's liveability and the health and wellbeing of communities, and bolsters tourism and other industries. Surface water and groundwater resources and their ecosystems, support agriculture and provide a range of other services: sustaining Aboriginal cultural practices; removing pollutants; regulating local climate; and providing recreational opportunities such as water skiing, fishing and nature-based pursuits (see page 119 of the Draft Murray Regional Water Strategy for further information regarding ecosystem services provided by riverine systems).

The distribution, abundance and health of native vegetation in the Murrumbidgee is strongly influenced by patterns of flooding

and drying. However, climate conditions and associated surface water flows are not the only determinant of the health of the environment in the Murrumbidgee region. Groundwater provides critical baseflow to the river during dry periods to help sustain drought refuges and support river red gum, black box, yellow box and lignum wetlands. In addition, groundwater sustains groundwater dependent ecosystems,¹⁸⁰ which occur along rivers and in wetlands of the mid and lower Murrumbidgee where there is greater connectivity between surface water and groundwater. The Murrumbidgee Regional Water Strategy provides an opportunity to advance our knowledge and management of these ecosystems (see Option 23: Improved protection of groundwater dependent ecosystems).

180. Groundwater dependent ecosystems are 'ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services': Kuginis L, Dabovic, J, Byrne, G, Raine, A and Hemakumara, H. 2016, *Methods for the identification of high probability groundwater dependent vegetation ecosystems* Department of Primary Industries—Water, Sydney, NSW.



Photography

Image courtesy of James Maguire, Department of Planning and Environment.
River Red Gum, Yarradda Lagoon.

Yanga National Park, Lowbidgee—a remarkable floodplain landscape

Yanga National Park covers an area of around 80,000 ha within the Redbank area of the northern Lowbidgee floodplain. The park is renowned for its open water and semi-permanent wetland systems that rely on flows from the Murrumbidgee River. It contains wetlands of national and international significance due to the presence of waterbird species that are protected under international migratory bird agreements.

Yanga National Park lies within the traditional lands of the Mutthi Mutthi people. There are important Aboriginal sites within the park, including mounds, scarred trees, historic sites, burials and middens.

There are 12 different wetland types in the park, predominantly tree-dominated wetlands (river red gum forests and black box woodlands) and shrub-dominated wetlands (lignum swamps). Ephemeral freshwater lakes, including Yanga Lake and Lake Tala, marshes, paleochannels and anabranches scattered within the forested floodplain form an array of habitats that play a critical role in the life cycles of the many fish, frogs and waterbird species.

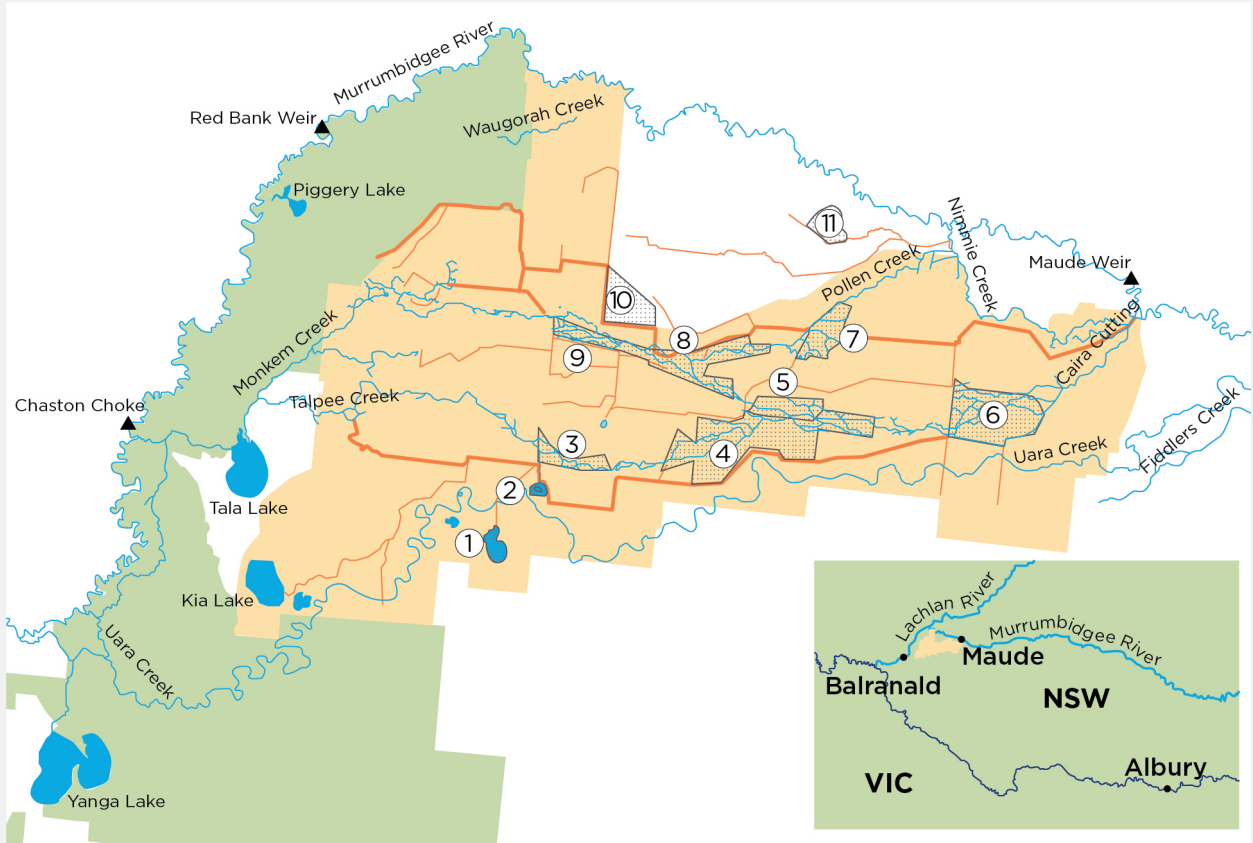
The Yanga National Park and surrounding floodplains are an important refuge and habitat for a wide range of biodiversity including 210 bird species, 24 reptile species, 13 fish species, 25 mammal species and 12 species of frogs.¹⁸¹ The area has been identified as one of the most significant wetland habitats for waterbirds in eastern Australia.

Yanga National Park and Gayini Nimmie-Caira are frequently targeted for annual environmental water deliveries. Since 2010, these areas have received around 25% of the total environmental water in the Murrumbidgee (most of this water comes from the Environmental Water Allowances and allocations made against the water entitlements held by the Commonwealth Environmental Water Holder). During dry to very dry periods, environmental watering aims to maintain key refuges for waterbirds, frog, turtles and other aquatic species in the core areas. During moderate to wet conditions, the focus is to restore key floodplain and wetland linkages.

The Yanga National Park SDLAM Project is one of the NSW Government's commitments in the region (see Section 2.3.1).

181. Office of Environment and Heritage 2015, *NSW SDLAM Adjustment Business Case—Murray and Murrumbidgee National Parks*

Figure 29. Yanga National Park and Gayini Nimmie-Caira



Legend:

- ▲ Weir
- Creeks
- Minor channel
- Major channel
- ▨ Wetlands
- Lakes
- Yanga National Park
- Nimmie Caira Project area

Key:

- ① Nolans Chance Lake
- ② Avalon Swamp
- ③ Avalon North Swamp
- ④ North and South Leas
- ⑤ Suicide Bank Swamp
- ⑥ Eulimbah Bank Swamp
- ⑦ Pollen Creek Dam
- ⑧ Telephone Bank Swamp
- ⑨ Littlewood Swamp
- ⑩ Nap Nap Creek Paddock
- ⑪ Nap Nap Swamp

Source: Nimmie-Caira Infrastructure modifications project—Phase 2 SDLAM adjustment assessment

3.2.2 Environmental issues

Condition of assets and species

The southern NSW inland regions are heavily regulated with multiple headwater storages, weirs, regulators and large offtake sites.

This regulation has disrupted the natural flow regimes of many rivers, wetlands and floodplains and has caused the health of the catchment's environmental assets and species to decline.¹⁸² The impacts of existing infrastructure and river operations (particularly in the regulated river system) include:

- reductions in the frequency and duration of connection between the river and its highly productive floodplains and nationally significant wetlands
- changes in the natural flow regime (low summer and autumn flows and high winter and spring flows) to meet irrigation and other demands. This has altered the seasonal pattern, volume, magnitude and frequency of flow events (including floods) that are required to support a healthy and ecologically resilient river system¹⁸³
- increases in annual flow and peak velocities in the upstream part of the regulated river are causing bank erosion in some areas of the Tumut River
- large extractions between Berembend and Gogeldrie weirs, which have reduced downstream flows

- creation of 'stagnant' environments that can result in stratification (leading to hypoxic conditions and fish deaths), algal blooms and barriers to fish passage, which reduce the ability of fish to migrate, breed, seek food and shelter, and to avoid predators.¹⁸⁴

The decline in the condition of the Lowbidgee floodplain is mainly attributed to the changed flooding regime, particularly flooding frequency, due to river regulation, upstream water diversion and localised land clearing. These changes reduced the original wetland area of 300,000 ha by around 58% by 1998 and left a large proportion of the remaining wetland degraded by a loss in flood-dependent vegetation.¹⁸⁵ Since 2009, the Lowbidgee has been a priority area for environmental water delivery to maintain and improve wetland health. The overall decline in wetlands and floodplain health and wetland area has also impacted water-dependent species, including the abundance and diversity of waterbirds, water-dependent frogs and native fish.¹⁸⁶

182. NSW Office of Environment and Heritage 2019, *Murrumbidgee Long-Term Water Plan, Part A: Murrumbidgee catchment*

183. Flows are now more frequent in the middle flow range, at the expense of smaller low flows, baseflows and higher flows, limiting natural wetland and floodplain connectivity to the river.

184. Water quality problems frequently occur due to a combination of alteration to natural flow regimes and land use change: Department of Primary Industries—Water 2017, *Murrumbidgee Water Resource Plan surface water (SW9): Status and Issues Paper*

185. Kingsford, RT & Thomas, R. 2004, Destruction of wetlands and waterbird populations by dams and irrigation on the Murrumbidgee River in arid Australia, *Environmental Management*, 34 (3)

186. Reduction in the frequency of floodplain inundation has also impacted the occurrence of large colonial waterbird breeding events throughout the region, particularly in the Lowbidgee. Six water-dependent frog species in the mid-Murrumbidgee wetlands and the Lowbidgee, including the endangered Southern Bell Frog, rely on refuge habitat to survive dry periods and floodplain inundation to maintain breeding habitat. Most of the mid-Murrumbidgee wetlands have been dry in recent years, with limited refuges for frog and fish habitat.

Flow regulation and extraction are two of the major factors influencing the health and condition of freshwater fish. Surveys in 2004 indicated that the fish communities of the Murrumbidgee catchment were severely degraded, with eight out of the 21 native species that previously existed in the catchment either locally extinct or surviving in low numbers. The decline in some species, such as silver perch, Macquarie perch and Murray cod, correlates to a range of factors, including the increasing number of weirs constructed in the Murrumbidgee.

Flow-related measures should be combined with complementary measures to support improvements in the health and condition of native fish. For example, while re-stocking programs attempt to restore fish numbers, they may not be successful in the long term if factors such as the required flow or habitat needs for the species are not met.

Alien fish such as carp can be advantaged over native fish by the conditions created by river operations. Carp control programs may achieve short-term gains but are unlikely to result in the permanent exclusion of carp, as, in part, programs do not address the underlying, flow-related behaviour that accounts for the success of the species.

Water quality

Water quality issues such as turbidity, algal blooms, high salinity, low dissolved oxygen levels and cold water pollution can all adversely affect habitats and health of native fish and other aquatic organisms. Such issues also affect a range of human uses including water extraction for irrigation and town water supplies, and water-based cultural and recreational activities.

Surface water quality

Surface water quality in the Murrumbidgee is strongly correlated to flow. High flow events often result in higher suspended solids (turbidity) and nutrients. There is a general trend in the Murrumbidgee towards increasing turbidity and nutrient concentration with distance down the catchment, as the impacts of land-use practices accumulate. Conversely, periods of low flow and warm temperatures occasionally result in algal blooms in the lower Murrumbidgee weir pools, river and lakes.

Previous analysis to support the development of the Murrumbidgee Surface Water Resource Plan found that:

- elevated levels of turbidity and nutrients are mainly linked to high flows and gully and bank erosion in Muttama Creek, Tarcutta Creek, Colombo Creek at Morundah, Yanco Creek and the Murrumbidgee River at Yanco and Balranald Weirs, Carathool and Waldaira
- dissolved oxygen is frequently below the target range in Billabong Creek, Colombo Creek at Morundah and the Murrumbidgee River downstream of Balranald Weir. This can be due to increased low flow periods causing eutrophication¹⁸⁷ or hypoxic blackwater events following large scale flooding

187. Eutrophication is the process by which a body of water becomes saturated with minerals and nutrients, leading to excessive plant and algal growth. Algal blooms and low-oxygen waters can kill fish and aquatic flora and reduce fish habitats.

- lakes in the lower Murrumbidgee, such as Lake Albert, Lake Wyangan, Barren Box Swamp and Yanga Lake, experience harmful algal blooms. Numbers of potentially toxic blue-green algae reach 'red alert' level for recreational use in most summers and remain on red alert for months. Lower Murrumbidgee weir pools and Burrinjuck Dam can also experience blue-green algal blooms
- from 2010 to 2012, high flows and salt loads from upland and mid-catchment tributaries resulted in the end-of-valley salt load target for the Murrumbidgee being exceeded¹⁸⁸
- Blowering Dam and Burrinjuck Dam have a high potential for severe cold water pollution because they impound deep storages, draw water from relatively deep levels in the storages, and release large volumes of water during summer.¹⁸⁹ The combined cold water pollution impacts of both dams persists for up to 200 to 300 km downstream of the Tumut-Murrumbidgee River confluence. Cold water pollution disturbs the growth, breeding and survival of some native fish, including Murray cod, freshwater catfish and other aquatic fauna.¹⁹⁰

High river flows, after a period of low flow, can transfer debris with elevated organic carbon content from the floodplains to the river. This occasionally triggers hypoxic blackwater events, which decrease dissolved oxygen levels and can result in fish deaths. Floods in 2010 and 2016 produced several hypoxic blackwater events (critically low levels of oxygen in the water) that resulted in fish deaths before environmental water (with higher oxygen levels) could be delivered to create localised refuge areas. There are no specific rules available to flush organic material from the Murrumbidgee floodplain to mitigate the risk of hypoxic blackwater events. Improved dissolved oxygen monitoring could inform early warning of events (see Option 27: Investigate water quality improvement measures).

In January 2019, following a year of well below average rainfall, reduced flow velocities and high temperatures led to stratification in a number of weir pools in the lower Murrumbidgee. At Redbank Weir, a sudden cold change resulted in destratification of the weir pool, lowering dissolved oxygen levels which caused thousands of fish deaths. This type of fish death had not been observed in the Murrumbidgee before and highlights the increased risks of such events under a changing climate. A review of the event and the associated management response recommended monitoring of depth profiles of dissolved oxygen and temperature in the lower Murrumbidgee River weir pools to inform future management decisions.¹⁹¹

188. The Murrumbidgee end-of-valley salt load target is 169,000 t/year under the Basin Salinity Management Strategy 2030.

189. Blowering Dam thermally stratifies from summer to spring, with large temperature differences between surface and bottom waters. Burrinjuck Dam's upper level intakes can only be used when the dam's storage is above 45% full.

190. Department of Infrastructure, Planning and Natural Resources 2004, *Cold Water Pollution below dams in New South Wales: A desktop assessment*. The NSW Cold Water Pollution Strategy plans to investigate options for Blowering and Burrinjuck dams as part of Stages 3 and 4.

191. Baldwin, D.S. 2019, *Weir Stratification and hypoxic water management—Murrumbidgee River*. A report prepared for the Commonwealth Environmental Water Office. In the regulated Murrumbidgee River, weir pool mixing to avoid thermal stratification that can make the bottom layer hypoxic, is the responsibility of general river operations.

Groundwater quality

Groundwater quality is also affected by multiple factors, which can be influenced by groundwater extractions and climate change, including:

- the quality of recharge sources
- groundwater-rock interactions or soil types
- rate of groundwater flow in the system.

Declining groundwater quality can affect all water users and the ecosystems that depend on that groundwater source. Reversing polluted or degraded groundwater can be costly, slow and sometimes impossible.

One of the key challenges in the Murrumbidgee region is the lack of long-term groundwater quality data to assess long-term trends and inform the sustainable management of groundwater in the region.¹⁹² Based on the available monitoring data, the main groundwater quality issues in the region are:

- PFAS contamination in the Mid-Murrumbidgee Alluvium poses a risk to future safety of regional town water supplies around Wagga Wagga
- groundwater quality in the Lower Murrumbidgee Shallow Groundwater Source varies from fresh close to the river, to saline. Due to the high salinity and low yield, the Lower Murrumbidgee Shallow Groundwater Source is generally targeted for groundwater extraction for stock use only

- groundwater in the Lower Murrumbidgee Deep Groundwater Source east of Hay is suitable for drinking water, but may require treatment for manganese. Further west of Hay, groundwater becomes more saline and is only suitable for some irrigation and stock water supply.¹⁹³ This limits towns like Balranald and Maude from accessing groundwater as a secondary source of town water supply
- There is a long-term increasing salinity trend in the Lower Murrumbidgee Deep Groundwater Source¹⁹⁴ within the main irrigation areas near Coleambally and Darlington Point, east of Hay. This trend is linked to the hydraulic connectivity between the shallow and deep aquifers and the high concentrated extraction, inducing connection with the more saline shallow alluvium. Localised areas of increased salinity within the irrigation areas have resulted in groundwater not being suitable for some crops.

The Murrumbidgee Regional Water Strategy is an opportunity to address groundwater quality issues in the region (see Option 27: Investigate water quality improvement measures, and Option 28: Manage groundwater salinity).

192. NSW Office of Water 2011, *Characterisation of hydrogeochemistry and risks to groundwater quality, National Water Commission—Raising National Water Standards Programme*

193. Department of Industry 2018, *Water quality management plan—GW9 Murrumbidgee Alluvium water resource plan area*

194. Department of Industry 2018, *Water quality management plan—GW9 Murrumbidgee Alluvium water resource plan area*

Introduced species

There are a number of introduced species that impact the landscapes and in turn the waterways of the Murrumbidgee region. Introduced aquatic species such as fish and plants can directly affect waterways whilst other introduced species, such as feral pigs and horses can destroy native vegetation, reducing groundcover and causing large scale degradation to areas such as wetlands and stream banks.¹⁹⁵

Introduced fish species such as carp, Redfin perch and trout continue to impact on native fauna species through competition, predation and altering habitats, limiting the restoration of native flora and fauna communities.¹⁹⁶ Due to the ubiquitous nature of carp across the Murray–Darling Basin, the permanent exclusion of carp from connected river reaches is unlikely to be achieved.

Water weeds, such as the introduced Elodea and Egeria species, form dense clumps that can cover large areas of waterways and affect recreational and tourism activities, town water supplies, fishway operation, ecosystems, and irrigation canals.

Invasive species are currently managed under the NSW Invasive Species Plan 2018–2021 which helps to prevent new incursions, eliminate or contain existing populations, and effectively manage already widespread invasive species. Its scope includes weeds, and vertebrate and invertebrate pests in terrestrial, freshwater, and marine environments.

Given the presence of invasive species, any management actions to improve the management of the riverine environment require careful and coordinated consideration of invasive species, to ensure that invasive species can't significantly negate any potential benefits of the action or receive a greater share of benefit compared to native species. This aspect has been built into considerations for numerous options.

195. Kosciuszko National Park wild horse control, www.environment.nsw.gov.au/topics/animals-and-plants/pest-animals-and-weeds/pest-animals/wild-horses/kosciuszko-national-park-wild-horse-management/wild-horse-control

196. Cadwallader, P. L. 1996, *Overview of the impacts of introduced salmonids on Australian native fauna*, Australian Nature Conservation Agency, www.environment.gov.au/system/files/resources/c7e5e90a-1e4b-4040-abba-38939d32ebbf/files/salmonids.pdf; Murray–Darling Basin Authority, *Fishes of the Murray–Darling Basin; Factsheet alien brown trout*, www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2201_factsheet_alien_brown_trout.pdf; National carp control program, The carp problem, www.carp.gov.au/the-carp-problem

Bushfires and water quality

The 2019/2020 bushfire season burnt around 5.6 million ha within NSW, including over 450,000 ha across the Snowy Valleys and Snowy Monaro local government areas, parts of the ACT, and around 208,000 ha in the Riverina.¹⁹⁷ This raised awareness of bushfire impacts to water quality and aquatic environments.

Indirectly, bushfires can remove riparian vegetation cover and affect its structure, thereby reducing shade, nutrient input and a source of food for in-stream animals including fish. Without shade in summer, higher water temperatures can reach lethal thresholds for many aquatic biota, including fish. The loss of litter fall and inputs of other nutrient sources such as insects undermines the riparian food web. Bushfires can also permanently destroy riparian vegetation, which can take generations to recover.

Bushfires result in the build-up of large amounts of ash in catchments. A lack of vegetation cover increases the erosive force of even moderate rainfall. Rainfall after bushfires can wash debris, ash and sediment into rivers and streams. This sludge can clog the gills of fish and smother other animals such as mussels. Organic material in bushfire ash and increased nutrients can encourage the growth of bacteria and algae that consume oxygen and lead to 'hypoxic blackwater' events leading to fish deaths and loss of aquatic invertebrates.

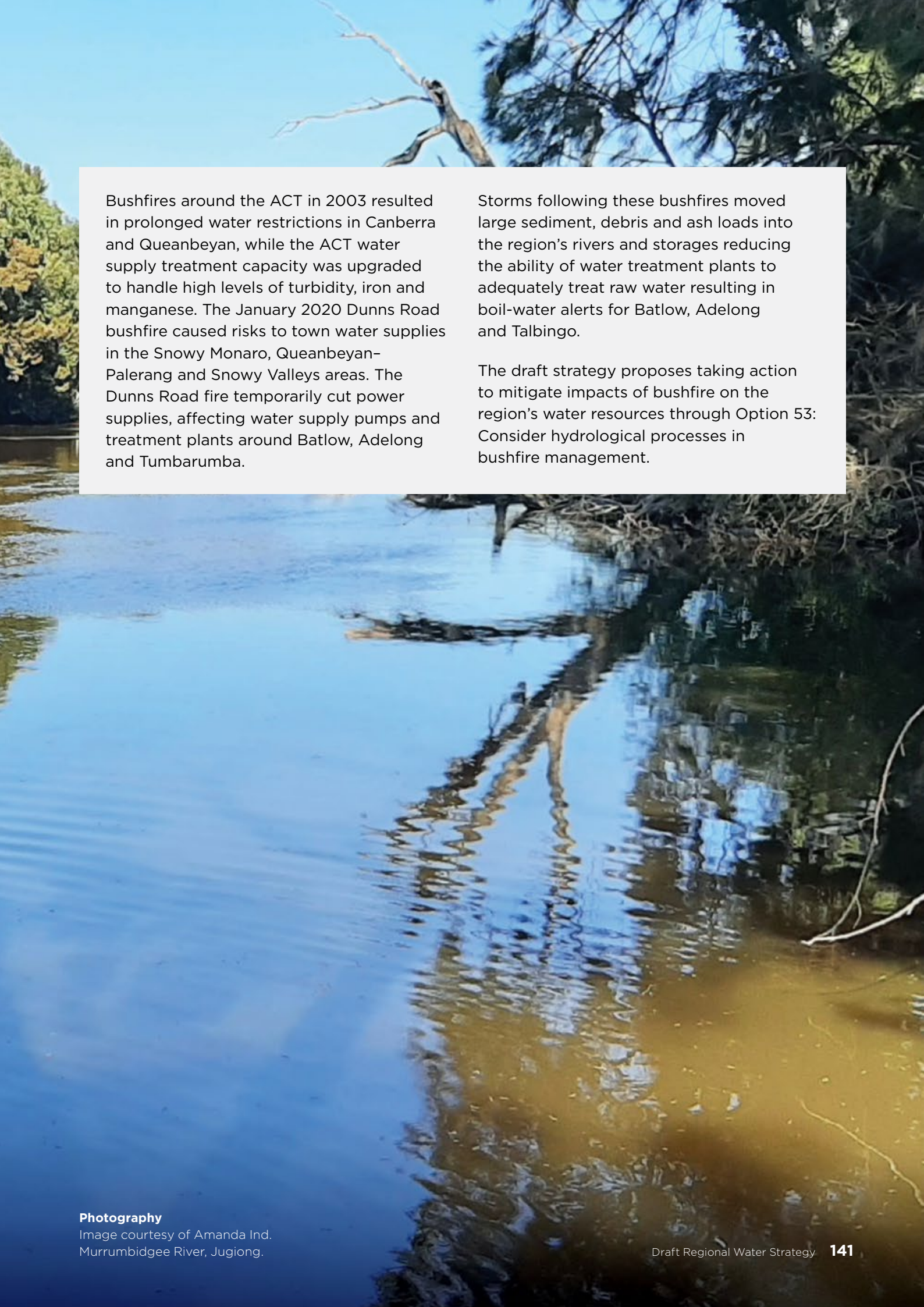
Ash and sediment also contain contaminants, including metals that may work their way up the food chain, while turbidity reduces the ability of aquatic plants to photosynthesise. Bushfire debris can also change the shape of rivers through landslides, filling holes that are preferred fish habitats and clogging feeding and breeding areas.

These impacts will persist until sufficient regrowth of trees, shrubs and ground cover prevents ash and sediment from entering the water. The long-term impacts of a loss of habitat and the food web to support native fish while bushfire impacted areas recover are significant.

As the Dunns Road bushfire in January 2020 approached, Department of Fisheries relocated several Macquarie perch from Mannus Creek in the upper Murray catchment. Around 140 critically endangered Stocky Galaxia from Tantangara Creek in the upper Murrumbidgee catchment were rescued, pending later release, ahead of heavy rainfall that could have resulted in a significant fish death event.¹⁹⁸ A small scale fish death event occurred in Tarcutta Creek, likely caused by poor water quality due to localised runoff over bushfire affected areas.

197. NSW Rural Fire Service 2020, *Incident details transmitted using the Common Alerting Protocol*

198. Department of Primary Industries website, *Threatened fish rescued across NSW in 2019/20*, www.dpi.nsw.gov.au/fishing/species-protection/current-threatened-species-projects



Bushfires around the ACT in 2003 resulted in prolonged water restrictions in Canberra and Queanbeyan, while the ACT water supply treatment capacity was upgraded to handle high levels of turbidity, iron and manganese. The January 2020 Dunns Road bushfire caused risks to town water supplies in the Snowy Monaro, Queanbeyan-Palerang and Snowy Valleys areas. The Dunns Road fire temporarily cut power supplies, affecting water supply pumps and treatment plants around Batlow, Adelong and Tumbarumba.

Storms following these bushfires moved large sediment, debris and ash loads into the region's rivers and storages reducing the ability of water treatment plants to adequately treat raw water resulting in boil-water alerts for Batlow, Adelong and Talbingo.

The draft strategy proposes taking action to mitigate impacts of bushfire on the region's water resources through Option 53: Consider hydrological processes in bushfire management.

Photography

Image courtesy of Amanda Ind.
Murrumbidgee River, Jugiong.

3.2.3 Impacts of future climate change on the environment

Higher temperatures and evapotranspiration, changes to rainfall patterns and associated flows, and more intense dry and wet periods have the potential to significantly impact ecosystems.

We are already starting to see the impacts of a changing climate in the region, with reduced average river heights and reduced frequency of overbank spilling along the river near Wagga Wagga and Hay since the 1990s.¹⁹⁹

New climate risk modelling in other inland regions²⁰⁰ indicates that all components of the flow regime could be impacted. Median and high flow volumes could be reduced by over 40% and the frequency and duration of wetland connections and large overbank flows could be significantly reduced. We could expect a similar trend in the Murrumbidgee region.

These potential flow impacts could have damaging effects on the region's aquatic ecosystem.

Updated hydrological modelling for the Murrumbidgee Regional Water Strategy is under development and will inform the assessment of options, including the assessment of environmental benefits and impacts, as we develop the final strategy.

Importantly, climate change will not occur in isolation, but will coincide with potential increases in demand and competition for water resources. The current flow management arrangements may not be as effective under a hotter and drier climate with more frequent drought periods. Further, the release of environmental water that is tied to flow thresholds may not be possible with prolonged periods of low or no inflow. This presents a long-term risk to river, wetland and floodplain health.

199. Speer, M.S., Leslie, L.M., MacNamara, S., & Hartigan, J. 2021, *From the 1990s climate change has decreased cool season precipitation reducing river heights in Australia's southern Murray-Darling Basin*. *Sci Rep*. Aug 9 11(1).

200. Based on new modelling for the Macquarie-Castlereagh and Namoi regions, documented in the associated draft regional water strategies.



3.2.4 Strategies to maintain and improve environmental outcomes in the Murrumbidgee

Plans and strategies

Long term water plans outline strategies for maintaining and improving the long-term health of rivers, creeks and floodplains. The Murrumbidgee Long-Term Water Plan describes the flow regimes that are required to maintain or improve the long-term health of the region's riverine and floodplain environmental assets and the ecological functions they perform. It also identifies the risks and constraints to meeting these long-term water requirements and informs decision-making regarding the use of environmental water.

The Reconnecting River Country Program²⁰¹ is aligned with the Long-Term Water Plan and seeks to ensure that the environmental benefits of recovered water to the river system are maximised. The preceding Constraints Management strategy identified constraints that affect the Murrumbidgee region's ability to meet environmental watering objectives:²⁰²

- the low level Mundarlo Bridge on the Murrumbidgee River between Gundagai and Wagga Wagga
- the channel capacity of the Tumut River downstream of Blowering Dam near Tumut township
- channel capacity of the Murrumbidgee River near Balranald.

In addition to these physical constraints, stakeholders along the Murrumbidgee River have raised concerns about periodic inundation of low-lying sections of their properties that are adjacent to the rivers and its distributary creeks.

Competition for channel capacity space can constrain environmental water delivery when peak irrigation demand and environmental demands coincide. Constraints on Blowering Dam releases and reduced outlet capacity of dams at low storage levels are also challenges to delivering adequate flows to achieve wetland and floodplain connection. One option being pursued to overcome some delivery constraints is building on the tail of natural flows to inundate low lying mid-Murrumbidgee wetlands and enhance connectivity along and across components of the floodplain. While some constraints relaxation measures are also being investigated, the challenge is to address any consequential third-party flood impacts.

The NSW Fish Passage Strategy is a coordinated 20-year plan to restore unimpeded fish access to mainstem²⁰³ rivers and key off-channel habitats below all major storage dams in the Murray–Darling Basin and along priority coastal waterways.²⁰⁴ Priority sites identified in the Murrumbidgee region include four proposed fishways at Balranald and Yanco weirs and Waugorah and Yanga regulators. Three of the priority sites are being considered under current SDLAM projects. The Department of Primary Industries—Fisheries has identified five additional priority weirs in the Murrumbidgee that impede fish movement: the Redbank, Maude, Hay, Gogeldrie and Berembeld weirs.

201. Reconnecting River Country Program, water.dpie.nsw.gov.au/water-infrastructure-nsw/sdlam/reconnecting-river-country-program

202. Murray–Darling Basin Authority 2013, *Constraints Management Strategy 2013 to 2024*

203. The mainstem river is the primary (or trunk) segment of a river. Water enters the mainstem from its tributaries.

204. Department of Industry 2018, *Fish Passage Strategy: Strategic Business Case Version 1*

The NSW Cold Water Pollution Strategy involved a desktop study to identify dams in NSW with the potential to cause cold water pollution.²⁰⁵ The assessment ranked Blowering Dam highest and Burrinjuck Dam fourth of all dams across the Murray–Darling Basin likely to cause severe cold water pollution. Actions to mitigate cold water pollution across the Basin have included monitoring programs, testing infrastructure operating protocols, designing multi-level offtake at Keepit Dam and trialling a suspended curtain in Burrendong Dam. Guidelines for managing cold water releases from high priority dams were developed to guide changes to structures and operating protocols that can deliver improved thermal outcomes downstream of large dams.²⁰⁶ While the first three stages of the strategy have been completed, investigations for Blowering and Burrinjuck dams have been deferred.

Environmental water

Types of environmental water

Environmental water has been managed for environmental purposes in the Murrumbidgee region since the commencement of the water sharing plans to maintain habitats for water-dependent ecosystems. There are two types of environmental water²⁰⁷ in the Murrumbidgee region:

- **planned environmental water**—water committed for ecosystem health or other environmental purposes and managed through provisions in water sharing plans. This water can be rules based (such as transparent and translucent flows, end of system flows) or ‘discretionary’ in the form of environmental water allowances (volume of water set aside for environmental purposes that can be ordered by water managers)
- **adaptive (or held) environmental water**—water allocated to water access licences held by the environmental managers for discretionary environmental use.

205. Preece, R.M. 2004, *Cold water pollution below dams in NSW: A desktop assessment*, Department of Infrastructure, Planning and Natural Resources, Sydney.

206. NSW Office of Water 2011, *NSW Cold Water Pollution Strategy. Guidelines for managing cold water releases from high priority dams*.

207. NSW Water Management Act 2000, section 8



Planned environmental water

The water sharing plans provide rules and specific accounts that are aimed at meeting the needs of the environment in the region. The Water Sharing Plan for the Murrumbidgee Unregulated River Water Sources provides access rules for taking surface water in individual water sources under certain flow classes and long-term average extraction limits. Water sharing plan rules around planned environmental water in the regulated river are more complex and cover:

- volume limits on total extraction—the long term average annual extraction limits
 - minimum end of system flow requirements²⁰⁸
 - daily environmental releases of 100% of low flow up to a limit for both Burrinjuck and Blowering dams—referred to as transparent release
 - daily releases of a proportion of medium to high inflows from Burrinjuck Dam between April and October—referred to as translucent release²⁰⁹
 - rules regulating the take of uncontrolled flows or supplementary take to protect certain components of the flow regime for environmental outcomes
- environmental water allowances, which create a discretionary volume of water in the dams that can be released for specific environmental purposes, such as wetland and floodplain inundation or flows to support the health of birds and fish. If an extreme water quality event poses an immediate threat to aquatic ecosystems, this water may also be used for dilution and flushing flows to improve water quality.²¹⁰

In 2018, the NSW Government undertook a preliminary review of translucency rules in NSW inland rivers, including the Murrumbidgee.²¹¹ The review recommended further analysis to determine whether the intended environmental outcomes could be achieved with simplified rules and a more flexible approach. This draft strategy proposes Option 30: Review environmental water arrangements, which includes further investigation of the translucency rules.

208. A minimum flow varying monthly between 180 and 1,330 ML/day is required to be passed to the end of the Murrumbidgee system at Balranald and 50 ML/day at Darlot on Billabong Creek at the end of the Yanco Creek system.

209. Translucent releases are between 22 April and 21 October each year only

210. Department of Industry 2019, *Incident Response Guide for the Murrumbidgee Surface Water Resource Plan Area*. In spring and early summer of 2016, releases from Environmental Water Allocation accounts were used to help dilute hypoxic blackwater events in the lower Murrumbidgee, and contributed to river reconnection flows in the following winter.

211. Department of Industry—Water 2018, *Review of translucency rules in NSW inland rivers. Effectiveness and alternative scenario review*.

Environmental water allowances in the Murrumbidgee

Environmental water allowances create a 'bank' of water stored in Blowering and Burrinjuck dams that can be released for specific purposes such as wetland inundation, supporting bird breeding or fish spawning events or flushing or dilution flows to address extreme water quality events. The use of these stored allowances is discretionary.

There are three main environmental water allocation (EWA) accounts that accrue water under the Water Sharing Plan for the Murrumbidgee regulated river.

The **EWA1 account** is credited up to 50,000 ML when the available water determinations for the water year plus any water carried over from the previous year are greater than or equal to 0.6 ML/unit share, times the total general security unit shares (1,891,815). Up to 50,000 ML may be taken from the second provisional storage volume account if there is no water in any of the environmental water allowance accounts. Up to 50,000 ML can be carried over but is subject to a 50% spill reduction.

The **EWA2 account** is credited from transparent and translucent releases. For transparent releases, it is credited with the release above 300 ML/day and for translucent releases, it is credited with 315 ML each day. There is no carryover limit, but any carryover is reset at the end of the water year.

The **EWA3 account** is constrained by the sum of foregone translucent releases from the previous water year up to the current date. The account is credited when the available water determinations for the water year plus any water carried over from the previous year are greater than or equal to 0.8 ML/unit share times the total general security unit shares (1,891,815) from the 1 July until 31 October. On the 1 November, 50% of the remaining volume is transferred to the second provisional storage volume account. Over November to December, it is only credited at 50% of the available water determination with the other 50% credited to the second provisional storage volume account. On the 1 January, any remaining balance is transferred to the second provisional storage and the account is no longer credited.

Photography

Image courtesy of Department of Primary Industries.
Blowering Dam, NSW.

Snowy Montane Rivers Environmental Flows

Since the Snowy Scheme was completed in 1974, its operation has affected the health and ecology of several high altitude (montane) rivers and streams. In response, the Snowy Water Inquiry was held in 1998 to examine these issues. The Snowy Water Inquiry Outcomes Implementation Deed was released shortly after, stating water recovery targets and environmental flow rules for the Snowy, Murray and Snowy Montane Rivers.

Under the Snowy Water Licence, the Snowy Scheme is required to make the following annual releases in addition to the Required Annual Releases to the Murray and Murrumbidgee rivers:

- Snowy Montane River Increased Flows:

- environmental releases into the Murrumbidgee River from Tantangara Dam
- environmental releases into the Goodradigbee River from Goodradigbee Aqueduct

- environmental releases into the Geehi River from Middle Creek and Strzelecki Creek Aqueducts
- environmental releases into the Snowy River from Falls Creek, Bar Ridge and Diggers Creek Aqueducts.

- A riparian release is also made to, as far as practicable, maintain the flow of the Murrumbidgee River at Mittagang Crossing at 32 ML/day.

These planned environmental releases are small compared with natural (pre-development) flows and are not protected from extraction. Due to the need to generate electricity and divert water westwards, it is not possible to restore the Snowy Montane Rivers to their natural state. However, there are opportunities to improve the protection and flexibility of these releases. This strategy proposes Option 30: Review environmental water arrangements, to review the effectiveness of existing water sharing plan provisions.

Photography

Image courtesy of Department of Primary Industries, Snowy Scheme, NSW.

Adaptive (or held) environmental water

A significant amount of water entitlements have been recovered for the environment in the Murrumbidgee region.²¹² This water, known as held environmental water, is managed by the NSW and Commonwealth environmental water holders. The Murrumbidgee regulated river has a large volume of held environmental water (1,140 GL), although around half of this is held as 'supplementary' access licences

(583 GL), with low reliability.²¹³ In addition, the environmental water managers hold around 6 GL of water entitlements in the Lower Murrumbidgee Deep Groundwater Source (Figure 30).

The majority of supplementary access licences are for the Lowbidgee. The second largest entitlement holdings is general security entitlements, followed by conveyance, high security and a small share in unregulated rivers.

212. As of June 2021, 442.4 GL of surface water entitlement has been recovered for the environment under the Basin Plan 2012. Department of Agriculture 2021, *Surface Water recovery under the Basin Plan as at June 2021*, www.awe.gov.au/water/policy/mdb/progress-recovery

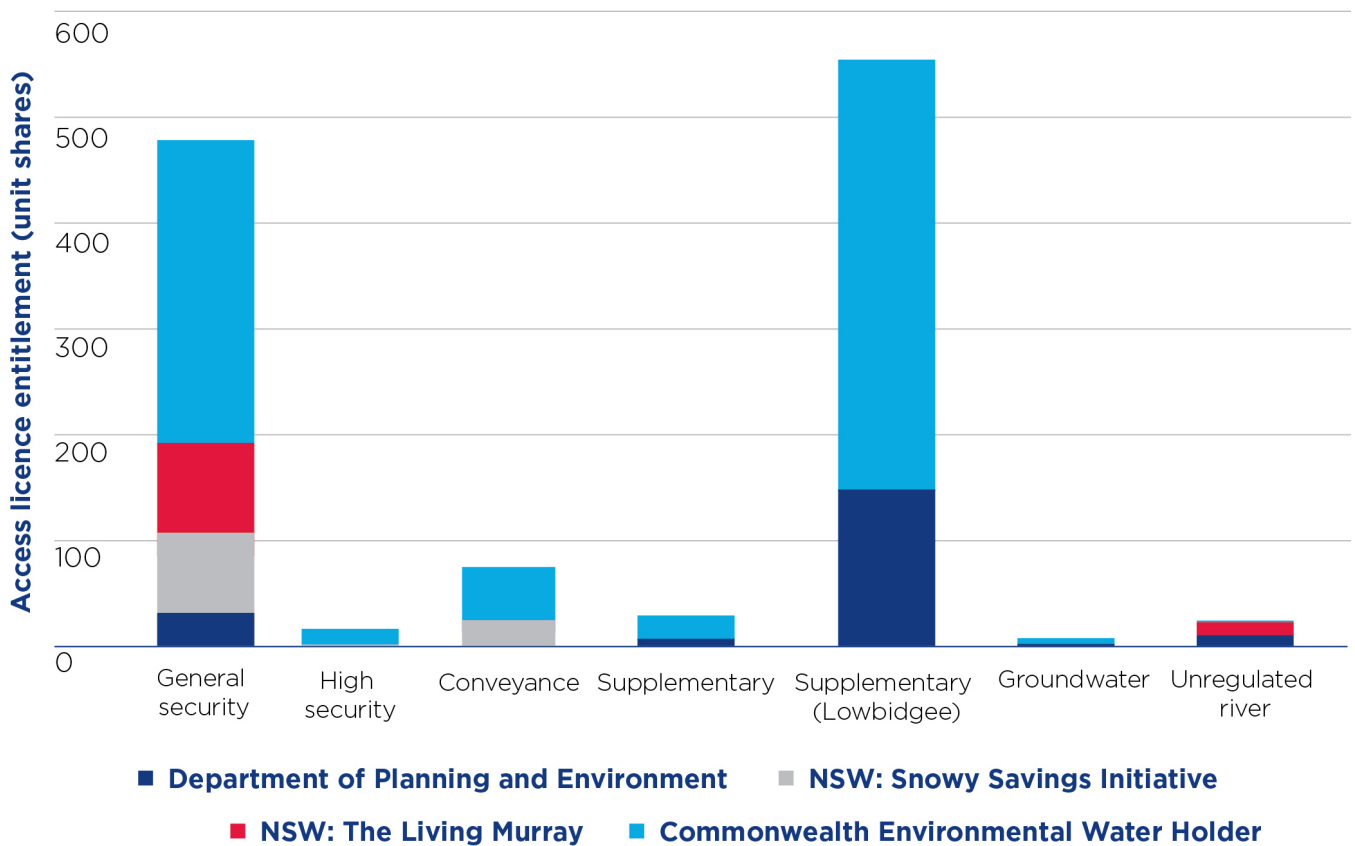
213. Supplementary water, formerly known as off-allocation water, is effectively surplus flow that cannot be captured or 're-regulated' into storages. Supplementary entitlements commenced in 2014. Supplementary water access licence holders can only pump water against these licences during announced periods of supplementary access. Department of Planning and Environment, *Supplementary Water*, www.industry.nsw.gov.au/water/allocations-availability/allocations/how-water-is-allocated/supplementary-water



Photography

Image courtesy of James Maguire, Department of Planning and Environment. Tuckerbil Swamp, Murrumbidgee Valley.

Figure 30. Licensed environmental water volumes in the Murrumbidgee region



Notes:

- These unit shares do not include rules-based or planned environmental water specified in water sharing plans.
- Snowy Savings Initiative entitlements are used to supply water to the Snowy Montane Rivers Increased Flows.
- The Living Murray entitlements are held under a joint venture arrangement with parties to the Murray Darling Basin Agreement. The Living Murray Program focuses on maintaining the health of six icon sites along the Murray River.

Source: Department of Planning and Environment, www.industry.nsw.gov.au/water/environmental-water-hub/public-register/environmental/licences

Water entitlements held by the state and Australian governments for environmental assets and ecosystem functions are subject to the same rules and obligations as water entitlement of the same class held by other water users. Hence, water available to meet environmental needs in the Murrumbidgee region is highly dependent on the region's climate and the resulting allocations and supplementary access announcements against the different water access licences, which means that volumes of water available to the environment can vary significantly from year to year. This, together with existing constraints and regulations, creates challenges to effectively deliver environmental water throughout the system.

Decisions around how environmental water is used depend on the total volume available, conditions in previous years, the prevalent status of ecosystem health and advice from community-based advisory groups. In very dry to dry conditions, the aim is often to protect the environment to avoid critical loss and/or to maintain key river and wetland functions. In wet to very wet years, more water is available to enhance floodplain and wetland connections.

Supplementary water use for the environment is subject to supplementary access announcements. When supplementary water is available, environmental managers often try to use it in combination with other sources of environmental water. Where possible, these watering actions aim to assist in protecting natural tributary inflows to maximise environmental outcomes. Supplementary water was made available in the Lowbidgee in August and September 2020 and was delivered to Yanga National Park, North Redbank and Nimmie-Caira wetlands.²¹⁴

If a water quality event poses an immediate threat to aquatic ecosystems, held environmental water may also be used for dilution and flushing flows to improve water quality, if allocations availability permits.²¹⁵

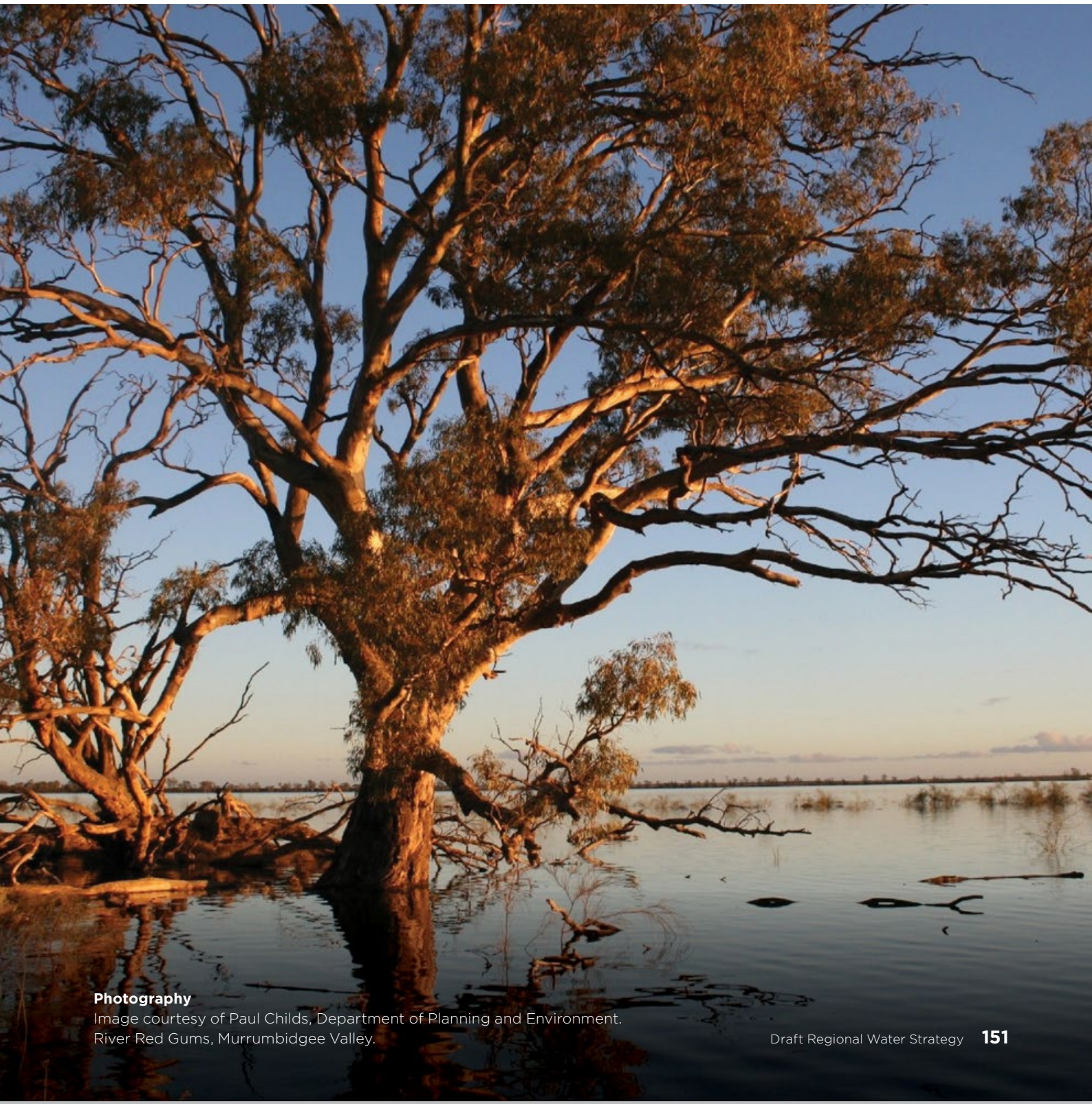
Annual variation in environmental water use is shown in Figure 31. During the Millennium Drought and recent dry conditions (2018 to 2019), there have been low general security allocations and limited supplementary access announcements. In recent years, the pattern of environmental water use and environmental outcomes has varied:

- 2016/17 was a very wet year, with significant natural flooding, which reset environmental watering priorities. Despite 100% general security allocation, there was limited need for large watering events. Heavy rain in early summer caused flooding, which resulted in hypoxic blackwater events in the lower Murrumbidgee. Environmental watering was used to target water quality issues and native fish recovery.
- 2017/18 was a dry year with 38% general security allocations (to March 2018) and a limited supplementary access announcement in December 2017. Carryover from 2016/17 enabled delivery of a whole-of-system wetland reconnection flow, which connected hundreds of wetlands along the Murrumbidgee from the mid-Murrumbidgee through to the Murray junction. Some significant environmental outcomes included improved condition of wetland habitat in the mid-Murrumbidgee and North Redbank, improved fish habitat and opportunities for breeding and movement.

214. Supplementary access announcements have also been made in 2021

215. Department of Industry 2019, *Incident Response Guide for the Murrumbidgee Surface Water Resource Plan Area*

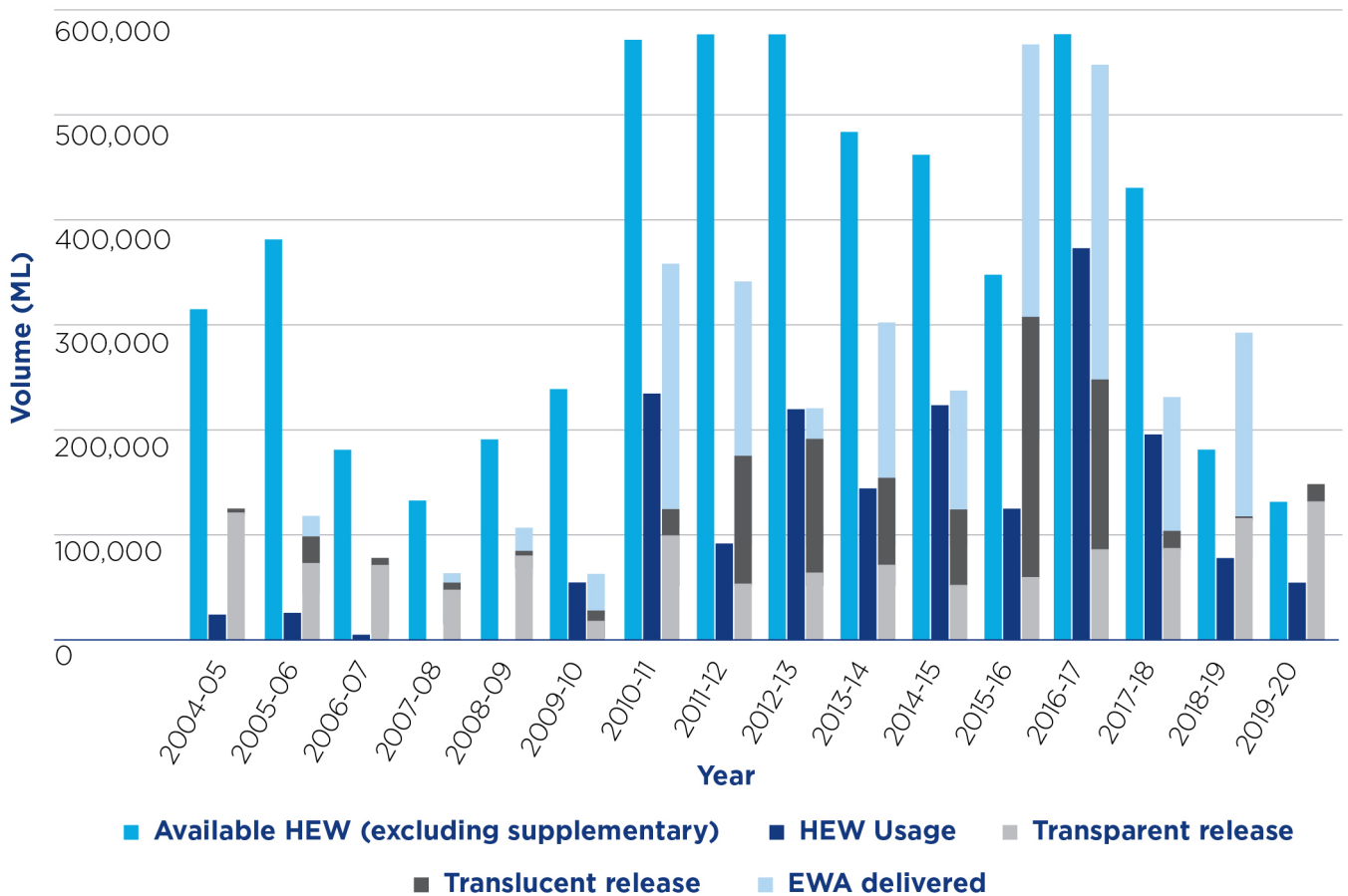
- 2018/19 was a very dry year with only 7% general security entitlement. Limited environmental watering was delivered to protect environmental assets in Yanga National Park in Lowbidgee and to maintain refuge habitats.
- 2020/21 was wet, with spills of Burrinjuck Dam and Blowering Dam in July 2021 and minor flooding along parts of the Tumut and Murrumbidgee rivers. In July 2021, general security allocations were at 50% and several supplementary access announcements were made earlier in the year.



Photography

Image courtesy of Paul Childs, Department of Planning and Environment.
River Red Gums, Murrumbidgee Valley.

Figure 31. Available held environmental water and its use since 2004 as well as planned environmental water delivery in the Murrumbidgee



Notes:

- Available held environment water (HEW) estimated as carryover plus allocation for each access licence category, at end of each water year, excluding all supplementary water.
- Planned environmental water (PEW) delivered includes transparent and translucent releases from Burrinjuck Dam and delivery of environmental water allocations (EWA).
- Environmental water allocations includes under release delivered. Planned environmental water data not available for 2019/20.

Sources: Department of Industry, Environmental Water Register, www.industry.nsw.gov.au/water/environmental-water-hub/public-register/environmental/licences; General Purpose Water Accounting Report 2018/19, Murrumbidgee Catchment; Environmental Outcomes Reports, Murrumbidgee, 2010-2019

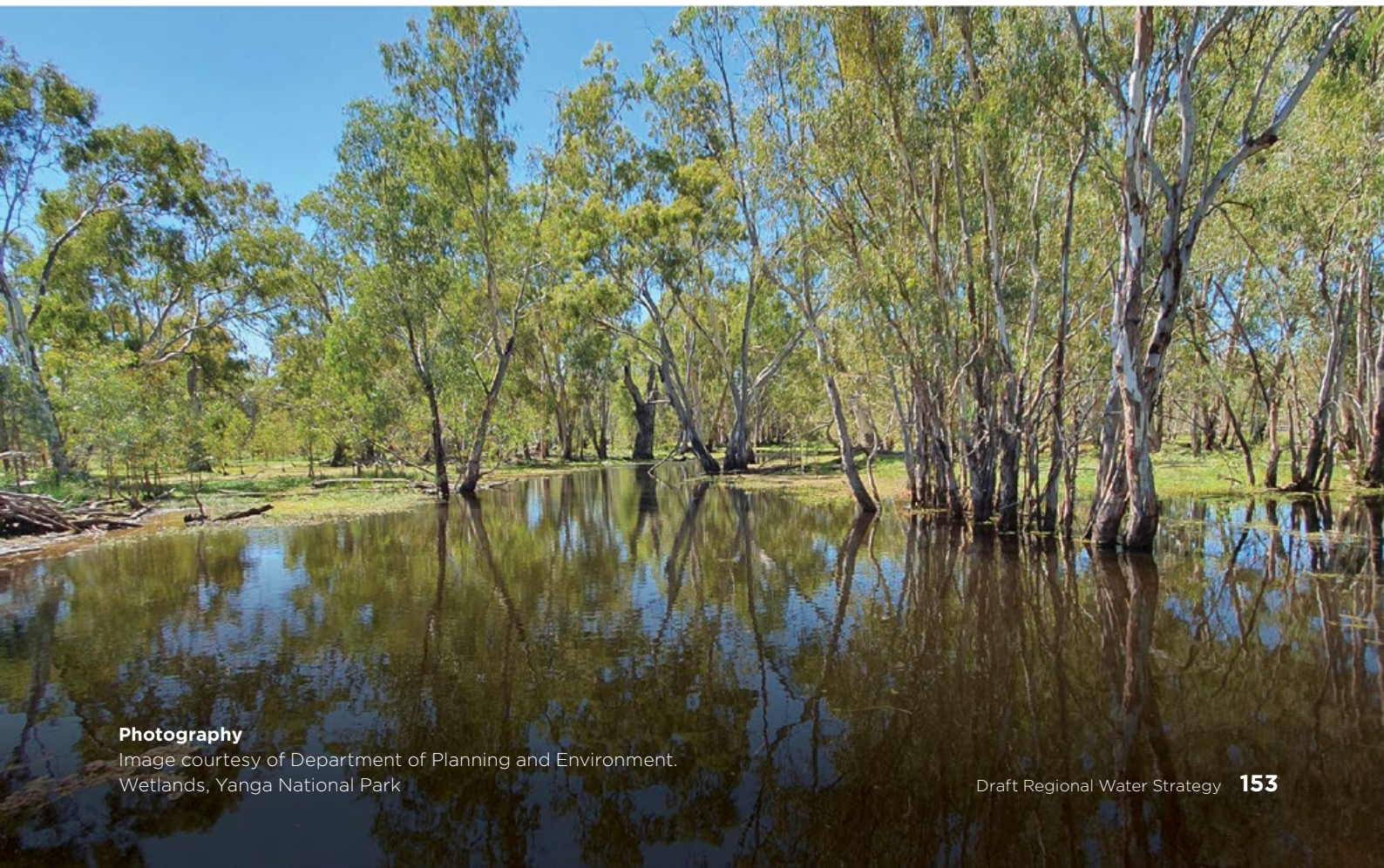
3.2.5 Opportunities and potential options

A more variable climate will require greater coordination to protect and enhance the region's vital environmental assets into the future.

Climate change on top of existing structural and operational barriers and changes in land use, will make it more difficult to manage our landscape and ecosystems, which will, in turn, affect the human activities that depend on and benefit from them. The Draft Murrumbidgee Regional Water Strategy's long list of potential options includes structural and non-structural measures to begin planning and preparing for these potential changes.

Proposed options include:

- Option 23: Improve protection of groundwater dependent ecosystems
- Option 24: Address cold water pollution
- Option 25: Improve flows to important ecological sites
- Option 26: Develop a river and catchment recovery program for the Murrumbidgee region
- Option 27: Investigate water quality improvement measures, including additional monitoring to enhance early warning systems
- Option 30: Review environmental water arrangements, including a review of the rules governing planned environmental water, such as translucent releases and environmental water allocations.



Photography

Image courtesy of Department of Planning and Environment.
Wetlands, Yanga National Park

3.3 Deliver and manage water for local communities

3.3.1 People and towns

The Murrumbidgee region is home to around 262,000 people and includes NSW's largest inland city, Wagga Wagga (population 54,400) and the regional centres of Queanbeyan (population 36,300) and Griffith (population 18,900).²¹⁶ The rest of the population lives in smaller towns or rural areas, located close to productive agricultural lands and transport routes.

The regional centres are cultural hubs for their surrounding areas and the broader Murrumbidgee region. The regional centres host a variety of festivals and events throughout the year that showcase the region's agricultural produce, such as the Batlow Apple Blossom Festival, Taste Riverina, Spirit of the Land festival in Leeton, Griffith Spring Fest and the Gears and Beers festival in Wagga Wagga. Towns along the river also host several fishing events, such as the Snowy Mountains Trout Festival in Adaminaby, the Bidgee Classic in Leeton and other fishing classics in Darlington Point, Hay and Balranald.

Based on the NSW Government's Common Planning Assumption, the region's population is expected to grow by between 9,000 and 29,000 people from 2016 to 2036.²¹⁷ More localised planning suggests the potential for growth of up to 32,000 additional people by 2036 in the Queanbeyan–Palerang, Yass Valley and Snowy Monaro areas,²¹⁸ which will drive jobs, housing and service demand—including water—for surrounding towns.²¹⁹ Potential growth of around 27,000 people is also expected for Wagga Wagga by 2040 and around 4,000 additional people for Griffith by 2036.²²⁰ Ongoing work is required to refine these population projections and understand the potential impact of the COVID 19 pandemic on future population distributions across NSW, including in the Murrumbidgee region.

Broader economic growth in the Murrumbidgee region will be stimulated by the Inland Rail Project, the Snowy 2.0 Project and the Wagga Wagga Special Activation Precinct.²²¹

216. Australian Bureau of Statistics 2016, *Census Quickstats, data for Significant Urban Area*, www.abs.gov.au/census

217. The range of population projections gives an idea of the different possible futures that might arise due to variations between the NSW Government's Common Planning Assumptions and other sets of assumptions, such as fertility, mortality and migration rates at the whole of state level.

218. Department of Planning and Environment 2017, *South East and Tablelands Regional Plan 2036*

219. Department of Planning, Industry and Environment 2019, *NSW population projections*

220. Department of Planning, Industry and Environment 2020, *Wagga Wagga Special Activation Precinct—Community and Social Infrastructure Assessment*. Population growth based on medium growth scenario; Griffith City Council population forecast, forecast.id.com.au/griffith/population

221. The Wagga Wagga Special Activation Precinct is described in more detail in Section 3.3.2 Water for people and towns

As the region grows, so will the need for town-based services such as healthcare, construction and retail. The NSW Government is investing heavily in transport, education, health, community, and digital connectivity infrastructure to cater for the region's future population and improve liveability and amenity for regional towns and communities, including:²²²

- \$250 million for a hospital and health facility project at Griffith Base Hospital
- a \$400 million package to improve digital connectivity across regional NSW
- over \$33 million in community infrastructure, such as sporting and recreation facilities, courthouses, and safety lighting in Cooma and Queanbeyan
- over \$37 million from the Fixing Local Roads Program in Cooma, Hay, Queanbeyan, Griffith and Snowy Monaro
- building new high schools in Bungendore and Jerrabomberra, and upgrading schools in Queanbeyan West and Yass.

Future population growth and urban development in the region, coupled with the ongoing pressures of drought and climate change, mean that the integration of long-term planning for water resources and other planning is critical.

As described in Chapter 2, water resources within the region are finite and generally fully allocated. This means that any options proposed for the Murrumbidgee Regional Water Strategy will need to recognise these limitations and the increasing pressures on the region's water resources from a combination of urban development, population growth and a changing climate. Planning, development and investment decisions by government and the private sector will need to take account of the constraints associated with water availability and reliability and consider the impacts on the region's environment. At the same time, there may be opportunities to share available water more effectively, use water more efficiently and secure water supplies for growing towns, including through the water market and new climate-independent water sources.

222. State of New South Wales (NSW Treasury) 2018, *NSW Budget 2019/20*



Photography

Image courtesy of Destination NSW. Streetscapes, Gundagai.

3.3.2 Water for people and towns

Challenges and issues

Around 70% of the Murrumbidgee region's population live in urban centres that rely on town water provided by a local water utility. Providing a secure and resilient water supply to regional centres, towns and outlying areas is vital for the long-term prosperity of the Murrumbidgee region, particularly given the decline in rainfall and increase in temperatures in south-eastern Australia since the mid 1990s.²²³ Healthy rivers, creeks, town water lakes, parks and open space are also critical to liveability, social equity and the amenity of towns and the wellbeing of regional communities.

The NSW Government is working closely with six councils, including Wagga Wagga, to deliver public space projects focused on improving access to and the quality of open spaces, public facilities and streets. The NSW Government has also developed a Smart Places Strategy, aligned with the State Infrastructure Strategy 2018, to plan smart cities, connected infrastructure and services. Part of the vision for the strategy is to use technology to better manage natural resources, including water.

The region faces several challenges to safeguarding secure, reliable town water supplies:

- Significant growth is expected in some regional centres and towns, where surface water and groundwater sources are fully allocated and heavily used, particularly around:
 - the Wagga Wagga Special Activation Precinct

- Queanbeyan, Yass and Snowy Monaro local government areas surrounding the ACT.
- Some towns reliant on unregulated river sources, such as Yass, do not have adequate secure yield, while several towns reliant on a single source, such as Cooma, Bungendore and Batlow, have high water security risk. These towns are also vulnerable to potential reduction in streamflow under a dry climate change scenario.
- Town water supply arrangements via the regional irrigation infrastructure operators need to be better understood to identify any potential risks and challenges to maintain adequate town supplies. Equally, further consideration needs to be given to the best way of addressing challenges faced by the region's two main regional town water supply schemes—Riverina Water and Goldenfields Water—with respect to the Mid-Murrumbidgee Alluvium.
- During extended dry periods, water allocated to towns in the regulated river may need to be reduced, as happened during the Millennium Drought.²²⁴ If no actions are taken, these situations could occur more frequently under a dry climate change scenarios.

223. Devanand, A., Leonard, M., & Westra, S. 2020, *Implications of Non-Stationarity for Stochastic Time Series Generation in the Southern Basins*, Pilot Study undertaken by Adelaide University.

224. Under the *Murrumbidgee Incident Response Guide*, the first priority for the taking of water during extreme dry periods is for basic landholder rights and essential town services, before the needs of the environment or other non-domestic purposes; in accordance with the principles laid out in the NSW Extreme Events Policy.

- Towns located in the lower Murrumbidgee that are reliant on surface water alone, like Hay and Balranald, could be more vulnerable under a future dry climate change scenario due to increased streamflow variability, increased frequency of low flows, higher conveyance losses due to increased evaporation and seepage.
- Poor water quality in some of the region's water sources is impacting the ability of local water utilities to provide safe drinking water in accordance with the Australian Drinking Water Guidelines.²²⁵
- High turbidity during floods or bushfires and algal blooms can affect the performance of water treatment facilities and disrupt water supplies to towns.

Local councils also told us that inter-jurisdictional issues, complex regulations, poor integration of regional growth and water resource planning pose additional water security challenges.

Towns within the region access water from a variety of surface and groundwater sources (Figure 32). The region's local water utilities hold 59,212 ML of surface water and groundwater water access licences and irrigation corporations hold 19,769 ML of surface water access licences to supply their connected towns and villages (Figure 33). Annual water use by the region's towns has typically been less than this.

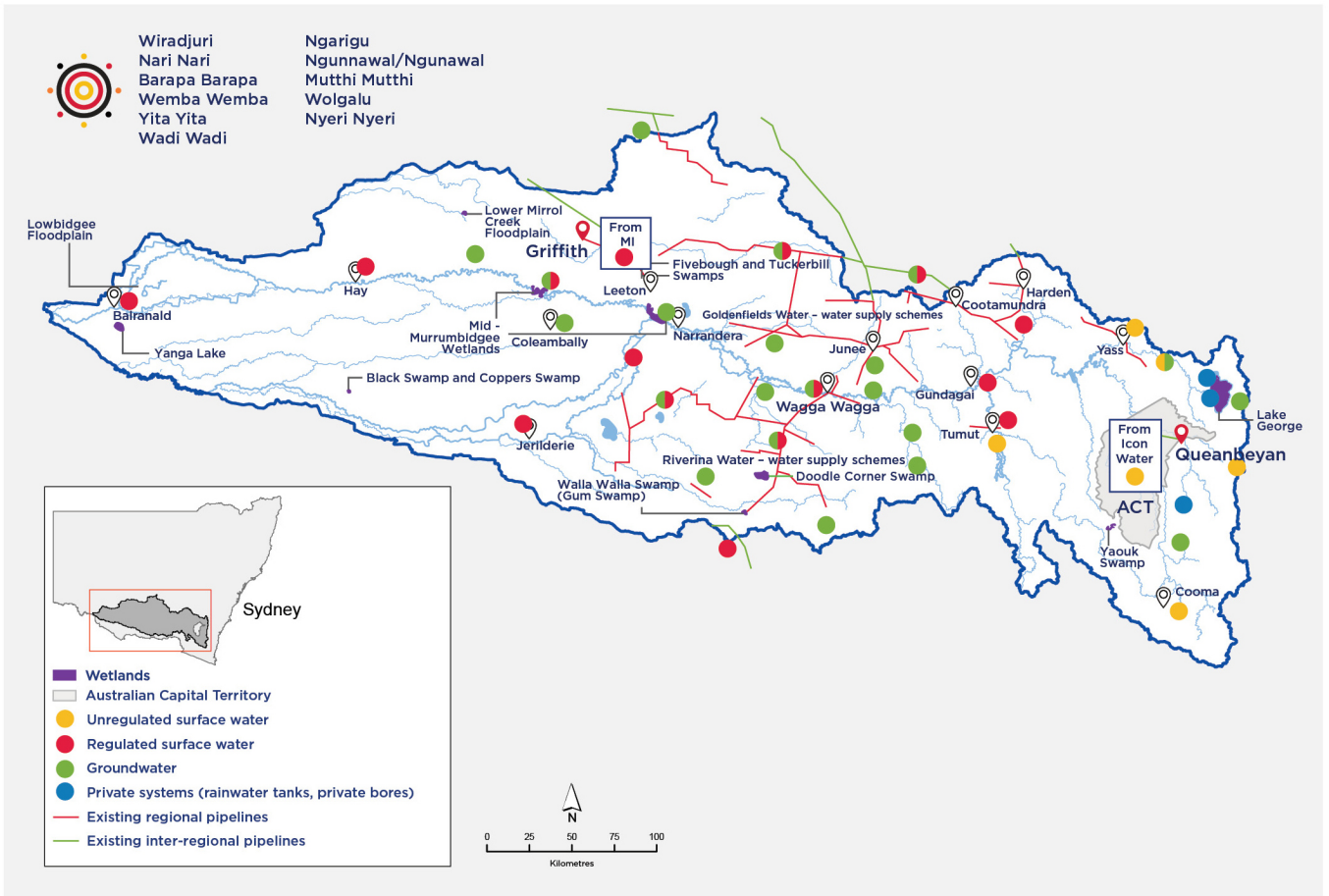
225. NHMRC and NRMCC 2011, Australian Drinking Water Guidelines, www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines



Photography

Image courtesy of iStock.
Balranald, NSW.

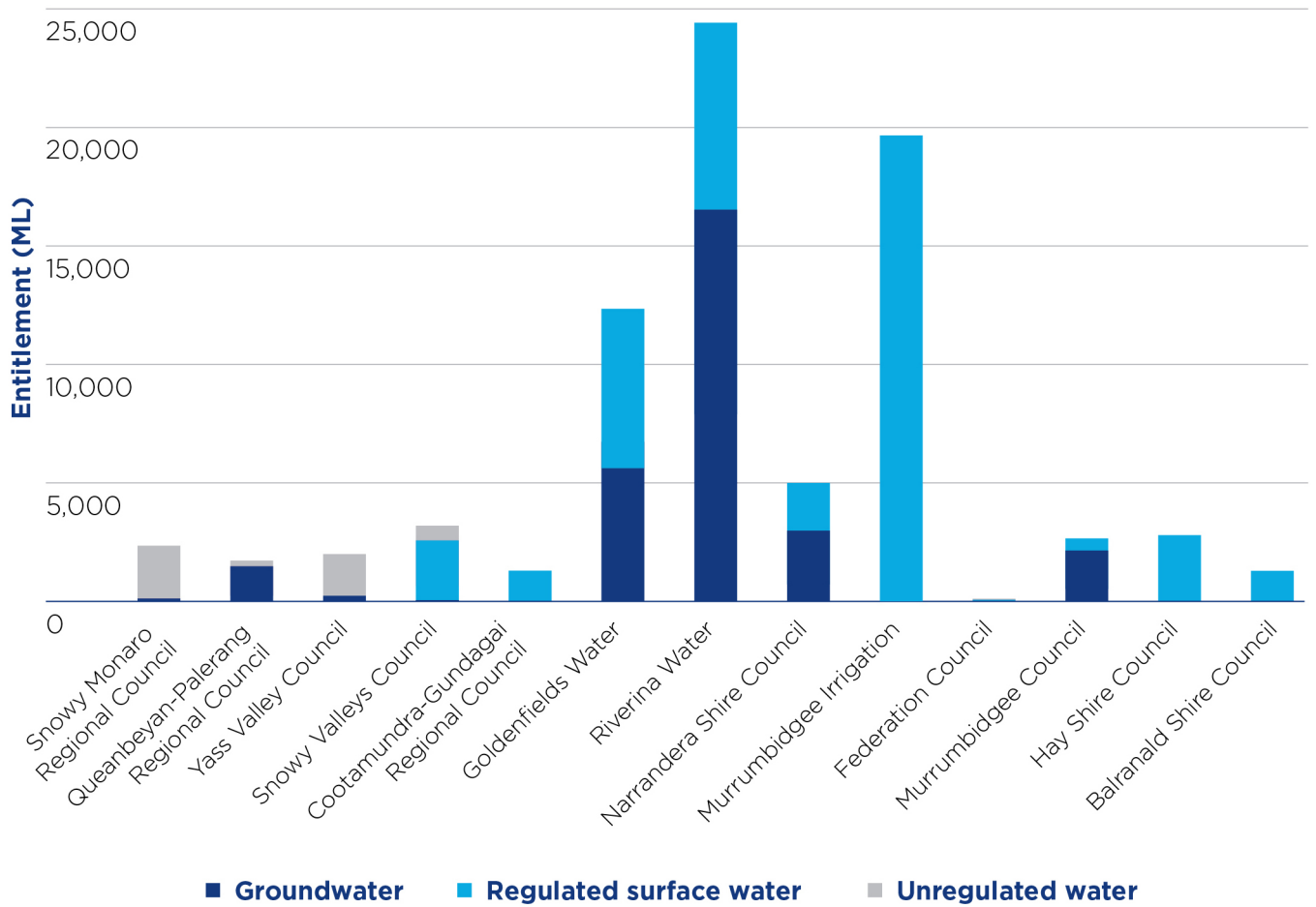
Figure 32. Murrumbidgee town water supply sources and town water supply linkages



Notes: For Goldenfields Water, Riverina Water, Yass Valley Council and Albury City Council supply schemes—approximate locations of major pipelines shown only.

- Approximate locations of major pipelines shown only for Goldenfields Water, Riverina Water, Yass Valley Council and Albury City Council.
- Some towns with independent water supplies and population under 1,000 people are not shown.

Figure 33. Water entitlements held by towns, local water utilities and irrigation corporations in the Murrumbidgee region to meet town water needs



Notes:

- Queanbeyan’s town water is supplied by Icon Water from the ACT water supply scheme. No local water utility entitlements are held for the town of Queanbeyan.
- Excludes town water supply entitlements of less than 100 ML held by Edward River, Carrathool, Hilltops and Coleambally Irrigation Co-operative limited.

Source: Department of Planning and Environment water licence database

Town water supplies— upper Murrumbidgee

Town water supplies in the upper-Murrumbidgee region are managed by shire or regional councils. The exception is Queanbeyan, which receives its drinking water from the ACT water supply system (from water sources spanning the ACT and NSW). These inter-jurisdictional linkages creates complexities and challenges for Queanbeyan-Palerang Regional Council's current and future water supply, and potential future connections to Yass Valley Council's water supply. Complexities include common water security and water restrictions with the ACT, transfers of water between NSW and the ACT, compliance with ACT strategies and standards—rather than NSW—and the need to negotiate agreements to supply new developments.

Several towns in the upper Murrumbidgee also rely on a single water supply source, putting them at high risk if water supplies fail:

- The towns of Cooma, Batlow and Yass rely on unregulated rivers that have low reliability during extended dry periods. During the Millennium Drought, Batlow experienced Level 4 water restrictions due to low streamflow in Little Gilmore Creek. Due to the prolonged dry conditions in 2018 and 2019, flows in the upper Murrumbidgee River and releases from Tantangara Dam decreased significantly, with streamflow below the 95th percentile for 54 days between January 2019 and January 2020. This prompted Level 3 water restrictions in Cooma and Bredbo.

- Bredbo sources town water from bores in the Lachlan Fold Belt MDB Groundwater Source and can experience water quality issues in the bore following minor flooding of the Murrumbidgee River.
- Bungendore's limited entitlement in the Bungendore Alluvial Groundwater Source and limited groundwater yields from bores in the Lachlan Fold Belt pose a potential constraint to growth of the town.

In the upper Murrumbidgee, extreme low and high flows have impacted the water quality of some town water supply sources. Water supplies to the towns of Yass, Tumut, Adelong, Cloverdale and Cooma are frequently affected by turbidity during floods and high river flows, resulting in temporary boil-water alerts. The Tumut water supply had three boil-water alerts in 2020.

Intense rainfall in 2010 caused major flooding in Queanbeyan and \$1.3 million in damage. The region also experienced widespread flooding during 2012 and 2016. The wetter conditions in 2020 resulted in flooding in Yass and flash flooding in Adelong.

Our new climate data and modelling is under development and will provide information on the availability and reliability of surface water entitlements held by local water utilities for a range of different climate scenarios. It will also assess impacts of any future growth in demand as part of the final strategy.

Growth and town water supply around the ACT

Expected growth and the region's connectivity with the ACT

The NSW Southern Tablelands has a diverse economy, underpinned by the variety of agriculture and tourism opportunities in the region, and connectivity with the ACT.²²⁶ The *South East and Tablelands Regional Plan 2036* provides a strategy for economic development of the area as 'a borderless region in Australia's most geographically diverse natural environment with the nation's capital at its heart'.

The *South East and Tablelands Regional Plan 2036* forecasts strong population growth in the Queanbeyan–Palerang, Yass Valley and Snowy Monaro local government areas around the ACT. This growth is being driven by:

- economic growth within the ACT providing a wider range of services and job opportunities that will drive the need for more affordable housing within close proximity to the ACT
- expansion in agricultural exports from the region, leveraging Canberra's international airport and road links
- an emerging hub for renewable energy, including Snowy 2.0 and wind farms between Queanbeyan and Crookwell
- increasing tourism in the Snowy Mountains and rural hinterland.

Achieving the vision of the South East and Tablelands as a 'borderless region' will require inter-jurisdictional planning for infrastructure delivery and service provision, including water supply.

Current water supply capacity to meet long term demand

The region's town water supplies include a range of surface water and groundwater sources. The current local water utility entitlements surrounding the ACT are not sufficient to meet future demand from the expected population growth. Icon Water's supply to the ACT and Queanbeyan is currently considered to be secure and reliable and is expected to meet the required level of service until around 2060, factoring in some additional water demand from NSW local government areas adjacent to the ACT in the future.

Current challenges to the region's town water supplies, and next steps, include:

- Bungendore's current water source, the Bungendore Alluvial Groundwater Source, is fully allocated, with insufficient capacity to meet long-term demand. Queanbeyan–Palerang Regional Council recently obtained a licence to pump from the Lachlan Fold Belt to address future demand. Investigations are ongoing to develop bores with adequate yield and confirm treatment requirements to address high levels of iron and manganese in this groundwater source.

226. Department of Planning and Environment 2017, *South East and Tablelands Regional Plan 2036*.

- Murrumbateman’s current groundwater supply, in the Lachlan Fold Belt, has insufficient capacity to meet long-term forecast demand and Murrumbatemen experiences intermittent water quality issues (for example, a high concentration of calcium).²²⁷
 - Yass Dam, the water supply for Yass, Bowning and Binalong, has insufficient capacity to meet long-term forecast demand and the dam experiences intermittent water quality issues.
 - the recently completed Yass to Murrumbateman pipeline is an interim measure to support short-term growth and address reliability issues
 - Yass Council is currently proceeding with a Yass Valley Water Supply strategy to address growth areas i.e. Murrumbateman, Yass and Parkwood. The options considered are expected to include a pipeline from the ACT to Murrumbateman and Yass, considered in the Yass integrated water cycle management strategy. The study may also need to address water supply constraints in accessing water from the ACT.
 - The Parkwood development, in the Yass Valley local government areas, may be serviced from the ACT water supply.
 - the NSW Premier signed an ACT/NSW memorandum of understanding for Regional Collaboration in June 2020. This includes the establishment of a steering committee, priority focus area plans and the Parkwood Urban Release Governance Framework.²²⁸
 - Despite expected growth in Michelago, the town does not have a reticulated water supply. Snowy Monaro Regional Council completed a servicing options study in 2020. Direct supply from the Murrumbidgee River is the preferred option; however, licensing issues remain to be resolved.
- The Murrumbidgee Regional Water strategy will inform and be informed by these ongoing investigations into regional issues and impacts. Option 15: Strengthening inter-jurisdictional water management will need to align with the work of the Steering Committee and several actions may be progressed through the committee.

227. Murrumbateman Water Supply, www.yassvalley.nsw.gov.au/our-services/water/murrumbateman-water-supply/

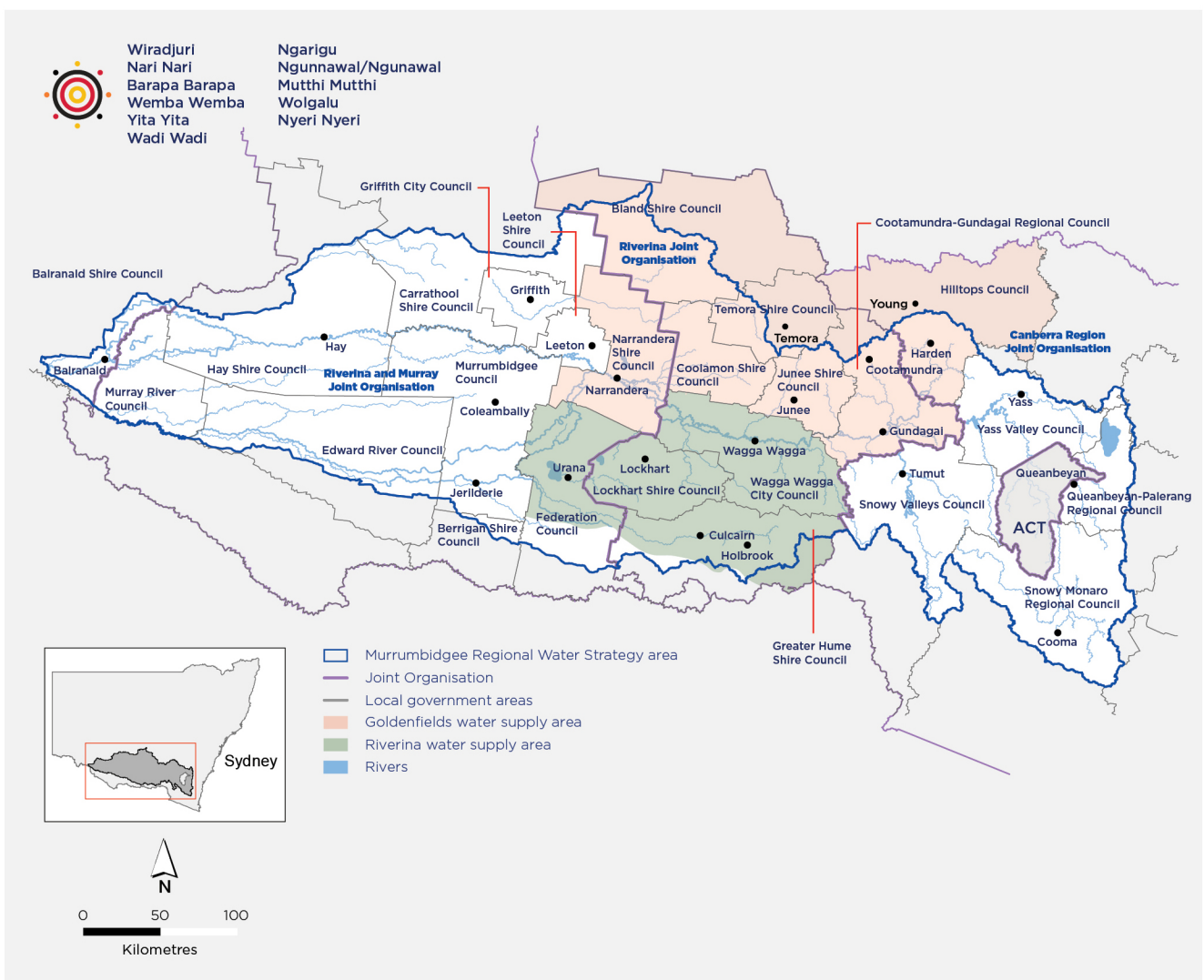
228. Parkwood Urban Release Area Governance Framework, www.regional.nsw.gov.au/__data/assets/pdf_file/0006/1274712/Parkwood-Urban-Release-Area-Governance-Framework.pdf

Town water supplies—mid-Murrumbidgee

Several communities located in the mid-Murrumbidgee are reliant on groundwater, supplied through Riverina Water and Goldenfields Water²²⁹ and by Narrandera Shire Council. Riverina Water and Goldenfields Water operate two large town water supply

schemes that provide water to towns in 11 local government areas via interconnected regional water supply schemes and several independent systems. The Goldenfields Water water supply scheme extends beyond the Murrumbidgee region, supplying several towns in the Lachlan region (Figure 34).

Figure 34. Riverina Water and Goldenfields Water Scheme boundaries



229. Riverina Water and Goldenfields Water are County Councils that operate under the provisions of the *Local Government Act 1993*.

These two regional town water supply schemes hold a portfolio of entitlements in various water sources, including the regulated river, unregulated rivers and three groundwater sources (Mid-Murrumbidgee Alluvium, Billabong Creek Alluvium and the Lachlan Fold Belt).

Murrumbidgee Irrigation Limited supplies bulk water from their irrigation canals to local water utilities within the irrigation area which includes Leeton, Yanco, Griffith and Yenda.

A few towns in the mid-Murrumbidgee rely on water sources in the Murray region, including Holbrook, Culcairn, Walla Walla and Walbundrie, which all pump from the Billabong Creek Alluvium. A few small towns in the Greater Hume Shire are supplied from Albury's regional scheme. These inter-regional linkages highlight the need for collaboration between the Murrumbidgee Regional Water Strategy and adjacent regions. The diversity of water sources for towns in the region and associated water-related challenges highlights the need for the regional strategy to complement the work being progressed via the Safe and Secure Water Program.



Photography

Image courtesy of Destination NSW.
Junee Courthouse, Junee.

Wagga Wagga Special Activation Precinct

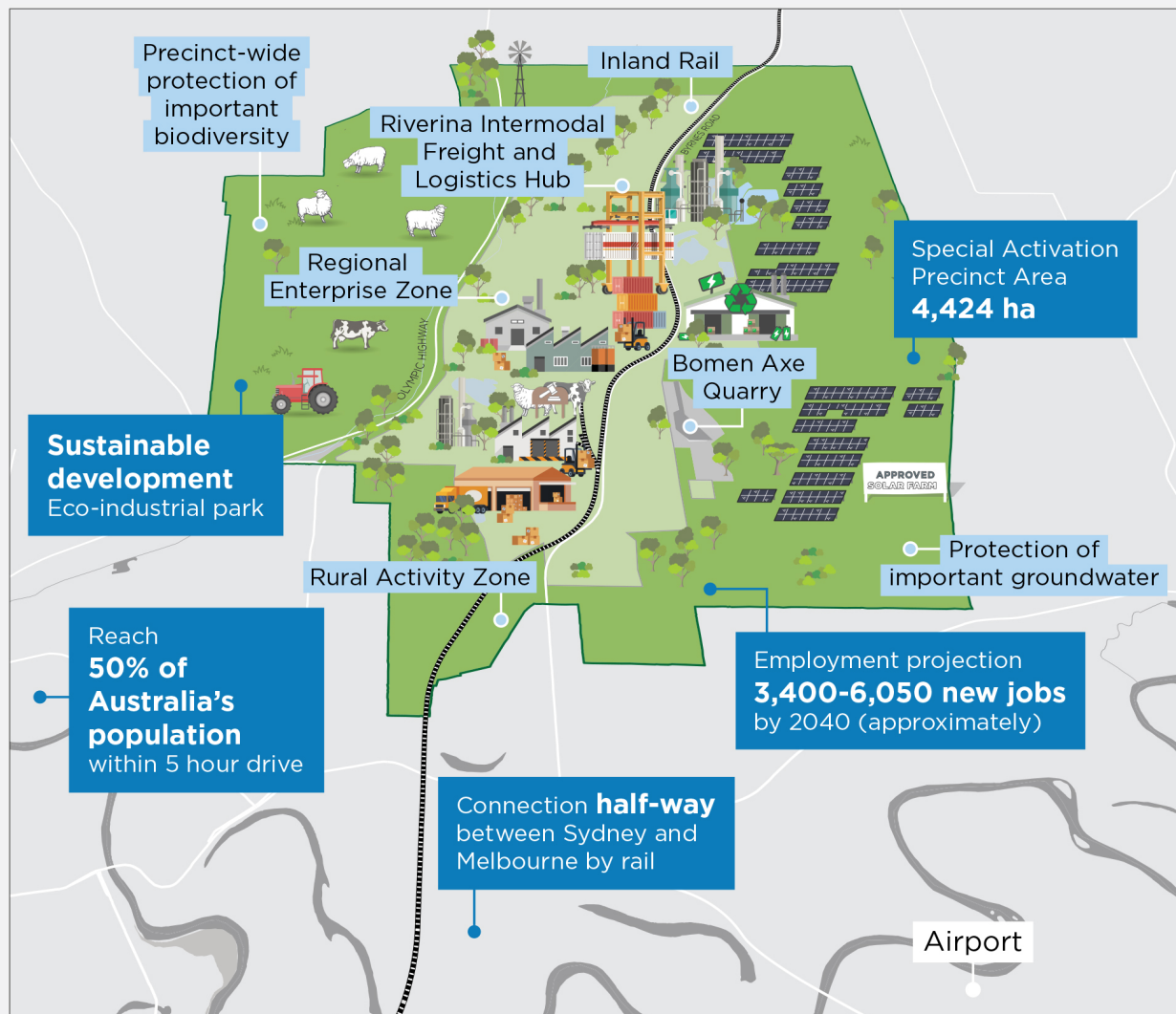
Wagga Wagga Special Activation Precinct—aspirations, vision and principles for the precinct

Special Activation Precincts are part of the 20-year economic vision for regional NSW. These precincts aim to attract businesses, create jobs and stimulate local economies in specific regional locations by streamlining the planning and approval process, investing in infrastructure and coordinating development. The Wagga Wagga Special Activation Precinct will capitalise on its highly accessible location and proximity to Australia’s richest food and agricultural

region to create opportunities for existing businesses and new investors in the region.

The Wagga Wagga Special Activation Precinct occupies approximately 4,500 ha in the north of Wagga Wagga, incorporating the Bomen Business Park at its centre. The precinct’s regional enterprise zone of 1,335 ha will be an economic and employment hub, targeting regionally significant businesses such as freight and logistics, agribusiness, advanced manufacturing, innovation and education, renewable energy and recycling. Developing over 40 years, the precinct is expected to create up to 6,050 new jobs by 2040 and up to 7,550 jobs by 2060.

Figure 35. Wagga Wagga Special Activation Precinct



The master plan sets targets for the Wagga Wagga Special Activation Precinct to become a sustainable eco-industrial precinct based on the principles of the UNIDO framework,²³⁰ which will include the goals of achieving best practice water cycle management, carbon neutrality, energy self-sufficiency and preserving the environment and cultural heritage. Thinking strategically about how existing water resources can be used and shared will be critical to the success of the Special Activation Precinct.

The following master plan provisions aim to protect Wagga Wagga's water resources:

- a groundwater protection zone will be implemented to restrict certain types of development and protect the region's groundwater sources, the main source of town water supply
- total use of groundwater and surface water must be managed within sustainable limits so that the water is available for future generations and water dependent ecosystems are safeguarded
- stormwater quantity and quality will be managed to protect waterbodies and riparian zones in the precinct and downstream
- industries settling in the precinct must hold appropriate water licences in accordance with the *Water Management Act 2000* and the relevant Water Sharing Plans.

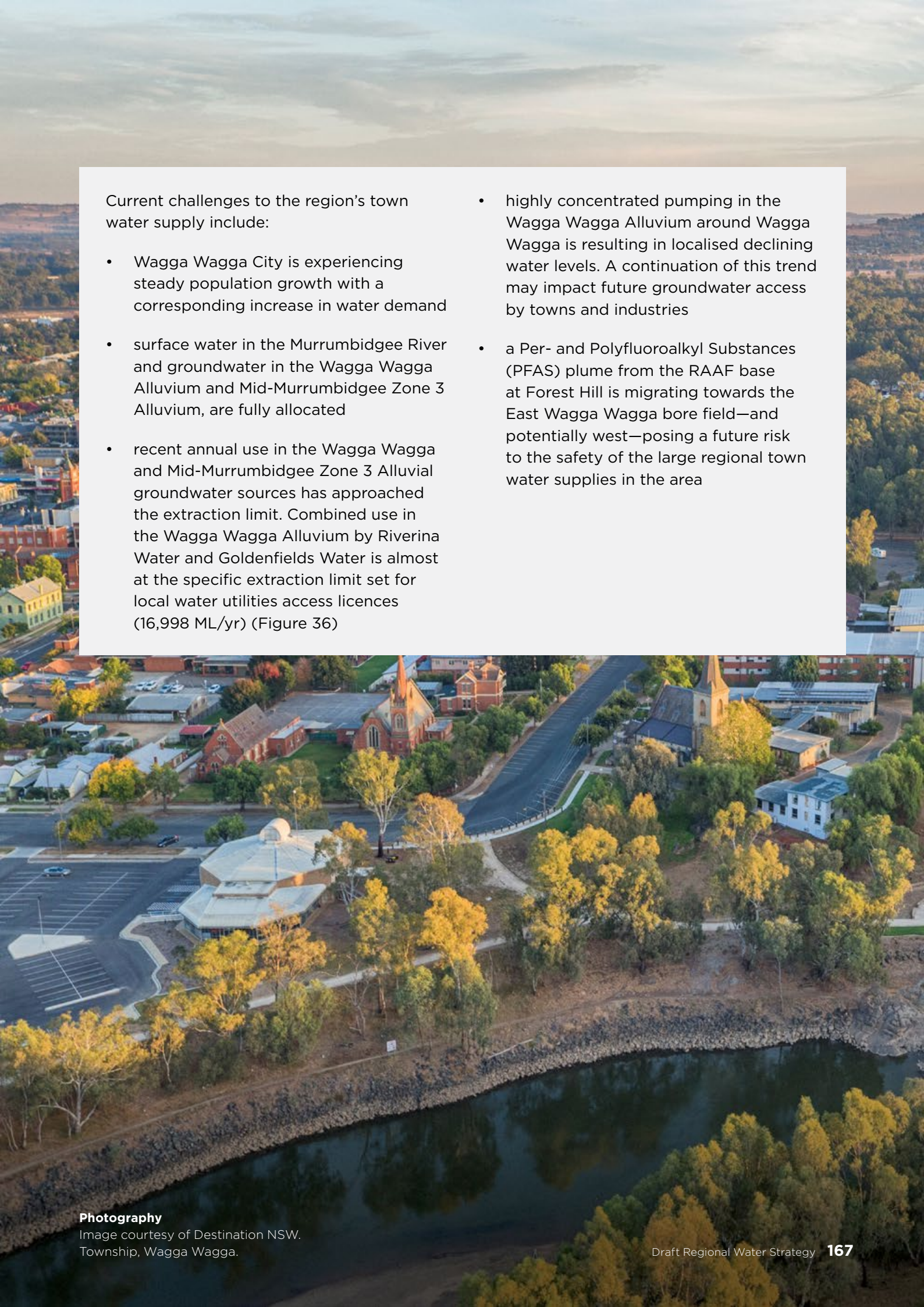
Wagga Wagga's current water supply

Wagga Wagga's town water supply is part of a larger regional supply scheme that also supplies towns within Lockhart Shire and parts of Greater Hume Shire and Federation Council; and is operated by Riverina Water. Currently, around 70% of the Riverina Water supply is sourced from groundwater, with the remaining 30% pumped from the Murrumbidgee River.²³¹ The scheme is heavily reliant on groundwater from the Wagga Wagga Alluvium, supplemented by pumping from the Mid-Murrumbidgee Zone 3 Alluvium in West Wagga and the Billabong Creek Alluvium in the south. To date, use of surface water has been less than 50% of the allocation due to variable water quality.

Riverina Water provides town water to the region via three major supply systems—North Wagga, Southern Trunk and Western Trunk—and eight independent village systems. The North Wagga system supplies the area where the proposed Special Activation Precinct is located, with all water currently sourced from the Wagga Wagga Alluvium. A small amount of bulk water is supplied by the adjacent Goldenfields Water and backup/supplementary supply can be delivered from the Western Trunk system; however, these supplies are also heavily reliant on the Wagga Wagga Alluvium.

230. United Nations Industrial Development Organisation (UNIDO) contributes to the Sustainable Development Goals by promoting the global development of standardised approaches for the implementation of eco-industrial parks.

231. Riverina Water County Council 2012, *Drought Management Plan*



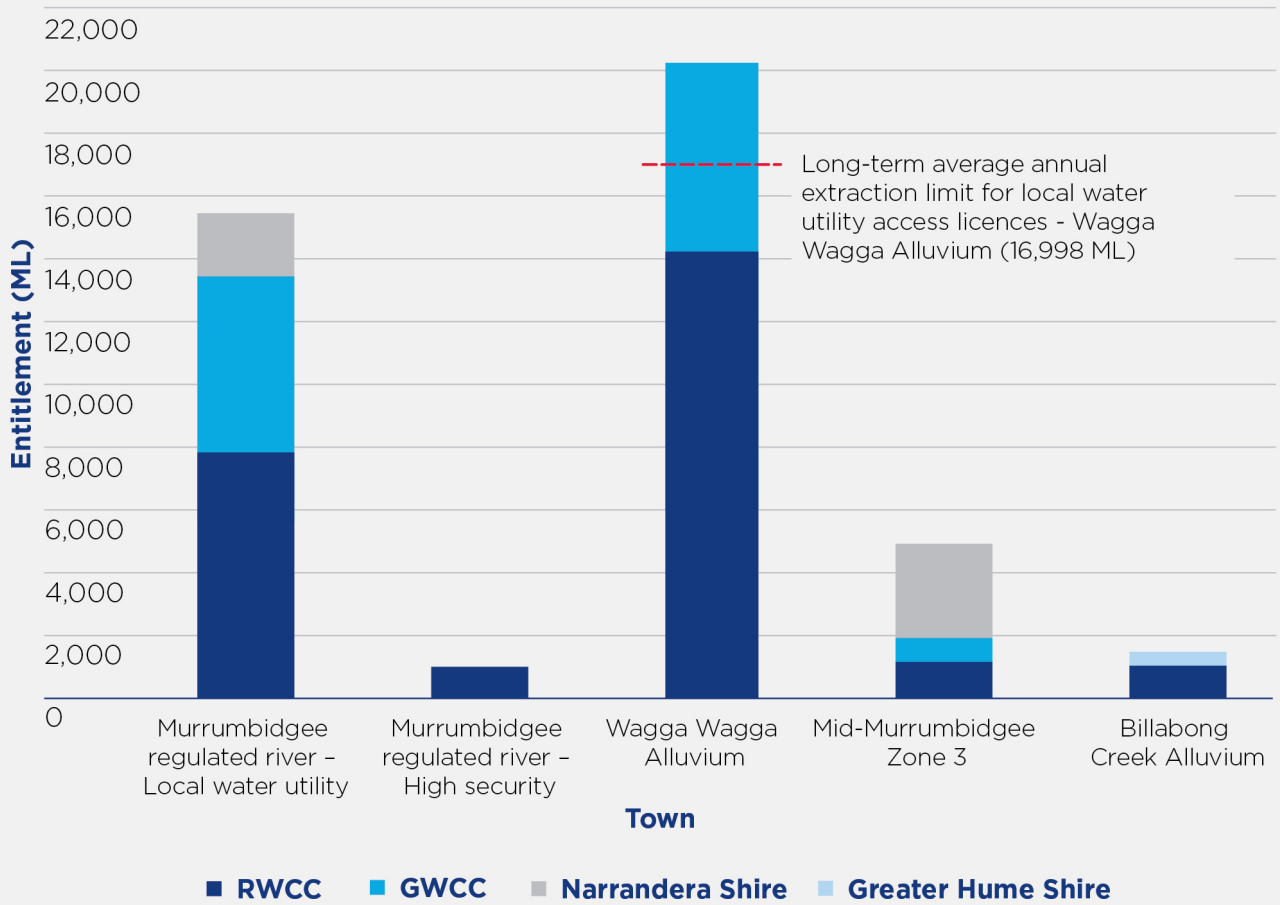
Current challenges to the region's town water supply include:

- Wagga Wagga City is experiencing steady population growth with a corresponding increase in water demand
- surface water in the Murrumbidgee River and groundwater in the Wagga Wagga Alluvium and Mid-Murrumbidgee Zone 3 Alluvium, are fully allocated
- recent annual use in the Wagga Wagga and Mid-Murrumbidgee Zone 3 Alluvial groundwater sources has approached the extraction limit. Combined use in the Wagga Wagga Alluvium by Riverina Water and Goldenfields Water is almost at the specific extraction limit set for local water utilities access licences (16,998 ML/yr) (Figure 36)
- highly concentrated pumping in the Wagga Wagga Alluvium around Wagga Wagga is resulting in localised declining water levels. A continuation of this trend may impact future groundwater access by towns and industries
- a Per- and Polyfluoroalkyl Substances (PFAS) plume from the RAAF base at Forest Hill is migrating towards the East Wagga Wagga bore field—and potentially west—posing a future risk to the safety of the large regional town water supplies in the area

Photography

Image courtesy of Destination NSW.
Township, Wagga Wagga.

Figure 36. Local water utility access licences in the mid-Murrumbidgee



Source: NSW Water Register, www.industry.nsw.gov.au/water/environmental-water-hub/public-register/environmental/licences

Opportunities to secure future water security for regional growth and the Wagga Wagga Special Activation Precinct

Wagga Wagga has experienced steady population growth for the last two decades. The 2016 population of around 54,400 people is expected to grow to around 100,000 people within two or three decades.²³² Several possible development scenarios investigated for the Special Activation Precinct indicate that future water demand in the precinct will more than double over the next 40 years.²³³ The overall projected increase in water demand could potentially exceed current groundwater extraction limits within the next 5 years, triggering further management actions.

Access to water supply for both the Special Activation Precinct area and northern growth areas, is provided by Riverina Water through the existing North Wagga system, which supplies the Bomen Business Park and Brucedale. Riverina Water has recently constructed a new water treatment plant to increase capacity and address periodic turbidity issues with the Murrumbidgee River source. To meet future water demands, use of surface water may need to be increased. Riverina Water is currently investigating options through its integrated water cycle management strategy.

It is anticipated that the current integrated water cycle management strategy will investigate the feasibility of a range of potential options, giving consideration to sustainable diversion limits and potential impacts to other water users in the region. The strategy is also expected to consider the use of recycled water for non-potable use, which would reduce additional demand for potable supply.

The Murrumbidgee Regional Water Strategy provides an opportunity to consider broader regional solutions to support communities and growth in the region, including the Wagga Wagga Special Activation Precinct. This could include a review of changes to constraints around trade of local water utility licences (Option 52: Water market and trade review), securing reliable groundwater access for towns (Option 21: Secure and reliable access to groundwater for towns) and investigating water recycling options (Option 18: Review impediments to water recycling projects and Option 19: Assess potable re-use for towns).

232. Department of Planning, Industry and Environment 2020, *Wagga Wagga Special Activation Precinct Draft Master Plan*

233. WSP Consultant 2020, *Final Masterplan Report—Infrastructure and Services Plan, Wagga Wagga Special Activation Precinct*

Town water supplies— lower Murrumbidgee

Town water supplies in the lower Murrumbidgee region are managed by shire councils. The town of Hay and Balranald each rely on water from the Murrumbidgee River via weir pools. Located towards the end of the Murrumbidgee River system, these weir pools are occasionally prone to low flow periods, which may result in algal blooms, and intermittent high flows that can cause turbidity issues. Provided additional treatment processes, such as activated carbon or advanced oxidation are operational, the presence of blue-green algae mainly affects the taste and odour of town water supplies.²³⁴ Some species of blue-green algae can be toxic to animals and cause illness to humans if untreated water is ingested. Hay and Balranald are also located in the lower part of the catchment. Due to large conveyance requirements and water delivery timelines, these towns are more vulnerable—particularly during dry times.

Town water security risk

In regional NSW, town water supply systems are designed on a consistent basis using the NSW Government's *Guidelines on Assuring Future Water Security*. Systems are planned and sized in consultation with the community, giving consideration to historical and future consumptive needs and climate projections. Local water utilities are responsible for providing water and sewerage services to their respective communities in a way that balances costs and community expectations about the levels of service.

All town water supplies have some level of inherent risk and are designed to accommodate moderate levels of restrictions. The NSW Government has developed water security risk ratings for town drinking water systems in the region, as part of the Safe and Secure Water Program.²³⁵ The water security risk score is combined with an environmental risk score, water quality risk score and socio-economic risk score to prioritise projects that address the highest risk regional town water supplies.

The water security risk rating is a combination of the inherent water security risk score (ratio of secure yield and demand) and the size of the affected population.²³⁶ Local water utilities undertake secure yield analysis as part of their integrated water cycle management planning.²³⁷

234. Water Quality Research Australia Limited 2010, *Management Strategies for Cyanobacteria (Blue-Green Algae) and their Toxins: a Guide for Water Utilities*, Research Report 74.

235. Department of Planning and Environment, *Safe and Secure Water Program*, www.industry.nsw.gov.au/water/water-utilities/infrastructure-programs/safe-and-secure-water-program

236. Ratio combined in accordance with Australian Standards: AS 4360/AS ISO 31000

237. Secure yield is defined as the highest annual water demand that can be supplied from a water supply headworks while meeting the 5/10/10 design rule and is determined using a system-specific hydrologic water balance computer model that incorporates historical and future meteorological information. Secure yield is determined in accordance with draft NSW Guidelines on Assuring Future Urban Water Security—Assessment and Adaption Guidelines for NSW Local Water Utilities. For town water systems that do not currently have reliable assessment of secure yield, the guideline methodology is extrapolated to estimate the inherent water security risk to these systems.

The secure yield analyses, for both surface water and groundwater supplies, take into account:

- headworks—water storage and treatment—arrangement and capacities
- the forecasted annual unrestricted drinking water demand placed by the community on the system’s headworks
- physical water delivery system and operational rules under water sharing plans

- operating protocols and past experiences in delivering water in drought conditions
- historical climate and an estimated future 1°C increase climate warming scenario.²³⁸

Table 7 shows the current water security risk ratings developed by the Safe and Secure Water Program, for town water supplies with medium to very high risk. These water security risk ratings, which are specific to each local water utility’s town water supply system, differ from the modelled surface water entitlement reliability risk analysed as part of the regional water strategies.

Table 7. Water security risk (medium to very high) for centres and towns in the Murrumbidgee region

Local water utility	Town water supply system	Water source(s)	Population served in 2014*	Water security risk**
Snowy Valleys Council	Batlow	Unregulated - Little Gilmore Creek	1,026	Very High
Snowy Monaro Regional Council	Cooma	Unregulated - upper Murrumbidgee River	6,301	Very High
Queanbeyan-Palerang Regional Council	Bungendore	Bungendore Alluvial	2,754	Very High
Balranald Shire Council	Balranald	Murrumbidgee Regulated River	1,161	Very High
Yass Valley Council	Yass, Binalong and Bowning	Unregulated - Yass River	6,195	High
Yass Valley Council	Murrumbateman	Lachlan Fold Belt	1,542	High
Leeton Shire Council***	Leeton, Yanco and Wamoon	Murrumbidgee Regulated River	8,400	High
Griffith City Council***	Griffith	Murrumbidgee Regulated River	18,754	High

238. For the purpose of accounting for climate change in the regional water strategies’ options assessment, it was assumed that the secure yield under a historic climate would be reduced by 35%—being the average of eight secure yield studies undertaken for inland supply systems, where the reduction in secure yield ranged from 20 to 50%.

Table 7. Water security risk (medium to very high) for centres and towns in the Murrumbidgee region (continued)

Local water utility	Town water supply system	Water source(s)	Population served in 2014*	Water security risk**
Murrumbidgee Irrigation	Yenda	Murrumbidgee Regulated River	1,021	High
Riverina Water County Council	Urana & Oaklands	Mid-Murrumbidgee Alluvium Murrumbidgee Regulated River	1,261	High
Cootamundra-Gundagai Regional Council	Gundagai	Murrumbidgee Regulated River	1,926	Medium
Goldenfields Water County Council	Regional Scheme	Mid-Murrumbidgee Alluvium Murrumbidgee Regulated River	34,600	Medium
Riverina Water County Council	Regional Scheme	Mid-Murrumbidgee Alluvium Murrumbidgee Regulated River	69,329	Medium
Narrandera Shire Council	Narrandera	Mid-Murrumbidgee Alluvium Murrumbidgee Regulated River	3,871	Medium
Hay Shire Council	Hay	Murrumbidgee Regulated River	2,298	Medium
Murrumbidgee Council	Darlington Point	Lower Murrumbidgee Deep Alluvium	1,016	Medium
Snowy Valleys Council	Tumut	Regulated River - Tumut River Lachlan Fold Belt	6,086	Medium

Notes:

The regional water strategies focus on modelled risk to local water utility surface water entitlement reliability and will not review nor has adopted the preliminary water security risk assessed by the Safe and Secure Water Program outlined in this table. The water security access risk assessment undertaken by the Safe and Secure Program considers: headworks arrangement and capacities; the physical delivery and operational rules under water sharing plans; local operating protocol; and past experiences in delivering water in drought conditions. This results in a water security access risk specific to each local water utility's town water supply system that is different to the modelled surface water entitlement reliability.

* The table only covers drinking water supply systems with a population greater than 1,000 people.

** Water security risk represents the preliminary risk as assessed by the Safe and Secure Water Program as of April 2020 and is subject to change over time based on further investigation, new information from councils and/or delivery of projects/ solutions addressing these risks.

*** Bulk supply from Murrumbidgee Irrigation Limited infrastructure.

Source: NSW Government's Safe and Secure Water Program

The high reliance on unregulated surface water sources in the upper Murrumbidgee and connected alluvial water sources in the mid-Murrumbidgee makes some town water supplies in the region more vulnerable to the types of extreme dry periods we now know have occurred in the past and that can occur in the future. This vulnerability is demonstrated by the periodic imposition of water restrictions throughout the Snowy Monaro, Snowy Valleys, Yass Valley, Cootamundra-Gundagai and Queanbeyan-Palerang local government areas since 2002. Some of the most severe restrictions, up to Level 4, were in place during the Millennium Drought for towns,

including Batlow and Cooma. In 2006, towns with typically more reliable water supplies, such as Leeton and Griffith, also faced up to Level 3 restrictions. More recently, low flows in eastern unregulated water sources saw water restrictions progressively rolled out in many towns from January 2019 to January 2020. For the regions surrounding the ACT, these challenges are compounded by high population growth.

These challenges highlight the importance of acting now to ensure adequate water security in the future.



Photography

Image courtesy of iStock.
Murrumbidgee River, Yanga Woolshed Landing.

3.3.3 Opportunities and potential options

This draft strategy considers a suite of options to improve the resilience of town water supply systems.

Using water more efficiently will help to mitigate the impacts of lower water availability and increasing demand. It will also contribute to meeting water security objectives and may delay the need for system augmentation. For example, permanent water conservation measures implemented in the ACT in 2004 are on track to reduce consumption by 25% by 2023, improving long-term water security.

Groundwater also has a role to play in securing water for towns, by diversifying towns water sources or providing emergency supply sources during drought. A strategic review of groundwater use by towns and opportunities to access groundwater, including currently under-allocated sources such as the Lachlan Fold Belt, will increase the security and resilience of town water supplies (see Option 21: Secure and reliable access to groundwater for towns).

Local water utilities are encouraged to prepare and implement a water conservation and demand management plan as part of their integrated water cycle management strategy, and several local water utilities are already implementing these plans (including water-efficient devices, leakage reduction, restrictions and water re-use). However, many local water utilities in the region are yet to start, or are in the early stages of developing a strategy, particularly smaller local water utilities. The Murrumbidgee Regional Water Strategy provides an opportunity to support initiatives

already being pursued by councils and may provide avenues to identify new initiatives that can be aligned with work undertaken as part of integrated water cycle management strategies. These initiatives can help to reduce non-revenue water²³⁹ and residential water consumption, which is generally higher across the Murrumbidgee region than the NSW regional median of 159.6 kL per connection per year.²⁴⁰

Elevated turbidity and nutrients that lead to the growth of algae in the Murrumbidgee are largely attributed to land use and inflow from the tributaries between the region's major dams and Wagga Wagga.²⁴¹ Treated effluent discharge is also a risk to water quality and town water supplies, mainly in unregulated water sources in the upper Murrumbidgee. Regional-scale support could be provided by coordinating catchment management improvement activities, region-wide water quality monitoring and ensuring that existing government water quality improvement programs consider town water supply management objectives when prioritising delivery (see Option 27: Investigate water quality improvement measures). Extending local water utility sewerage systems to several unsewered villages and upgrading sewage treatment plants would help to reduce the impacts of on-site sewage systems and effluent discharge in high-risk areas—areas where poor water quality threatens public health, surface water or groundwater sources with high ecological value. For example, Hilltops Council is investigating options to replace ageing septic tanks with a sewerage scheme in Jugiong to address public health issues related to potential contamination of water sources.

239. Non-revenue water is water that has been produced but is 'lost' before it reaches the customer, through system leaks, metering inaccuracies or unauthorised consumption.

240. This refers to total residential water consumption per connection (kL) for 2018/19. www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data

241. CSIRO 1995, *Sources of suspended sediment and phosphorus to the Murrumbidgee River*

The Safe and Secure Water Program includes several projects in the region aimed at improving town water access security, improving the quality of treated effluent discharged to the river system and improving raw water treatment facilities to ensure town supplies are more resilient to fluctuations in water availability and quality. The Murrumbidgee Regional Water Strategy will provide an opportunity to assess towns' water entitlement reliability at a regional scale and consider any broader options to improve water security. This will include exploring new and better ways for towns to improve water efficiency and water conservation, and to keep regional towns 'green' during dry periods, (see Option 22: Maintain water-related amenity in the Murrumbidgee region during droughts).

Ageing water and sewerage infrastructure requires additional and ongoing capital investment to maintain service levels. This presents a challenge, particularly to the smaller councils in the region, in meeting the costs of augmenting and operating water and sewerage systems. Local water utilities' operating costs and typical residential bills across the region generally exceed the NSW regional median. Even the two larger water supply utilities, Riverina Water and Goldenfields Water, have high operating costs due to the large coverage of their regional schemes.

Smaller councils and local water utilities can often find it difficult to attract and retain skilled staff and keep pace with the advances in regulation and technology that could save money and improve services. The Town Water Risk Reduction Program will support councils and local water utilities to meet these challenges. Improving the overall performance of the region's local water utilities would have positive health and economic impacts for the broader region.

The Town Water Risk Reduction Program has initiated several pilot studies to test and improve the regulatory framework and facilitate collaboration, including two pilots involving local water utilities within the Murrumbidgee region:

- Co-design and test different and flexible approaches to regulating Local Water Utilities strategic planning—involving collaboration between Griffith City Council and local water utilities in two other regions.
- Test the approach to co-regulator collaboration—involving collaboration between Riverina Water and Goldenfields Water to reduce risks to town water supply from the East Water bore field.

Integrated Water Cycle Management

A 30-year integrated water cycle management strategy addresses the complex linkages between elements of the urban water cycle (water supply, wastewater and stormwater) and community expectations. This is done within the urban area and between its water related physical and legislative operating environment. This multi-level approach enables cost-effective integration of these urban water systems in consultation with the local community.

Integrated systems often rely less on limited natural water sources and reduce pollutant loads to the environment. They encourage water conservation and efficient water use, enable the implementation of cost-effective recycling of treated wastewater and urban stormwater use options and satisfy the water sensitive urban design and 'liveable cities and towns' objectives.

The 30-year strategies ensure that any necessary capital works projects are appropriately sized; and essential for the provision of appropriate, affordable, cost-effective urban water services that meet community needs and protect public health and the environment.

Town Water Risk Reduction Program

The Town Water Risk Reduction Program is a two-year program supporting local water utilities to manage safe, secure and sustainable water supply and sewerage services to regional communities across NSW. The program is taking a collaborative approach to improve the regulatory framework, including integrated water cycle management strategies, as well as addressing critical skill shortages, encouraging collaboration between utilities, facilitating greater NSW Government support and considering alternative funding models.

Every local water utility faces unique challenges and risks. The Town Water Risk Reduction Program team works in partnership with councils, local water utilities, government agencies and the broader sector to design and implement long-term solutions that suit their circumstances and address the specific challenges faced by their communities.

While the Safe and Secure Water Program will continue to provide funding to Local Water Utilities to address specific risks in their systems, the Town Water Risk Reduction Program looks at broader improvements in the system—both at a state and local government level—that enables Local Water Utilities to manage risks more effectively and efficiently.

With no new water available in the region, innovation will be critical to support the expected growth in regional centres and towns in the Murrumbidgee.

Greater climate variability and climate change—on top of regional growth pressures, lack of integration and inter-jurisdictional issues—is likely to increase town water security risk and the vulnerability of town water supplies and amenity. Opportunities to improve the integration of land and water management, explore re-use options to diversify town water supplies, support demand management and lift performance standards will build the resilience of towns to future climate risks.

Some of the potential options presented in this draft strategy are listed below, with details provided in Section 4.4.

- Option 21: Secure and reliable access to groundwater for towns
- Option 14: Investigate land use change and population growth impacts on water resources
- Option 15: Strengthen inter-jurisdictional water management
- Option 18: Review impediments to water recycling projects
- Option 22: Maintain water-related amenity in the Murrumbidgee region during drought
- Option 40: Investigate inter-regional connections.



Photography

Image courtesy of Destination NSW. Streetscapes, Gundagai.

3.4 Enable economic prosperity

3.4.1 Jobs and industries

As the fourth largest region in NSW in terms of economic output, population and employment, the Murrumbidgee region's economic output was \$15.9 billion in 2018/19, which accounted for 2.6% of NSW's output as measured by gross value added.²⁴² In 2016, over 102,700 people were employed in the Murrumbidgee region.²⁴³

The region has a very diverse economy, reflecting its varied landscape, climate and transport links.²⁴⁴ In the Snowy Mountains region, key industries include tourism, power generation, manufacturing and agriculture. In the Queanbeyan and Yass Valley areas (surrounding the ACT); public administration, construction and health care services are major industry sectors and employers. The eastern part of the Murrumbidgee region supports

businesses across a variety of sectors including agriculture, food manufacturing, health care and transport and logistics; which leverage the strategic location along freight and transport routes, including the inland rail corridor. The western-Murrumbidgee region is dominated by agriculture and associated processing.

The wider Murrumbidgee–Murray region is frequently referred to as the state's 'food bowl' due to its large regional contribution to agricultural production in NSW.²⁴⁵ In 2018/19 agriculture, forestry and fishing industries in the Murrumbidgee contributed \$1.8 billion in economic output as measured by gross value added.²⁴⁶

242. REMPLAN 2019, *REMPLAN Economy: Custom data*, www.remplan.com.au/economy. Note: Figures are based on 16 main local government areas within the region, with the main regional centres located within the Murrumbidgee region. Several other local government areas span across two or more regions, including the Lachlan, Murray and Western regions.

243. REMPLAN 2019, *REMPLAN Economy: Custom data*, www.remplan.com.au/economy

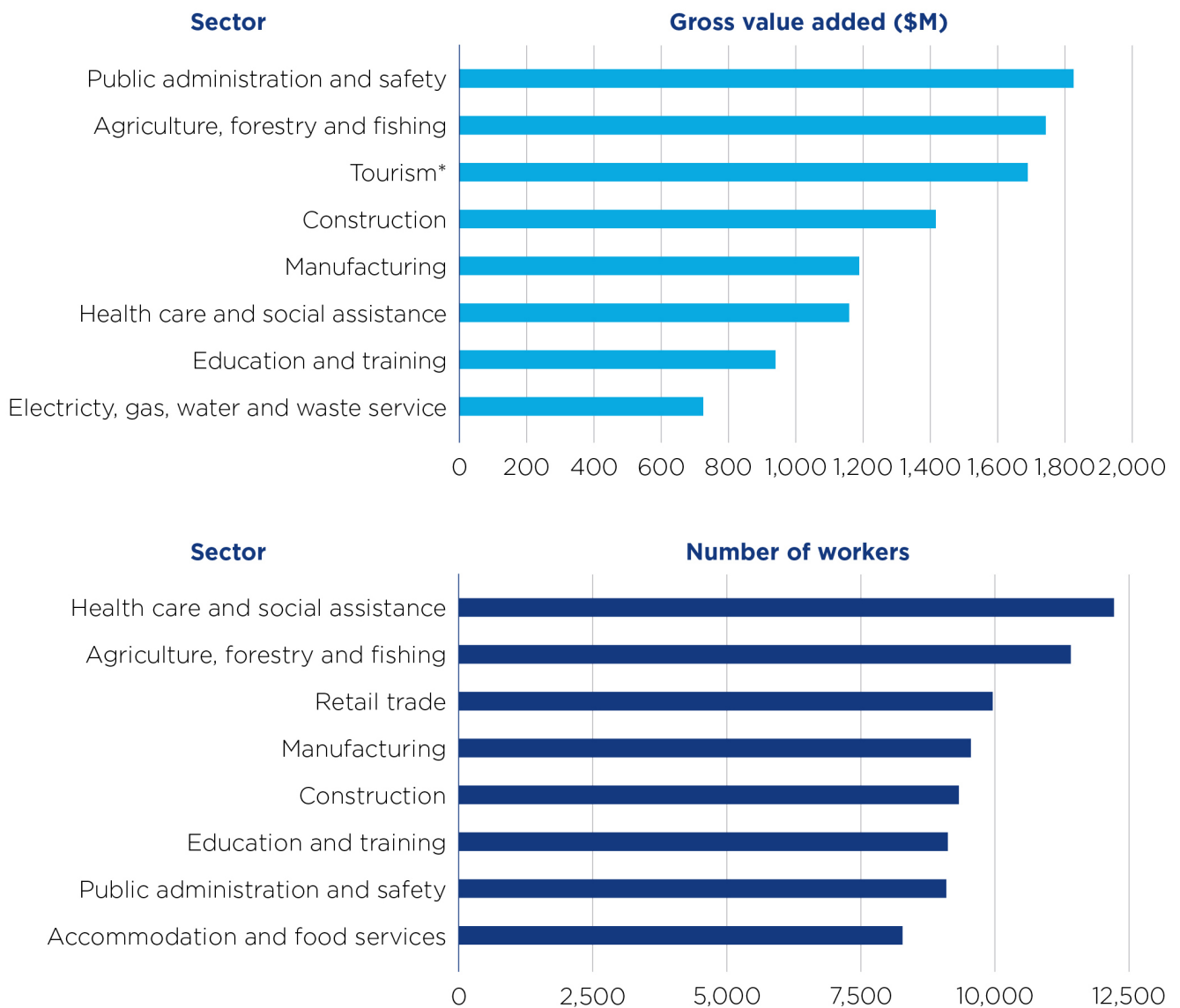
244. Department of Planning, Industry and Environment 2017, *Riverina Murray Regional Plan 2036*; Department of Planning, Industry and Environment 2017, *South East and Tablelands Regional Plan*

245. Department of Planning, Industry and Environment 2017, *Riverina Murray Regional Plan 2036*

246. REMPLAN 2019, *REMPLAN Economy: Custom data*, www.remplan.com.au/economy



Figure 37. Employment and economic outputs of key industries in the Murrumbidgee region



Notes: Figures are based on 16 main local government areas within the region, with the main regional centres located within the Murrumbidgee region. Several other local government areas span across two or more regions, including the Lachlan, Murray and Western regions.

*Tourism is not a defined industry category. The listed value is total expenditure on Tourism services as defined by REMPLAN.

Source: REMPLAN Economy: Custom data 2019

The Murrumbidgee region has long been a centre for knowledge and innovation in agribusiness and value-added manufacturing and is emerging as one of NSW's key renewable energy hubs.²⁴⁷ The region has also seen an expansion of health care and social assistance services and public administration, which has been strongly influenced by growth in and surrounding the ACT. Recent announcements to establish the South Jerrabomberra Regional Job Precinct will strengthen this link with the ACT and support growth in the region's knowledge-based industries.²⁴⁸

South Jerrabomberra Regional Job Precinct: leveraging opportunities associated with the Poplars Innovation Precinct

Located at the doorstep to Queanbeyan, the South Jerrabomberra Regional Job Precinct will build on a \$23 million investment by the NSW Government to improve infrastructure within the existing business park and leverage opportunities associated with the Poplars Innovation Precinct. The focus of the Precinct will be to improve the local planning framework and allow better collaboration across different parts of state and local government to support the defence, space, cyber-security, information technology and scientific research sectors.

The broader Murrumbidgee–Murray region is anticipating growth in several key industries including agribusiness and advanced value-added manufacturing, health care and social assistance, freight and logistics, tourism, education and training, forestry and renewable energy.²⁴⁹ Industrial and commercial growth in strategically located regional centres is expected to be driven by increases in agricultural outputs, diversification of agribusiness and new value-added processing and manufacturing opportunities. The NSW Government is focused on driving continued growth in the region by leveraging its location and natural assets and supporting the specialisation of industry and business.²⁵⁰

NSW Government investment in the Inland Rail Project, the Wagga Wagga Special Activation Precinct, the South Jerrabomberra Regional Job Precinct and the expansion of agribusiness and manufacturing around Griffith and growth around the ACT will contribute to further to jobs and economic growth.

247. Department of Planning, Industry and Environment 2017, *Riverina Murray Regional Plan 2036*

248. Regional NSW, *South Jerrabomberra Regional Job Precinct*, www.nsw.gov.au/snowy-hydro-legacy-fund/special-activation-precincts/regional-job-precincts/south-jerrabomberra

249. Department of Planning and Environment 2017, *Riverina Murray Regional Plan 2036*

250. This focus is reiterated in the nine Regional Economic Development Strategies relevant to the Murrumbidgee region: Western Murray, Eastern Riverina, Albury–Wodonga, Western Riverina, South-Western Slopes, Capital, Snowy Monaro, Snowy Valleys and Southern Tablelands.

Inland Rail: creating new regional opportunities

The Inland Rail Project is a once-in-a-generation project that will become the backbone of freight and supply chain networks connecting regional NSW with Victoria and Queensland. Opportunities for regional NSW include:

- more jobs, with the project expected to create 16,000 new jobs during construction and an additional 700 ongoing jobs across the network
- better connections within the national freight network
- better transit time, reliability and cost savings—less than 24-hour transit time

will mean that perishable goods can access markets faster

- transport cost savings, with horticulture and post-processed food supply chains estimated to save \$76 per tonne on average when travelling via Inland Rail compared to road trips.²⁵¹

The Inland Rail passes through an area covered by seven regional water strategies (Murray, Murrumbidgee, Lachlan, Macquarie-Castlereagh, Namoi, Gwydir and Border Rivers). The final regional water strategies will factor in anticipated demographic and industry developments associated with Inland Rail to better understand how these may change future water demands over the next 20 to 40 years.

251. Australian Government, Department of Infrastructure, Transport, Regional Development and Communications 2019, *CSIRO Supply Chain Mapping-Pilot Study*, www.inlandrail.gov.au/understanding-inland-rail/publications-and-reports/inland-rail-supply-chain-mapping-pilot-study



Photography

Image courtesy of Destination NSW.
Streetscapes, Coolamon.

Agriculture

The Murrumbidgee region is an important agricultural region, contributing around 25% of NSW's fruit and vegetable production, 42% of grape production, and 50% of Australia's rice production.²⁵² In 2018/19, the agricultural sector contributed \$1.8 billion to regional output in terms of gross value added. In 2016, the sector directly employed over 11,000 people—approximately 11% of total employment in the Murrumbidgee region.²⁵³

The varied landscape, climate and transport links in the region support a diverse mix of agricultural industries that are directly and indirectly reliant on the region's surface groundwater sources:

- the eastern, upper Murrumbidgee region is mainly used for grazing beef cattle, forestry, dryland cropping and fruit production—including apples, pears and cherries
- the mid-Murrumbidgee hosts broad-acre cropping—cereal, oilseed and pulses—beef and sheep grazing, intensive poultry and pigs, and irrigated crops—cotton, rice and maize
- the mid to lower Murrumbidgee produces irrigated crops like cotton, rice, sorghum and maize, most of the state's citrus—oranges and lemons, stone fruit, nuts—almonds, hazelnuts and walnuts, and vegetables. The irrigation areas around Griffith produce around 95% of NSW's gross value of production of grapes for wine production.

Driven by the development of new shorter growing season crop varieties and favourable commodity prices, production of irrigated cotton has expanded into the Murrumbidgee over the past decade.²⁵⁴ In addition, the last decade has seen an expansion in some horticulture crops—mainly almonds and hazelnuts—in the mid and lower Murrumbidgee region, which are now at different stages of maturity.²⁵⁵

Irrigated agriculture, including post-farm processing of irrigated agriculture produce, is a major economic driver within the region and a key cornerstone of regional communities like Leeton and Coleambally.²⁵⁶ Further diversification of industries presents an opportunity to buffer against an increasingly variable and changing climate and the risks of reduced water availability, high water market prices and fluctuating commodity prices. In many parts of the broader Murrumbidgee–Murray region, diversification is already occurring with growth in a variety of irrigated, dryland and animal products.²⁵⁷ In addition, many irrigators are now managing their irrigation layouts in ways that provide flexibility to opt in or out of different production methods, which can include dryland or irrigation of a variety of potential crops. This gives them more options to capitalise on seasonal conditions and prices.

252. Murray-Darling Basin Authority 2019, www.mdba.gov.au/discover-basin/catchments/murrumbidgee

253. REMPLAN 2019, *REMPPLAN Economy: Custom data*, www.remplan.com.au/economy

254. Department of Primary Industries, *Performance, Data and Insights*, www.dpi.nsw.gov.au/about-us/publications/pdi/2020/cotton; Cotton Australia Annual Reports, www.cottonaustralia.com.au/annual-reports

255. Australian Government, Department of Agriculture, Water and Environment, *Horticulture farms in the Murray–Darling Basin*, www.agriculture.gov.au/abares/research-topics/surveys/irrigation/horticulture#horticulture--production-in-the-murraydarling-basin

256. Several communities in the Murrumbidgee have a high dependency on irrigated agriculture. For further information, see www.mdba.gov.au/sites/default/files/archived/guide_pbp/AppendixC_Murrumbidgee_community_profile.pdf

257. Department of Primary Industries 2018, *Discussion paper: R&D to increase the flexibility, productivity and profitability of Riverina farming systems*, Unpublished.

Alongside the regional water strategies, the NSW Government is undertaking a vulnerability assessment of the impact of climate change on the state's agricultural industries and the potential opportunities for these industries to adapt.²⁵⁸ These findings will be available in mid-2022 and will be a key input to future water policy and initiatives. The government has also developed a right to farm policy.²⁵⁹

The Murrumbidgee Regional Water Strategy provides an opportunity to build on this work and look at options that will support the region's industries to build resilience and mitigate the impacts of future climate risks.

258. Department of Primary Industries, *Climate Change Research Strategy 2021*, www.dpi.nsw.gov.au/dpi/climate/about-dpi-climate/climate-change-research-strategy

259. Department of Primary Industries, *Right to Farm Policy*, www.dpi.nsw.gov.au/agriculture/lup/right-to-farm-policy



Photography

Image courtesy of Destination NSW.
Cows grazing, Gundagai.

Tourism

Another industry that is directly and indirectly reliant on the region's water resources and a healthy environment is tourism. The Murrumbidgee region is a popular tourism destination offering numerous recreational activities, events and outdoor attractions. In 2019, the region hosted 8.2 million visitors (international, domestic overnight and domestic daytrip).²⁶⁰ Tourism provides jobs for 7,694 workers in the region, which represents 7.5% of the region's total employment.²⁶¹ In 2018, tourism expenditure amounted to about \$1,668 million across the region's local economies.²⁶²

Attractions and events that rely on water resources and a healthy environment include:

- national parks, including the Kosciuszko, Brindabella and Murrumbidgee Valley national parks
- the Murrumbidgee River, its tributaries and town water lakes for boating, fishing and swimming
- local festivals including the Australian Art Deco Festival (Leeton), Gears & Beers Festival (Wagga Wagga), Griffith Spring Festival, Festival of the Falling Leaf (Tumut) and the Taste Coleambally Food and Farm Festival
- nature-based attractions including bird watching and hiking.

The NSW Government is improving visitor access to major rivers and lakes to increase water-based activities and leveraging the region's agricultural abundance for food and wine experiences.²⁶³ The sustainable management of water resources will be critical to further growth in tourism across the region.

Tourism in the Murrumbidgee region, like the rest of Australia, has been affected by the COVID-19 pandemic. Given the uncertainties associated with international travel over recent years, there are positives for tourism in the region, which already relies heavily on domestic travel. In 2020, the NSW Government provided funding to six annual events, acknowledging the importance of these events in attracting tourists to the region.²⁶⁴

Against the backdrop of COVID-19, the NSW Visitor Economy Strategy 2030²⁶⁵ has also been developed to help drive growth and investment in the tourism sector such that NSW can become the premier visitor economy in the Asia Pacific.

260. See Destination NSW 2020, *Capital Country Visitor Profile Year ended September 2020*, www.destinationnsw.com.au/wp-content/uploads/2021/02/capital-country-visitor-profile-ye-sep-2020.pdf and Destination NSW 2020, *Riverina Visitor Profile Year ended September 2020*, www.destinationnsw.com.au/wp-content/uploads/2021/02/riverina-visitor-profile-ye-sep-2020.pdf. Due to the regional boundaries under which industry information is collected and reported, it is not possible to present specific information for the Murrumbidgee region as defined by this draft strategy. These visitor figures are based on those from the Riverina and Capital Country tourism regions, which are similar.

261. REMPLAN 2019, *REMPPLAN Economy: Custom data*, www.rempln.com.au/economy

262. REMPLAN 2019, *REMPPLAN Economy: Custom data*, www.rempln.com.au/economy

263. riverinamurray.com.au/app/uploads/2019/06/Riverina_Murray_DMP_April_2018_DigitalLQ.2.pdf

264. This funding was awarded through the NSW Government's \$1 million 2020 Regional Events Fund, www.nsw.gov.au/regional-growth-fund/regional-events-acceleration-fund

265. Destination NSW visitor *Economy Strategy 2030*, www.destinationnsw.com.au/about-us/strategies-and-plans/visitor-economy-strategy-2030

Renewable energy

The NSW Government has signalled its strong support for renewable energy and its intention to make NSW an ‘energy superpower’. The *Electricity Infrastructure Investment Act 2020* sets out a framework to coordinate investment in new generation, storage and network infrastructure.²⁶⁶ The Act gives effect to the NSW Government’s Electricity Infrastructure Roadmap and aims to encourage renewable energy projects in the region.

The government has set out an ambitious plan to establish a major Renewable Energy Zone in NSW’s south-west region around Hay.²⁶⁷ Although in its early stage of development, this zone will play a vital role in delivering affordable energy generation to help replace NSW’s existing power generation and will unlock a significant pipeline of large-scale renewable energy and storage projects. This will support private sector investment in regional areas and is anticipated to create many jobs at its peak. A range of renewable energy projects are already in the planning or construction phase for the renewable energy zone, including the Darlington Point solar farm (333 MW) and the Collector wind farm (228 MW). The western town of Balranald is set to become home to two of NSW’s biggest solar farms—Limondale (349 MW) and Sunraysia (255 MW).²⁶⁸

As of 2021, the Murrumbidgee region is already home to major renewable energy operations, including the Snowy Mountains Scheme. There are also several large wind farms located on the southern tablelands in the upper Murrumbidgee region around Yass and Bungendore.

Although not directly reliant on large quantities of water, further investments in solar and wind renewable energy generation and storage projects will drive job and population growth in the Murrumbidgee region, which needs to be considered in developing options for the Murrumbidgee Regional Water Strategy.

Industry water use

Water is an important input to many production processes.

All water-dependent industries in the Murrumbidgee are required to hold a water access licence to take water for any commercial production purposes.²⁶⁹ Many industries hold a portfolio of water access licences in both surface water—high security, general security or supplementary—and groundwater, and trade water allocations or entitlements to meet their water needs. Some industries also rely on town water supplies including motels, abattoirs, food processing operations and recreational and tourism businesses.

Depending on the type of water access licence held by (or the water access arrangements applicable to) the individual business, water availability can vary significantly between years. In particular, industries relying predominantly on surface water (e.g. general security and supplementary access licences) are more exposed to the region’s climate, as these licences will only be allocated water if other high priority needs and commitments have been met and sufficient water is available.

266. Energy NSW, *NSW Electricity Strategy*, www.energy.nsw.gov.au/government-and-regulation/electricity-strategy

267. Energy NSW, *Renewable Energy Zones*, www.energy.nsw.gov.au/renewables/renewable-energy-zones

268. Galletta, S., & Tribe, M. 2020, *Two of Australia’s biggest solar farms set for NSW, as market operator looks at how to manage power grid*. www.abc.net.au/news/2018-10-10/two-of-australias-biggest-solar-farms-set-for-balranald/10359110

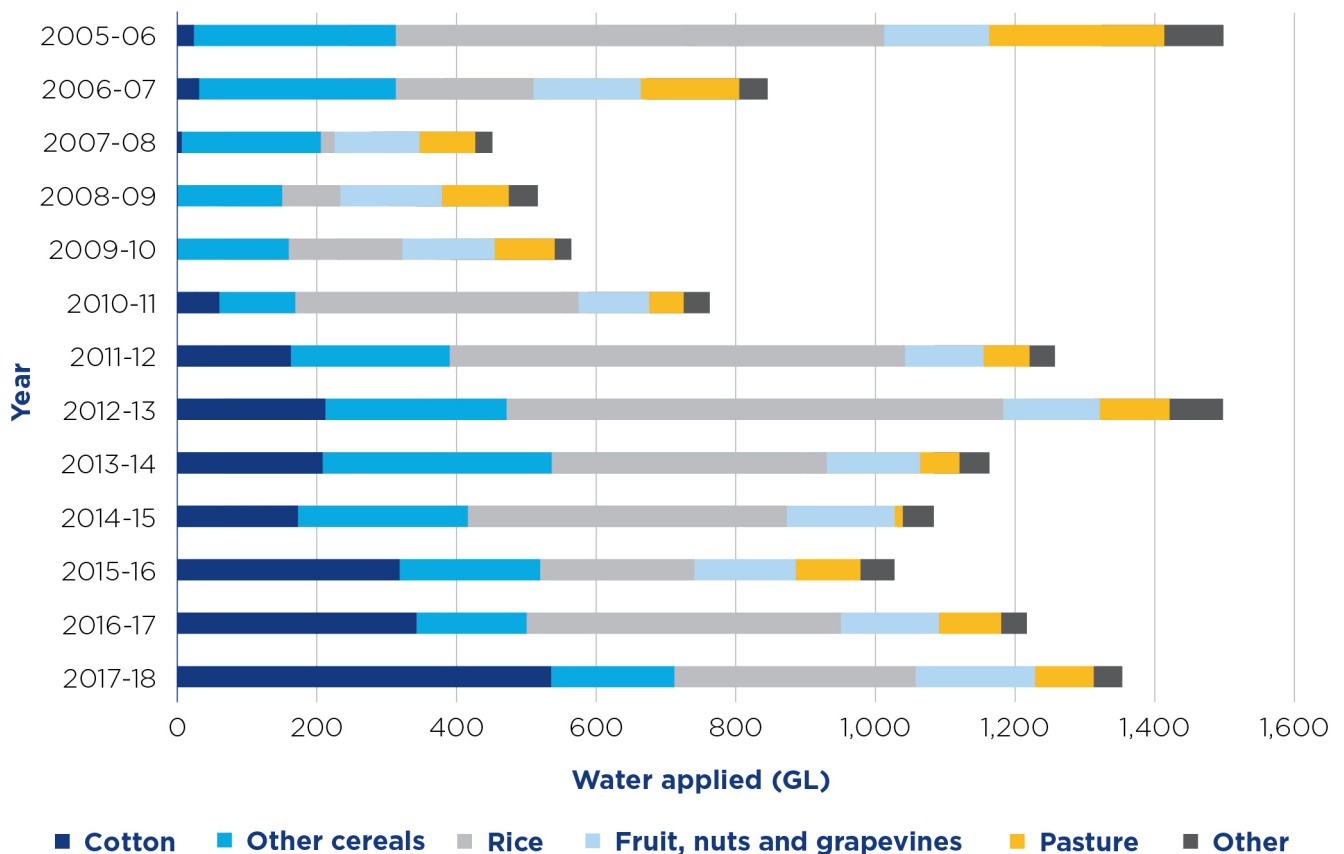
269. Unless these industries have alternative contractual arrangements through existing town water supply systems

Similarly, unregulated river licences may only be activated when there is sufficient water at the point of extraction and when the relevant water sharing plan permits the taking of water. In the past, the expansion and contraction of annual cropping has generally been driven by water availability for general security licences. When water availability is high—that is, high or full allocation for General Security water access licences, annual crop production has often expanded. Conversely, production of annual crops contracted significantly during the Millennium Drought due to consecutive

years of very low general security allocations. The flow-on effect of this contraction on regional communities was significant, leading to the closure of related processing facilities in some towns.²⁷⁰

Water use by fruit, nuts and grapevines has remained comparatively constant from 2005/06 to 2017/18. However, growth in permanent plantings in the region is likely to drive greater water demand in the future, as the areas of cultivation increase and orchards mature.

Figure 38. Water use by crop, Murrumbidgee NRM region, 2005/06 to 2017/18



Source: Natural Resource Access Regulator 2019, Water Market Intelligence, www.nrar.nsw.gov.au/__data/assets/pdf_file/0011/384671/NRAR-market-intelligence-report-August-2019.pdf

270. Department of Primary Industries, *Performance, Data and Insights*, www.dpi.nsw.gov.au/about-us/publications/pdi/2020/rice

As reflected in the most recent drought, reduced water availability and increased water costs have driven declines in irrigation activities in 2019/20. As highlighted by the Australian Bureau of Statistics, the total area of irrigated crops reduced and/or growers switched to alternative crops with less reliance on water. Fruit, nuts and grapevines were the only crops that saw an increase in irrigation area and volume from 2018/19.²⁷¹

With the change in industry profile to a larger proportion of permanent plantings, water use and demand patterns are likely to change further in the Murrumbidgee region. Although total water use for industries is bound by the sustainable diversion limits for surface water and groundwater systems, changes within and between industries—including the growth of permanent plantings in the lower Murrumbidgee and Murray regions—is altering the geographical use of surface water in the catchment, trade patterns and seasonal water demand in the regions.

The impacts on conveyance and transmission requirements, channel capacity constraints and evaporation losses will need to be investigated and considered in future water management arrangements in the region.

In terms of industries' reliance on surface water and groundwater sources in the Murrumbidgee, the main irrigation corporations rely primarily on surface water from the regulated Murrumbidgee, while a large number of private diverters in both the mid-Murrumbidgee and lower Murrumbidgee rely on both surface water and groundwater.²⁷² During periods of low surface water allocation, groundwater use has increased significantly in the past, particularly in the Lower Murrumbidgee Deep and Mid-Murrumbidgee Zone 3 Alluvial groundwater sources (Figure 39). Under future climate change, lower surface water availability could further increase reliance on these groundwater sources.

271. Australian Bureau of Statistics, *Water use on Australian Farms*: www.abs.gov.au/statistics/industry/agriculture/water-use-australian-farms/latest-release

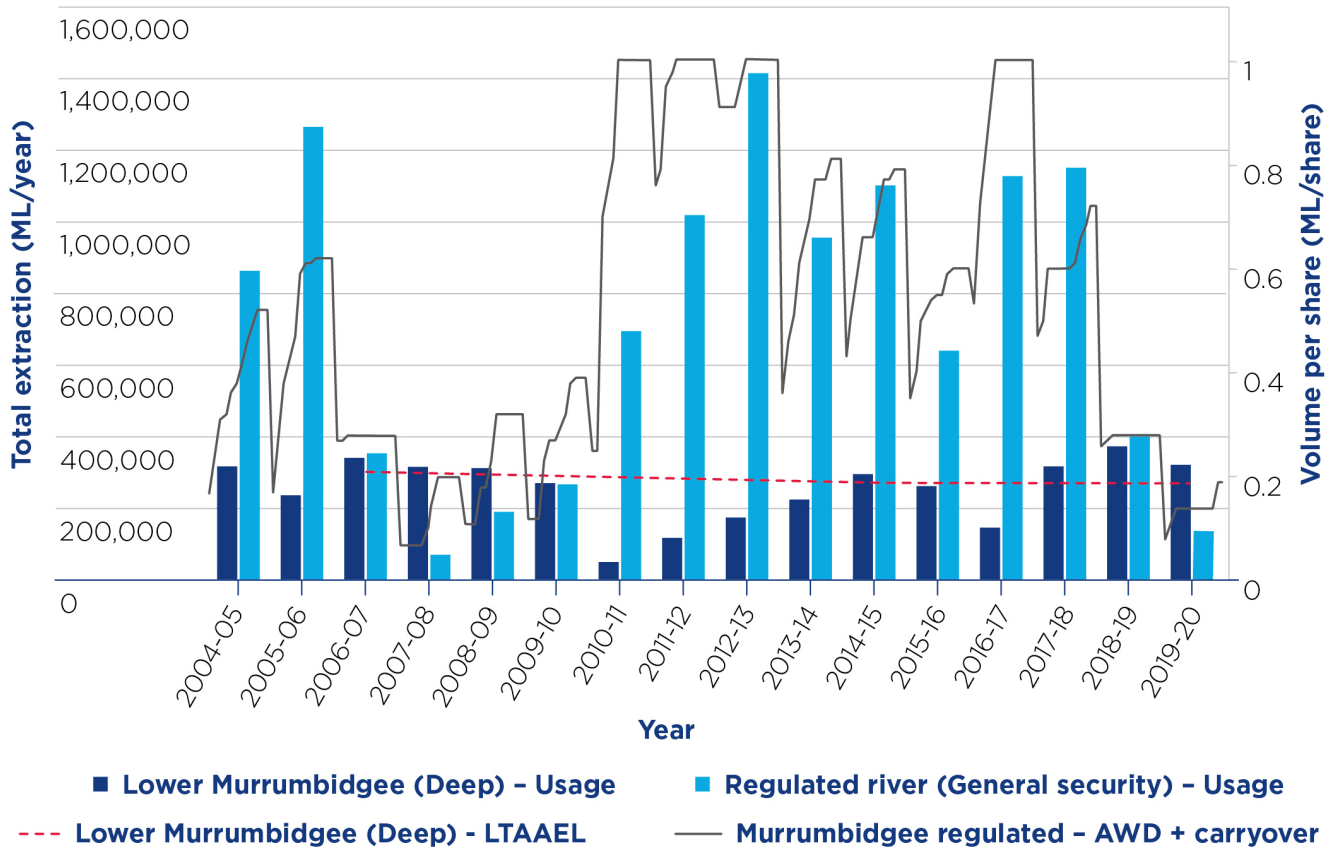
272. All commercial businesses need to hold a water licence and works approval to access a water source

Photography

Image courtesy of Destination NSW.
Yarran Wines, Yenda.



Figure 39. Comparison of annual usage and surface water allocation: Murrumbidgee regulated river general security and Lower Murrumbidgee Deep Groundwater Source



3.4.2 Water availability in a more variable and changing climate

Given the significance of water for industries and businesses in the Murrumbidgee, concerns about surface water reliability and availability have been raised by stakeholders over many years. In particular, stakeholders have raised concerns about the possibility of reductions in surface water availability—for example, water use tracking below the water sharing plan extraction limits in regulated systems as a result of water user behaviour, climate and NSW’s policy and regulation framework. In response to these concerns, the Murray–Darling Basin Authority has conducted further assessments into the trends in water use in the southern Murray–Darling Basin.²⁷³ This assessment found that there are potential indications of ‘underuse’ in the southern regions but there are various causes that require further analysis.

The regional water strategies provide an opportunity to support this analysis further. Several options included in the long list for this draft strategy would provide valuable information to support this work (see for example Option 48: Investigate water availability in the Murrumbidgee region and Option 46: Undertake a water dependent industry resilience study). However, it is critical that NSW water resource plans are accredited, which would allow NSW to have a basis to better understand and quantify whether there is a reduction in water availability. The NSW Government has recently introduced a new provision for regulated river water sharing plans to review and address significant future under-use against water sharing plan or sustainable diversion limits. Key requirements of this provision include gaining a sound

understanding of the drivers of underuse and that any amendments to management arrangements would need to be within the requirements of the Basin Plan.

Furthermore, the Murray–Darling Basin Authority has committed to work with the states, including NSW, on monitoring and reporting on trends in use relative to sustainable diversion limits, and continuing to improve sustainable diversion limit accounting and better communicate how the accounting operates.

The NSW Government is committed to work closely with the Murray–Darling Basin Authority on these matters, as well as continuing to provide and improve information available for water users about how water is managed in NSW. Currently, information is available through a variety of means including the Department of Planning and Environment website²⁷⁴ and the Water Insights Portal.²⁷⁵ In addition, the Bureau of Meteorology has recently released the Murray–Darling Basin Water Information Portal as an online portal to access storage levels, water allocations and trading information across the Basin.

In addition, strategic consideration of groundwater resources will also help to support industry resilience in the Murrumbidgee and ensure industries’ present and future water needs can be met. Better integrating groundwater into the strategic planning framework and ensuring groundwater is used to its sustainable potential will support economic prosperity into the future.

273. Murray–Darling Basin Authority, *Analysing Trends in water use relative to sustainable diversion limits in the southern Basin 2020*, www.mdba.gov.au/publications/mdba-reports/analysing-trends-water-use-relative-sustainable-diversion-limits-southern

274. NSW Government, *Water*, www.dpie.nsw.gov.au/our-work/water

275. WaterNSW, *Water Insights*, www.waternsw.com.au/waterinsights/water-insights

In terms of future industry growth, groundwater needs to be considered a key part of the equation. New groundwater infrastructure and technologies, active and efficient groundwater markets and robust data and information could support industries in the context of a more variable and changing climate.

To support economic prosperity in the Murrumbidgee region, new initiatives will be needed to keep pace with changing climatic conditions, industry profiles and water needs, and to make sure that industries across the region have access to reliable water supplies.

Regional NSW has released its Future Ready Regions Strategy, which outlines 14 commitments to achieve sustainable, secure and healthy waterways; build stronger primary industries prepared for drought; and support stronger communities and diverse regional economies.²⁷⁶ The key actions listed in the Future Ready Regions Strategy align with the NSW Water Strategy and the Murray and Murrumbidgee regional water strategies and aim to build resilience and better prepare us for future droughts in the regions.

Improvement in agricultural water efficiency still represents an opportunity for the region despite large scale investment through the Australian Government. There are irrigation networks that haven't partaken in these initiatives and many that have only seen partial upgrades and improvements.

Therefore, more work is needed to make more efficient use of limited supplies across the region.

The \$1 billion Farm Innovation Fund also helps farmers by providing low interest loans for investment in permanent farm infrastructure including: improving water efficiencies with irrigation systems, capping and piping of bores, new dams, installing water tanks and de-silting of ground tanks; all of which help farmers mitigate the risks of reduced water availability and high water prices.

The Murrumbidgee Regional Water Strategy is an opportunity to closely focus on the resilience of water resources in the Murrumbidgee and better understand industry changes, water use patterns and access risks, as well as the possible impacts these can have on river operations and environmental and cultural assets (see Option 44: Better understand water use with data collection and analytics). It also provides an opportunity to look at options to support regional industries and businesses to effectively and efficiently use all available water resources up to the allowable limit (Option 51: Undertake joint exploration for groundwater with the NSW Geological Survey) and improve water markets and trade (Option 52: Review water markets and trade).

New climate risk modelling will give us a better understanding of the risks to future water availability and enables us to test how different infrastructure, operational and policy options will perform under a more variable and changing climate. The new modelling is under development and will be released in the near future, as we progress the strategy.

276. Regional NSW, *Future Ready Regions*, www.nsw.gov.au/regional-nsw/future-ready-regions

3.4.3 Opportunities and potential options

Options are being considered in the Draft Murrumbidgee Regional Water Strategy to investigate the resilience of existing industries to future climate change and to better collate, analyse and disseminate data to water users. This would benefit and potentially add value to existing regional industries, as well as open up opportunities for emerging industries.

Some of the potential options that would enable economic prosperity are listed below, with details provided in Section 4.4:

- Option 46: Undertake a water dependent industry resilience study
- Option 48: Investigate water availability in the Murrumbidgee region
- Option 44: Better understand water use with data collection and analytics
- Option 52: Water market and trade review
- Option 49: Investigate non-residential water efficiency (towns and industries)
- Option 51: Undertake joint exploration for groundwater with the NSW Geological Survey
- Option 45: Improve the understanding of groundwater sources and processes, risks and impacts.



Photography

Image courtesy of Destination NSW.
Glendale Citrus and Hazelnut Orchard, Sandigo.

Chapter 4

Options for the Murrumbidgee Regional Water Strategy



Photography

Image courtesy of Destination NSW.
Gundagai Rotary Lookout, Gundagai.

Snapshot

We have developed a long list of options that could be included in the final Murrumbidgee Regional Water Strategy.

- To identify these options, we have drawn ideas from previous studies, experiences of past droughts, consultation with local councils, local water utilities and joint organisations and government reforms and programs.
- Each option is expected to address at least one of the objectives set for the regional water strategies.
- The options aim to contribute to achieving our vision of having healthy and resilient water resources for a liveable and prosperous Murrumbidgee region.
- The options have been developed with regard to legislative frameworks and inter-jurisdictional Acts and Agreements that NSW is party to.
- The options are not listed in a particular order, nor prioritised.

The options aim to tackle the challenges facing the Murrumbidgee region and maximise opportunities arising from regional growth and investment.

Options in the current long list focus on addressing some of the key problems in the Murrumbidgee region including:

- an inadequate water management framework to meet the needs and aspirations of Aboriginal people
- current water sharing arrangements based on 120 years of data
- insufficiently integrated land and water planning and management
- vulnerability of town water supplies and amenity
- degradation of riverine and floodplain ecosystems

- limitations of existing water infrastructure, delivery and operations
- limits to water availability in times of a changing climate.

In each of these areas, we are open to exploring fresh ideas and innovative solutions that will add value to regional industries, leverage new investments and support new economic, employment and environmental opportunities.

Not all options will be progressed in the final strategy.

- Inevitably, these options will involve trade-offs and choices. To fully understand the impacts, trade-offs and synergies, we will seek feedback on these options before undertaking a formal assessment process.
- The assessment process will look at the positive and negative effects of each option, its cost-efficiency, how widely its benefits are likely to be distributed and its feasibility. Not all the regional water strategies objectives can be quantified. When the outcome is difficult to assess in a financial context, options will be assessed on how effective they are at achieving objectives, rather than on a cost basis.
- Options that are common between the Murrumbidgee and Murray regions will be assessed together to ensure efficiencies in the assessment process and in the development of the final strategies.
- Preferred options, and packages of options delivered together will be informed by a range of evidence including new climate modelling, expert judgement, and community input. These will form the final, comprehensive Murrumbidgee Regional Water Strategy.

4.1 Our vision for the Murrumbidgee Regional Water Strategy

The current challenges in the Murrumbidgee region stem from projected population growth in the upper Murrumbidgee, ongoing competition for water resources across the region, physical constraints, and the broader complexities prevalent in the southern connected basin. Future climate conditions—changing rainfall and snowfall patterns, increased evapotranspiration, potentially longer dry periods and storms that are more intense—are likely to further exacerbate these challenges. Although we cannot change the region's climate or the basic hydrology of our river and groundwater systems, we can deliver better outcomes for the region by changing how we:

- operate the water system, such as water sharing arrangements, water delivery, allocations, environmental flow management, water trade, compliance and flood management
- design and operate infrastructure in the region, such as water storages, pumps, pipes and channels
- gather, analyse and report data and information about water resources
- use water and how water users behave, including demand management measures
- communicate, engage and collaborate with water users and communities
- or any combination of the above.

We have identified policy, planning, regulatory, educational, technology and infrastructure options that address the challenges the region may face and maximise opportunities arising from growing regional centres, emerging and expanding industries and new investments in transport and community infrastructure.

The options included in the long list also align with the actions in the NSW Water Strategy and complement these initiatives on a regional level.

Our vision for the strategy

Our vision for the strategy is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous Murrumbidgee region. To achieve this, we need to position the region so there is the right amount of water of the right quality delivered in the right way for people, Aboriginal communities, towns, industries and the environment.

4.2 Identifying and developing the options

We have developed a long list of options that could be included in the final Murrumbidgee Regional Water Strategy. In preparing this list, we recognise and acknowledge the large amount of work that has been done over the last decades to identify initiatives that could improve water management and water security in the region. We have collated these initiatives and supplemented them with further options based on feedback from local councils, local water utilities, joint organisations, Aboriginal communities and government agencies. The public consultation process and further engagement with Aboriginal people will provide another opportunity to identify additional options and seek feedback on the long list of options.

Bringing all of the options together will help us to align and better sequence the various water reform processes as we develop the strategy.

In developing the list of options for the Murrumbidgee region, we have specifically considered the following:

- Each option is expected to address at least one of the regional water strategy objectives (Section 1.2). Some options will support multiple objectives. Other options may have positive benefits for one objective while having negative impacts for another objective. We do not have all the information at the moment to understand these impacts. We will do further work to understand these impacts and seek your views on how each option may impact you and your values.
- While considering a range of options to maintain and improve the resilience of the region's water resources in the face of a variable and changing climate, we have also included options that take the next step in identifying innovative water solutions that will add value to existing industries, create opportunities for new industries and generate greater benefits that extend across the community.
- As discussed in Section 1.3.1, the NSW Government is investing in new climate datasets and improved modelling that give us a more accurate understanding of future climatic conditions in the Murrumbidgee region. Options in the long list propose reviews of existing policy settings, operational rules and management plans considering this new data.
- As discussed in Sections 1.3.2 and 1.3.3, we have drawn on a range of sources to develop the options, including existing studies, inquiries and reviews, past experiences of droughts, engagement with local councils, local water utilities and joint organisations and current NSW Government initiatives and programs. This process acknowledges the significant amount of thought and work already directed towards addressing the region's water-related challenges. More information about these sources is in the Regional Water Strategies Guide and the NSW Water Strategy.²⁷⁷

277. Department of Planning, Industry and Environment 2021, *NSW Water Strategy*, accessed 16 September from water.dpie.nsw.gov.au/plans-and-programs/nsw-water-strategy

- We have had conversations with local councils, local water utilities and joint organisations to understand their views about water-related challenges and opportunities in the region for potential options that would improve water security and quality for towns and communities (see Section 1.3.2).
- We have aligned the Draft Murrumbidgee Regional Water Strategy with the NSW Water Strategy, and the Riverina Murray and South East Tablelands Regional Plans²⁷⁸ and sought expert advice from government agencies and independent regulators.
- Parallel work on the Draft Murray Regional Water Strategy has informed the development of the Draft Murrumbidgee Regional Water Strategy. Synergies between both regions made it imperative that options being developed for the Murrumbidgee Regional Water Strategy considered the potential impacts on the wider southern connected system.

As discussed in Section 1.3.2, face-to-face engagement with Aboriginal communities in the Murrumbidgee region was delayed due to the COVID-19 pandemic. We expect further options will be identified when consultation with Aboriginal communities is progressed.

We have not ordered or prioritised the options identified for the Murrumbidgee region and many options on the list have not been costed.

278. Department of Planning, Industry and Environment 2021, *Regional Plans*, accessed 16 September from www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans



Photography

Image courtesy of Destination NSW.
Tumut, Kosciuszko.

4.3 Which options will be progressed?

Not all options in the long list will be progressed through to the final strategy. Only feasible options will be progressed following an assessment process.

Inevitably, these options—and their priority in the Murrumbidgee Regional Water Strategy—will involve trade-offs and choices. To understand the impacts and trade-offs we will first seek your feedback on these options and then use a formal options assessment process which will look at:

- **Effect**
To what extent are the options expected to contribute to or otherwise impact on the objectives over the planning horizon and/or during extreme events?
- **Impacts and magnitudes of impacts**
A risk assessment of the positive or negative impact of the option on the objectives, and the magnitude and frequency of these impacts.
- **Cost efficiency**
To what extent are the options likely to deliver cost effective outcomes?
- **Distribution of benefit**
Is there likely to be a broader public or regional benefit from the option, or is the benefit concentrated to a small number of users?
- **Feasibility**
To what extent is the option likely to be feasible, (including regulatory/policy change, stakeholder acceptance, time to implement, cost, alignment with government policy (national and international) and technical)?

Further information on this process is in the Regional Water Strategies Guide.

It is unlikely that a single option will be capable of addressing all the identified risks across the objectives we have set for the strategy. The greatest benefits are likely to be realised by combining options (or packaging them) so that they complement each other to improve the efficiency of the system, offset impacts or unlock greater benefits by using the different levers that are available—such as policy and infrastructure levers. Other opportunities may be unlocked through the NSW Water Strategy or the Murray Regional Water Strategy.

For example, infrastructure options may improve water reliability for industries and water security for towns but could have negative environmental impacts. To mitigate these impacts, and increase the benefit of the projects, infrastructure projects could be combined with:

- environmental options that could mitigate the impacts of the infrastructure on native fish species and environmental assets, such as wetlands and estuaries
- demand management measures to make sure industries are operating as efficiently as possible
- policy and regulatory options that review whether the water sharing arrangements under altered conditions are appropriate.

Combining some of the options might mean that other options cannot be pursued. At present, we do not have enough information to understand the trade-offs between options or combinations of options that are described in Table 8.

As development of the strategy progresses, preferred options and combinations of options—and their trade-offs—will be informed by multiple lines of evidence including new climate modelling, expert judgement and community input. In particular, the NSW Government has invested in new modelling to gain a more accurate understanding of

future climatic conditions in the Murrumbidgee region (Section 1.3.1). This new data, along with economic analysis, will be used to help assess the pros and cons of each option and the impact of various combinations of options in addressing the key challenges facing the region.

It is important to remember that the way we progress options will need to take account of the *Water Management Act 2000* and NSW commitments under the Murray–Darling Basin Plan—for example, the sustainable diversion limits set in the Basin Plan for each valley and each water source.²⁷⁹

279. Murray–Darling Basin Authority 2019, *Sustainable diversion limits*, www.mdba.gov.au/basin-plan-roll-out/sustainable-diversion-limits



4.4 Murrumbidgee: Long list of options and government commitments

Table 8 summarises the long list of options we have identified for the Draft Murrumbidgee Regional Water Strategy. Detailed information about each option, the challenges it will address, its potential combination with other options and further work required to progress the option is set out in the *Murrumbidgee: Long list of options*.

The current long list of options focuses on addressing some of the key challenges in the Murrumbidgee region:

- inadequate water management framework to meet the needs and aspirations of Aboriginal people
- current water sharing arrangements based on 120 years of data
- insufficiently integrated land and water planning and management
- vulnerability of town water supplies and amenity
- degradation of riverine and floodplain ecosystems
- limitations of existing water infrastructure, delivery and operations
- limits to water availability in times of a changing climate.

Concentrating on the seven key challenges will enable us to address the challenges facing water users in the Murrumbidgee region, while maximising opportunities for regional communities and industries, and supporting their aspirations.

We heard from communities that the regional water strategies should not just focus on the risks and challenges of today. This is why our current long list of options not only focuses on the issues identified in Chapters 2 and 3, but also includes a number of options that may become important in future decades.

These options need to be supported by comprehensive and robust data and information and the right tools and infrastructure to implement change in the future.

However, this means that some of our draft long list options are still in a conceptual state. We need to continually work with communities, environmental managers, Aboriginal peak bodies, Aboriginal people and industries to develop and refine these ideas.

Regional water strategy: objectives



Deliver and manage water for local communities

Improve water security, water quality and flood management for regional towns and communities.



Enable economic prosperity

Improve water access reliability for regional industries.



Recognise and protect Aboriginal water rights, interests and access to water

Including Aboriginal heritage assets.



Protect and enhance the environment

Improve the health and integrity of environmental systems and assets, including by improving water quality.






Affordability

Identify least cost policy and infrastructure options.

Table 8. Long list of options and government commitments

Option	Description	Objective
Existing government commitments		
<ul style="list-style-type: none"> Sustainable Diversion Limit Adjustment Mechanism 	<p>In 2017, the Basin States and the Australian Government agreed on a package of 36 Sustainable Diversion Limit Adjustment Mechanism (SDLAM) projects across the southern connected Murray-Darling Basin.</p>	
<p>Inadequate water management framework to meet the needs and aspiration of Aboriginal people— <i>Opportunities to protect and strengthen cultural landscapes, practices, knowledge and traditions. Supporting empowerment, self-determination and economic advancement of Aboriginal people, as well as strengthening community wellbeing.</i></p>		
<p>1. Improve access to culturally significant areas and waterways for Aboriginal people</p>	<p>This option would investigate the benefits and constraints of developing formal access arrangements between Aboriginal people and landholders in the Murrumbidgee region.</p>	
<p>2. Review Aboriginal Cultural Water Access Licence framework</p>	<p>This option would undertake a review of water access licences for Aboriginal cultural uses to determine their effectiveness and identify opportunities for improvement.</p>	
<p>3. Assess access arrangements for the Murrumbidgee Aboriginal Cultural Water Access Licence</p>	<p>This option would consider opportunities to expand the use of the Murrumbidgee Cultural Water Access licence.</p>	
<p>4. Fund water entitlements for Aboriginal communities</p>	<p>This option would provide funding to support Aboriginal people to purchase water entitlements and water infrastructure—such as pumps—that can be used to improve economic and cultural outcomes across the southern connected basin.</p>	 
<p>5. Secure flows for water dependent cultural sites</p>	<p>This option would investigate opportunities to improve the timing, rate and consistency of flows to places of cultural significance. The places would be identified by Aboriginal community members.</p>	

Option	Description	Objective
6. Shared benefit project (environment and cultural outcomes)	This option would investigate opportunities to work more closely with environmental water holders for shared benefits from using water for the environment that would also achieve cultural environmental outcomes, recognising it does not replace the provision of cultural flows.	
7. Support long-term participation of local Aboriginal people in water-related matters	This option would provide support for local Aboriginal groups to be actively involved in consultation and decision-making processes around water management in the Murrumbidgee.	
8. Incorporate Aboriginal history of water and culture in the southern Basin into water data	This option would aim to document and integrate Aboriginal science and culture into government processes to help better manage the river systems.	
Current water sharing arrangements based on 120 years of data—Opportunities to consider the adequacies of existing water sharing and management arrangements in the region under a more variable and changing climate.		
9. Review drought rules for the Murrumbidgee region	This option would review the adequacy and effectiveness of the Incident Response Guides applicable to the Murrumbidgee region by testing them against the new climate data and updated modelling being developed for the Murrumbidgee Regional Water Strategy.	
10. Review the allocation and accounting framework in the Murrumbidgee (surface water)	This option would review several settings of the current water accounting and allocation process in the Murrumbidgee regulated river system and consider whether and how the new climate data should be used when making allocation decisions.	 
11. Review groundwater extraction limits	This option would review the existing groundwater extraction limits to incorporate up-to-date information, including scientific studies that incorporate new climate change datasets to give an improved understanding of groundwater processes.	 





Option	Description	Objective
12. Provide increased clarity about sustainable groundwater management	This option would review, revise and develop policies to give water users greater clarity and certainty in how groundwater is managed in NSW.	
13. Investigate Water Access Licence conversion	This option would test the potential risks and benefits of allowing voluntary conversion from general security to high security and high security to town water supply water access licences in the Murrumbidgee Regulated River Water Source.	
<p>Insufficiently integrated land and water planning and management—<i>Opportunities to better integrate water resource management into other processes including assessing current land uses and land-use trends in the Murrumbidgee, to better understand spatial changes in the region’s water uses and emerging pollution and flooding risks.</i></p>		
14. Investigate land use change and population growth impacts on water resources	This option would investigate opportunities to better integrate the NSW land use planning and water resource management frameworks.	
15. Strengthen inter-jurisdictional water management	This option would investigate improvements to the inter-jurisdictional water management arrangements in the upper Murrumbidgee region in consultation with the Australian Capital Territory Government and the Australian Government.	
16. Develop climate risk evidence base to inform the next Snowy Water Licence Review	This option would seek to gather information and evidence to inform the next Snowy Licence Review in 2027.	
17. Enhance southern inland floodplain management plans	This option would develop valley-wide, connected floodplain management plans using the northern NSW Murray–Darling Basin floodplain management plan (NSW Healthy Floodplains Project) template.	

Option	Description	Objective
<p>Vulnerability of town water supplies and amenity—<i>Opportunities to improve policy and planning around water re-use and recycling, and strengthen water security for local communities and important water-related amenity in the region.</i></p>		
<p>18. Review impediments to water recycling projects</p>	<p>This option would review impediments (such as cost, pricing, regulatory or engineering constraints, or community acceptance) to water recycling projects in the Murrumbidgee region.</p>	
<p>19. Assess potable re-use for towns</p>	<p>This option would assess the benefits and costs of potable re-use in the Murrumbidgee region and investigate potential locations for new and expanded re-use schemes from sewage treatment plants.</p>	
<p>20. Managed aquifer recharge investigations and policy</p>	<p>This option would investigate opportunities to undertake managed aquifer recharge in the Murrumbidgee region, including investigating the recharge capacity of sites for temporary storage of stormwater, river flow or purified recycled water in aquifers.</p>	
<p>21. Secure and reliable access to groundwater for towns</p>	<p>This option would undertake a strategic review of groundwater use by towns across the region to improve understanding of the regional need, challenges and opportunities for towns to access groundwater.</p>	
<p>22. Maintain water-related amenity in the Murrumbidgee during droughts</p>	<p>This option would investigate opportunities to maintain water-related amenity, including town water lakes, local parks and recreational areas, in and around towns in the Murrumbidgee region during droughts or extended dry periods.</p>	
<p>23. Improve protection of groundwater dependent ecosystems</p>	<p>This option would advance our knowledge and management of groundwater dependent ecosystems in the Murrumbidgee region, such as the mid-Murrumbidgee wetlands, Lowbidgee wetlands, and Great Cumbung Swamp.</p>	

Option	Description	Objective
<p>Degradation of riverine and floodplain ecosystems—<i>Opportunities to address the risk to the environment, the ecology and groundwater dependent ecosystems and improve the health of the region's rivers and groundwater sources.</i></p>		
<p>24. Address cold water pollution</p>	<p>This option would build on and address gaps within the 2004 NSW Cold Water Pollution Strategy and associated updates (2011 and 2012).</p>	
<p>25. Improve flows to important ecological sites</p>	<p>This option would consist of several projects that aim to restore important ecological flows and connectivity between the river and floodplains in the mid-Murrumbidgee region and Lowbidgee.</p>	
<p>26. Develop a river and catchment recovery program for the Murrumbidgee region</p>	<p>This option would consist of a program aimed at better managing catchment hydrology, addressing erosion issues and restoring riparian and river habitats at priority locations within the catchment. This program would also include a component that undertakes long-term analysis of the impact of climate variability and climate change on future water availability for the catchment with focus on floodplains and river environments.</p>	
<p>27. Investigate water quality improvement measures</p>	<p>This option would involve conducting a gap analysis of water quality information to identify opportunities to support surface and groundwater water quality management in the Murrumbidgee region.</p>	
<p>28. Manage groundwater salinity</p>	<p>This option would conduct a range of reviews, investigations and collaborations to address groundwater salinity challenges in the Murrumbidgee region.</p>	
<p>29. Assess pollution from disused mines and mineral occurrences</p>	<p>This option would investigate the need to understand and mitigate pollution from disused mines and quarries in addition to the work undertaken by the Legacy Mines Program.</p>	
<p>30. Review environmental water arrangements</p>	<p>This option would use the new climate datasets and updated hydrological models (once completed) to review the effectiveness of existing NSW water sharing plan rules to meet the environmental watering requirements as outlined in the <i>Murrumbidgee Long-Term Water Plan</i> under long-term climate change projections.</p>	
<p>31. Re-establish threatened fish species through habitat restoration and conservation restocking</p>	<p>This option would aim to improve the condition, connectivity, and resilience of native fish by restoring habitat through protection and rehabilitation of priority areas using best practice management, while building the skills and sharing the knowledge of local landholders, community groups, and Aboriginal people.</p>	

Option	Description	Objective
32. Monitor sediment compaction over the long term	This option would develop a long-term monitoring program for the Murrumbidgee region to ensure sediment compaction does not occur in the future, reducing risks to groundwater storage and long-term bore yields.	
Limitations of existing water infrastructure, delivery and operations—Opportunities to improve system efficiencies (infrastructure and delivery) and enhance river operations.		
33. Investigate alternatives for increased storage capacity	This option would investigate alternative infrastructure projects to increase the storage capacity in the Murrumbidgee region downstream of Blowering and Burrinjuck Dams.	
34. Investigate new storage at Lake Mejum-Coolah	This option would review previous investigations into additional storage capacity in the mid-Murrumbidgee to address deliverability issues and to improve the system efficiency.	
35. Install gravity pipeline along Tumut River	This option would investigate the feasibility of installing a gravity pipeline along the Tumut River to address the channel capacity constraint by enabling release of higher flows downstream of Blowering Dam.	
36. Raise Blowering Dam	This option would investigate the feasibility of increasing the active storage of Blowering Dam. Alternatives to be considered include raising the dam by 4 m to increase active storage in the Murrumbidgee region by 200 GL, with a corresponding increase in the dam capacity of 12%, and additional downstream or adjacent off-stream storage.	
37. Enlarge Burrinjuck Storage Reservoir	This option would investigate the feasibility of increasing the storage capacity of Burrinjuck Dam, increasing the region's active storage.	
38. Expand Bundidgerry off-river storage and a new transfer canal	This option would investigate augmenting the existing Bundidgerry storage in the mid-Murrumbidgee region to address deliverability issues in the summer months, such as supply shortfalls, and to improve efficiency.	
39. Augment Tombullen Storage and modify operational changes	This option would investigate the feasibility of two options to improve the efficiency of Tombullen storage, including augmenting the storage capacity to increase the re-regulating storage in the mid-Murrumbidgee region and investigating potential operational changes for Tombullen Storage to mitigate water quality issues.	
40. Investigate inter-regional connections	This option would investigate the construction of inter-regional town water supply pipeline connections between the Murrumbidgee region and neighbouring regions.	

Option	Description	Objective
41. Change environmental releases from Murrumbidgee storages	This option would investigate changes to operations related to the release of discretionary environmental water. The suggested change would be to release more from Blowering Dam and less from Burrinjuck Dam during winter.	
42. Review flood management and airspace operation	This option would review existing operations and rules governing flood operation of Blowering and Burrinjuck dams and the interaction with airspace rules and relevant Snowy Water Licence rules. It would also investigate potential operational or rule changes to improve the storages flood mitigation function.	
43. Investigate groundwater desalination for industry and towns	This option would investigate the opportunities associated with desalination of groundwater to make it suitable for industrial and town uses.	
Limits to water availability in times of a changing climate—Opportunities to better understand water use behaviour, identify the information needs of water users, and improve resilience within the region.		
44. Better understand water use with data collection and analytics	This option would undertake a research project to better understand water use and water user behaviour in the Murrumbidgee region.	
45. Improve the understanding of groundwater sources and processes, risks and impacts	This option will combine desktop studies, field studies and numerical models—delivered in collaboration with consultancies and research centres—to give water users and towns access to data and information about groundwater resources.	
46. Undertake a water dependent industry resilience study	This option would include a comprehensive long-term study on the impacts of climate variability and climate change on future water availability to determine the impacts on water-dependent industries in the Murrumbidgee region including those reliant on town water supply systems.	
47. Develop targeted education and capacity building programs	This option would develop targeted education and capacity-building programs to build community confidence in water management, with a focus on the Murrumbidgee region, and help communities, industries and the environment to better manage their water needs and water-related risks.	

Option	Description	Objective
48. Investigate water availability in the Murrumbidgee region	This option would consider whether there is systemic reduction in available water in the Murrumbidgee region and investigate possible causes and potential responses.	
49. Investigate non-residential water efficiency (towns and industries)	This option would investigate opportunities to improve the efficiency of non-residential water use of both raw and town water supplies such as by agriculture, schools, hospitals, industrial uses (e.g. food processing) and recreational and amenity uses (water parks, sports ovals, town water lakes).	
50. Investigate the expansion of cloud seeding in key water supply catchments	This option would investigate potential additional benefits from expanding current cloud seeding activities in the mountainous areas surrounding Snowy Hydro Limited catchment area.	
51. Undertake joint exploration for groundwater with the NSW Geological Survey	This option would use regional and locally targeted geophysics to identify potential resources (fractured and porous rock systems like the Lachlan Fold Belt and Western Murray Porous Rock) followed by drilling, testing and water quality analysis to assess the resource's suitability for supply.	
52. Review water markets and trade	This option would progress the implementation of water market reforms, based on the recommendations of the Australian Competition and Consumer Commission's Murray-Darling Basin NSW water markets inquiry.	
53. Consider hydrological processes in bushfire management	This option would investigate how bushfire management could be strengthened in priority watersheds by including protection of rainfall-run-off processes as a key bushfire management priority in national parks and reserves.	

Chapter 5

Where to from here?

We have developed this draft strategy based on the new evidence base we have, the latest policies and programs for the region and feedback from government agencies, local councils and Aboriginal people.

The outcomes, challenges, opportunities and options we have identified in this strategy will be tested, evaluated and refined based on your input.

Ongoing analysis, using the new climate datasets and integrated hydrologic models will provide an updated understanding of risks to water security and availability in the Murrumbidgee region, which will be released following the draft strategies. This will inform the development of the final Murrumbidgee Regional Water Strategy and provide a more robust tool for assessing the benefits and impacts of our long list of options, across the southern regions.

Photography

Image courtesy of iStock.

Murrumbidgee River, near Darlington Point.

5.1 Finalising the strategy

Our next steps are to use the feedback you provide to analyse, screen and assess the long list of options, put together a portfolio of options to be progressed and develop a final strategy for release in 2022. We will also be prioritising face-to-face engagement with Aboriginal communities to develop additional options for the final strategy.

We recognise that in getting to the final strategy there may be hard trade-offs, but the only way we can make the best decisions possible is to deal with issues proactively and realistically. This will give us the most likely chance of long-term success.

The final Murrumbidgee Regional Water Strategy will have the flexibility to adapt over time and to new situations and circumstances. It will incorporate regular review processes to ensure the region has an effective strategy in place that remains relevant for future water management.

Following completion, each regional water strategy will be reviewed when the equivalent water sharing plans are reviewed.

Photography

Image courtesy of iStock.
Murrumbidgee River, Balranald.

5.2 Implementing the strategy

Community engagement does not end with consultation but is a vital part of implementation. The final Murrumbidgee Regional Water Strategy will map out our approach to implementation and include an implementation plan. This plan will set out how NSW Government agencies and other organisations with a role in NSW water management will deliver key actions and strategies for maximising water security and availability for all users and the environment. This implementation plan will be clear about timeframes and responsibilities for delivery.

We want to be clear about how we work with communities and regions to ensure:

- we are accountable for what we promise our regions
- we have the right partnerships in place to drive forward action
- we are transparent in how we go about those actions
- we seek feedback from those with on-the-ground and lived experience that the directions and actions we pursue continue to be the right ones for each region.

When the actions will be implemented

Not all actions will be implemented in the short term. Following public consultation, we will prioritise when to progress or implement each action as part of the implementation plan.

Some actions will need to be implemented in collaboration with a range of partners, including local councils and cross-government agencies. Actions will be implemented as funding becomes available over the next 20 years, and we will use the regional water strategies to assist us in making the case when we seek funding. The final regional water strategy will identify the priority for each action—immediate, mid- or longer term.

We want your feedback on which actions should be prioritised for implementation over the next three to five years, and which ones should be implemented in the mid- or longer term.

Your voice is important

We have prepared this draft strategy to continue our discussions with you about the future management of water in your community. It has been prepared in consultation with local councils, local water utilities, joint organisations and Aboriginal people.

We would like to hear your views of the draft strategy and whether you have any further information that could help us to assess the benefits or disadvantages of any of the options. This may include:

- how your household, business, industry or community currently manages the impacts of a highly variable climate
- the current and future challenges you see in the Murrumbidgee region and how you think these should be addressed
- how the management of water resources can be improved or leveraged to create and take up new opportunities in the region
- the option presented in the draft strategy
- how we can achieve our aims for accountability and transparency
- the best ways of partnering with communities and regions to implement the strategy.

Your views on the strategy's vision and objectives are also important. This Draft Murrumbidgee Regional Water Strategy is on public exhibition from 11 April to 22 May 2022 for a six-week period. A range of supporting information is available at www.dpie.nsw.gov.au/murrumbidgee-regional-water-strategy

You can have your say on the draft strategy by providing written feedback to the Department of Planning and Environment by midnight 22 May 2022 via:

Web: www.dpie.nsw.gov.au/murrumbidgee-regional-water-strategy

Email: regionalwater.strategies@dpie.nsw.gov.au

Please note that all submissions will be published on the department's website unless you let us know in your submission that you do not wish the content to be released.

We will be holding online sessions on the draft strategy during the public exhibition period to help shape the final strategy. These sessions will give participants an understanding of the context for the strategy, introduce the new climate modelling method and what the options for better managing water in the Murrumbidgee region could mean. Times and locations for these sessions can be found at www.dpie.nsw.gov.au/murrumbidgeeregional-water-strategy

We will also continue to meet with local councils, local water utilities, Aboriginal communities and other stakeholders. Talking with these groups is critical for designing a strategy that builds on their knowledge and capacity, is feasible in terms of implementation and links to their relevant initiatives, plans and strategies.

An aerial photograph of a river with a large blue overlay. The river flows through a landscape with green vegetation and rocky banks. The blue overlay covers the upper two-thirds of the image, and the word "Attachments" is written in white, bold, sans-serif font across it.

Attachments

Attachment 1

Targeted stakeholder engagement

Overview

A thorough engagement program supports the development of the regional water strategies. The purpose of the engagement is to inform, obtain information and feedback and collaborate with stakeholders on the development of the regional water strategy.

Given the inter-connectedness of the Murray and Murrumbidgee regions, and the significant overlap in stakeholder groups, engagement outcomes have been consolidated in this report.

The development of the Murray and Murrumbidgee regional water strategies will be supported by five engagement phases:

1. Targeted engagement with councils, local water utilities, Joint Organisations and Aboriginal people on the development of the draft regional water strategies.
2. Public exhibition of the draft regional water strategies and targeted engagement with State and regional peak bodies.
3. Further targeted engagement with councils, local water utilities and Joint Organisations in each region, as well as Aboriginal people.
4. Public exhibition of the updated draft regional water strategies and the shortlisted actions.
5. Public release of final regional water strategy.

An internal working group and an interagency panel was formed to assist in the development of the Draft Murrumbidgee and Murray regional water strategies. The working group and interagency panel, chaired by the Department of Planning and Environment—Water, included representatives from across the Department of Planning and Environment—Water divisions and also from:

- Department of Planning and Environment—Planning
- Department of Planning and Environment—Environment and Heritage
- Department of Primary Industries—Agriculture
- Department of Primary Industries—Fisheries
- Local Land Services
- WaterNSW
- NSW Health
- The Office of Local Government
- The Natural Resources Access Regulator
- Department of Regional NSW.

This report documents targeted stakeholder feedback obtained during Phase 1 of the development of the Draft Murrumbidgee and Murray regional water strategies.

Engagement

Discussions were held with the following councils, local water utilities, Joint Organisations and Aboriginal communities between August 2020 and March 2022:

Local councils*/local water utilities/joint organisations of councils
Albury City Council
Balranald Shire Council
Berrigan Shire Council
Bland Shire Council
Canberra Region Joint Organisation
Carrathool Shire Council
Coolamon Shire Council
Cootamundra-Gundagai Regional Council
Edward River Council
Federation Council
Goldenfields Water County Council
Greater Hume Shire Council
Griffith City Council
Hay Shire Council
Hilltops Council
Icon Water
Junee Shire Council
Leeton Shire Council
Lockhart Shire Council
Murray Darling Association
Murray River Council
Murrumbidgee Council
Narrandera Shire Council
Queanbeyan Palerang Regional Council
Riverina and Murray Joint Organisation

Local councils*/local water utilities/joint organisations of councils

Riverina Joint Organisation

Riverina Water County Council

Snowy Monaro Regional Council

Snowy Valleys Council

Temora Shire Council

Wagga Wagga City Council

Wentworth Shire Council

Yass Valley Council

Aboriginal community

Murray Lower Darling Rivers Indigenous Nations

The Riverina Murray Regional Alliance

In addition, meetings were held in the following towns however not all were attended:

- Euston
- Queanbeyan
- Yass
- Tumut
- Wagga Wagga
- Barham
- Moulamein
- Balranald.

* The regional water strategy team did not have the opportunity to meet with every council individually. Joint briefings organised through the Joint Organisations of councils facilitated conversations with a diverse set of representatives from member councils. For this reason, Bega Valley Shire Council and Goulburn Mulwaree Council were present at some meetings but have limited jurisdictional overlap with the Murray or Murrumbidgee regional water strategy areas.

The purpose of discussions was to establish a collaborative relationship with local councils, local water utilities, Joint Organisations of councils and Aboriginal people as well as to gain an understanding of key water-related challenges and risks in the Murrumbidgee and Murray regions.

Discussions with Aboriginal people focused on water-related challenges to Aboriginal people in the regions. Due to the COVID-19 pandemic, our face-to-face engagement with Aboriginal communities in the Murray and Murrumbidgee regions was significantly hindered, however we are committed to having ongoing conversations with Aboriginal people to ensure their views are reflected in the final Murray and Murrumbidgee regional water strategies.

What we heard

Quick stats, recurring themes and hot topics

A total of 29 meetings were held with over 136 people from August 2020 to March 2022. A summary of participants and recurring themes and hot topics raised by them are outlined below.

Councils/local water utilities/ other organisations	Aboriginal community
Quick Stats	Quick Stats
19 targeted meetings, including four round tables	10 targeted meetings**
152 participants	10 participants
Face to face and online meetings	Face to face and online meetings
Over 63 ideas, opportunities and challenges and suggestions identified	Over 41 ideas, opportunities and challenges and suggestions identified

**Some meetings had no attendance by Aboriginal people.

Recurring themes	Recurring themes
Collaboration and an ongoing partnership approach are highly valued	Water is culturally significant to Aboriginal people and should be protected
Water security is important for regional growth and community wellbeing	River health and long-term sustainable management of water resources is a priority
The inter-connectedness of water in the Murray and Murrumbidgee regions is central to water management	The need for ongoing and improved consultation with Aboriginal people is required throughout the development of the regional water strategies
A consistent and whole-of-government approach to water policy, planning and regulation is needed	Access to water and water entitlements needs to be improved for Aboriginal people
Groundwater is an essential water source for the region that must be protected and managed sustainably	Aboriginal people should be given an opportunity to play a more active role in water management

Councils/local water utilities/ other organisations	Aboriginal community
Hot topics	Hot topics
Water access and water availability, including water trading and licensing	Need for Aboriginal people to have a voice in water management, be compensated to attend consultation sessions, and incorporate Aboriginal people's knowledge (including traditional ecological science) into water resource management and planning
Interaction between regional water strategies, existing government commitments, current policies and regulation (including water sharing plans and water resource plans)	Need for a pathway to greater water entitlement holdings by Aboriginal people for economic and cultural purposes and improvements to the application process for Aboriginal Cultural Water Access Licences
Town water security in the context of future population and industry growth	Perceived government inaction following ongoing consultations leading to a breakdown in trust
Contamination risks and responsible management of groundwater sources	Education and employment opportunities in the water sector would help advance Aboriginal involvement, especially for youth
New water storage facilities and the ability to achieve water deliver efficiencies throughout the system	Poor water management has led to environmental issues including erosion and loss of habitat/breeding grounds for plants and animals
Management of water for the environment could be improved and requires greater transparency	Concern that access to water by industry and landowners is prioritised over Aboriginal people's access

Detailed feedback

The following is a summary of the feedback from the first round of targeted engagement in the Murray and Murrumbidgee regional water strategy areas.

Council engagement

Topic	Comment
New climate datasets and updated hydrological modelling	<p>Attendees expressed an interest in the new regional water strategy climate datasets and updated hydrological modelling. A number of questions and concerns were raised, including:</p> <ul style="list-style-type: none"> • how the new climate datasets and modelling could be shared and used by local councils and water utilities to inform future water management and planning decisions, including councils' future integrated water cycle management strategies • how the new climate datasets and modelling could provide insight into the vulnerability of groundwater sources to climate change, which was identified as a potential data gap • how the new climate datasets and modelling may help to analyse and mitigate future water security risks • clarity on the differences between the Department's new climate datasets and modelling and the climate change research conducted by other agencies, organisations, and government departments • whether the hydrological models have considered treated effluent return flows to waterways, which are generally minimal during drought but high during wet periods • need to emphasise that there is uncertainty about modelling and climate forecasting for the region • how the new climate datasets and modelling will be kept up-to-date and whether it will also enable an analysis of extreme wet periods, including flooding.
Water management	<p>Attendees sought clarity on the roles and responsibilities of different agencies with responsibility for water management and provided suggestions on how regional water management could be improved, including:</p> <ul style="list-style-type: none"> • create a better understanding of who is responsible for water management and ensure water is equitably shared in the region • incentivise more efficient water use by industry • consider new/augmented water storages which could address water security issues, improve system efficiencies, and enhance flood mitigation • consider the use of stormwater, especially in light of more severe weather and drought • optimise water allocations to benefit the regional economy more broadly, noting that local industries are heavily dependent on water. There were also concerns that high value crops were being prioritised • ensure that agency roles around Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) management are clear, as raised recently with Town Water Risk Reduction Program • interest in solidifying a broad, integrated catchment management approach • stressed that communities rely on water for recreation and tourism.
Groundwater	<p>Attendees stressed that groundwater is an essential resource for the region and expressed concerns and questions regarding its management. Attendees particularly raised:</p> <ul style="list-style-type: none"> • the reliability of groundwater needs to be protected given that some towns like Bungendore rely entirely on groundwater for their water supply. It was mentioned that there is a need for alternative water infrastructure to secure town water supply • the importance of mitigating and preventing groundwater contamination • the need for clarity on how new groundwater licences are granted • questions on whether new groundwater sources could be identified • questions on how appropriate the existing groundwater sustainable diversion limits are.

Topic	Comment
Water allocations, trading, pricing and licensing	<p>Attendees expressed a strong interest in NSW's water allocation process, water trading, and licensing. They shared a range of questions and suggestions including:</p> <ul style="list-style-type: none"> the regional water strategies and the NSW Government need to be clear and transparent about how water is allocated the regional water strategies need to provide clear information on what avenues are available to access additional water to support future population growth in the region it should be easier for councils to trade water entitlements (such as urban water entitlements, wastewater discharge, and excess bulk water) without penalty interest in how inter-valley trade operates and if trade can occur from one water source into another. There was also interest in how the regional water strategies will model inter-valley transfers interest in obtaining greater clarity on proposed increases to bulk water charges for southern NSW water users the region has reliable water source, although there are some pressure points and residual risks resulting in long water delivery times and channel capacity issues.
Environment and environmental flows	<p>Improving the management of water for the environment was noted as a priority by some participants who shared the following concerns and suggestions:</p> <ul style="list-style-type: none"> desire for more information and transparency about expected environmental flows, so that irrigation water demand and environmental water demand could be better balanced water levels in the rivers can rise and fall very quickly causing issues such as bank erosion and flooding with little warning changes could be made to the timing of environmental releases to avoid negatively impacting local communities and industry interest in the environmental impacts of cross-border transfers and treated wastewater.
Water quality	<p>Attendees discussed the importance of water quality across the region and the range of factors that affect it, including:</p> <ul style="list-style-type: none"> impacts on water quality are more likely to be experienced during periods of drought or high rainfall recurring water quality problems include algal blooms in surface waters and increased carbon dioxide levels in aquifers interest in whether the Water Quality Management Plans were developed in consultation with local councils and water utilities concern regarding ecological risks from Snowy Scheme releases, which could result in wide-spread algal blooms in the catchment contamination caused by septic systems, mining activities and existing PFAS in groundwater (mid-Murrumbidgee) raised concerns and were seen as a significant threat to water security.
Inter-connected nature of the region and cross-border agreements	<p>Attendees emphasised the interconnectedness of the Murrumbidgee and Murray regions but highlighted that each region was different and had region-specific issues that should be captured in the respective regional water strategy. They shared the following feedback:</p> <ul style="list-style-type: none"> concern that a 'region by region' approach to developing the strategies may undermine regional connections between the Murray and Murrumbidgee region. However, attendees also mentioned that it will be important that the strategies pick up on different issues in the upper, mid and lower parts of the catchment concern that the need for interjurisdictional collaboration was not adequately covered in the draft regional water strategies the Murray and Murrumbidgee regions border both Victoria and the ACT, and many local and regional water systems are highly interconnected and reliant on cross-border sources interest in mapping current water resource ownership and transfers across borders clarity on how the regional water strategies address water management within other states and territories a desire for border communities in Victoria and the ACT to also be consulted during the regional water strategies process interest in the potential to increase water supply by accessing inter-state sources.

Topic	Comment
<p>Interaction between regional water strategies and existing policies and plans</p>	<p>Attendees asked how the regional water strategies will take account of and integrate existing government commitments and other water management policies and plans. Attendees offered a range of suggestions including:</p> <ul style="list-style-type: none"> • clarity on how the regional water strategies will integrate and respond to existing or ongoing water projects and programs as well as past inquiries, reviews and studies • concern regarding delays in implementing recommendations from previously completed studies, inquiries and reports • interest in how the regional water strategies will support local councils in a way that existing mechanisms and documents do not • better coordination with councils about local water infrastructure projects could help improve delivery and maximise outcomes • clarity on the operation and licensing of the Snowy Scheme, including whether the regional water strategies will include options that concern the Snowy Scheme • clarity on whether the regional water strategies would influence legislation regarding land use planning, river corridor management or Integrated Water Cycle Management plans • that regional water strategies and any future sub-regional water strategies need to relate to each other • the need for consistent boundaries across all local, regional, state, and national plans and strategies • the need for a transparent link between the NSW Water Strategy and regional water strategies.
<p>Engagement and partnership with communities to develop the regional water strategies</p>	<p>Attendees advocated for a collaborative approach to developing the regional water strategies and stated that:</p> <ul style="list-style-type: none"> • licence holders and local groups should be engaged early to inform the Murray and Murrumbidgee regional water strategies • engagement with grassroots groups, regulatory industry groups and local Aboriginal groups is important to the development of the strategies • the regional water strategies' options assessment process must be transparent about how shortlisted options were selected • the region is unique due to two existing major water authorities (Riverina Water and Goldenfields Water) which should be accounted for in the Draft Murrumbidgee Regional Water Strategy • collaboration between Department of Planning and Environment—Water and local councils, local water utilities is essential to develop and implement the regional water strategies.
<p>Town water security</p>	<p>Attendees emphasised the importance of securing town water supplies, particularly given the pressures of predicted population growth and changes to industry. There were a number of questions and suggestions including:</p> <ul style="list-style-type: none"> • taking a more pro-active approach to delivering and maintaining town water infrastructure, especially given the regions' ageing infrastructure • concerns regarding shifting maintenance costs for state and federally-delivered infrastructure and water re-use schemes to local councils • regional population growth and investment including the Wagga Wagga Special Activation Precinct may affect local and regional water demand • interest in whether water availability could inform population growth or influence industry changes • local councils are under increasing pressure to add additional water connections to service new developments • concern that the regional water strategies will rely on NSW Government common planning assumptions (population projections) which may not accurately represent regional population growth • suggestion that water security risk ratings identified in the strategies should be changed or further information provided for context • need to account for changes to industry, such as potential growth of the mining industry.

Aboriginal engagement

Topic	Comment
<p>The cultural significance of water</p>	<p>Attendees emphasised the cultural significance of water to Aboriginal people and shared a range of thoughts, ideas and concerns—in particular, Aboriginal people:</p> <ul style="list-style-type: none"> • emphasised the significance of traditional medicines and the need to protect native plant species that might be threatened by poor water management • emphasised the cultural significance of water to Aboriginal people and the desire to share stories to help communicate this • shared concerns that while culturally-significant sites have been protected, this can be overridden by large scale projects • shared concerns that landholder and industry access to water is prioritised over cultural water and water for Aboriginal people • shared concerns that the water management framework does not account for the importance of the rivers and the sacred and spiritual connection of Aboriginal people to water.
<p>Aboriginal water entitlements, cultural licences and access</p>	<p>Attendees expressed concern that Aboriginal people are locked out of culturally-significant sites and have limited access to water entitlements. They shared the following thoughts, ideas and concerns:</p> <ul style="list-style-type: none"> • having greater access to water entitlements would enable Aboriginal peoples and organisations to make better use of their land holdings • concern that Aboriginal people are prevented from accessing certain sections of the river due to private land ownership • Aboriginal Cultural Water Access Licences are difficult to apply for and their acquisition can be associated with additional costs • disappointment that Aboriginal Cultural Water Access Licences cannot be used for economic purposes • frustration about the lack of progress on the Federal Government’s \$40 million commitment to increase water entitlement ownership for Aboriginal people in the Murray-Darling Basin • emphasised the importance of building awareness in Aboriginal communities about opportunities that exist for Aboriginal people around water • concern about cost of buying water entitlements and the limited capital that Aboriginal people have to buy water entitlements • the Murrumbidgee Cultural Water Licence can only be used in four sites due to high costs and a lack of infrastructure • more transparency is required about water access licences in the region, such as who holds them, how they can be used and how the allocation process works • cultural water allocations are needed and could be supported through partnerships with local water utilities.

Topic	Comment
Sustainable water management and river health	<p>Attendees expressed concern regarding the health of the rivers and waterways in the region and the long-term environmental impacts caused by unsustainable management. They shared the following thoughts, ideas and concerns:</p> <ul style="list-style-type: none"> • concern regarding river health and that current water management approaches don't value a healthy river system • concerns about expansion of irrigation activities in the lower Murray River • there are no words in any Aboriginal language to describe 'no flow' demonstrating this is a new and concerning challenge for river health • concern around the growth of water-intensive agriculture • concern regarding the health of the river and the need for more sustainable management • emphasised the importance of environmental flows to the health of the rivers • expressed the view that Aboriginal people have sustainably managed water for thousands of years and current approach is impacting Country—and that there is a need to incorporate Aboriginal people's knowledge (traditional ecological science) into water resource management and planning to complement and integrate with Western scientific methods • concern that current river management arrangements are causing environmental issues in the upper Murrumbidgee. Fast moving water has caused erosion and removal of vegetation that are important habitats and breeding areas for native species • concern that there was no consultation or forward planning before the banks were artificially stabilised in the upper Murrumbidgee, resulting in negative environmental impacts • rehabilitation work could 'offset' environmental/cultural damage from past council work • concerns that there are conflicting views between the Department of Primary Industries—Fisheries and the Aboriginal community regarding cultural fishing and fish management.
Aboriginal engagement and involvement in development of regional water strategies	<p>Attendees stressed the importance of meaningful consultation with Aboriginal people when developing the regional water strategies, including promoting engagement activities to ensure greater participation. They shared the following thoughts, ideas and concerns:</p> <ul style="list-style-type: none"> • frustration about ongoing consultations with Aboriginal people regarding water and perceived government inaction • Aboriginal people should be paid to attend engagement sessions given the time commitment, similar to the approach in Victoria and South Australia • consultation times could be changed (i.e. outside of business hours) and transport could be provided to make it easier for Aboriginal people to attend • government could develop policies to enable all Aboriginal people to attend consultation activities, regardless of their employment status • the need for consultation to be followed through with action, and that Aboriginal people had lost trust in the process • concern that the NSW Government departments wouldn't give community members an opportunity to review the meeting minutes.

Topic	Comment
Water management	<p>Attendees expressed an interest in current water management approaches including how Aboriginal people could play a more active role. They shared the following thoughts, ideas and concerns:</p> <ul style="list-style-type: none"> • there is a limited relationship between the Department of Planning and Environment and local Aboriginal communities, inhibiting good water management • there isn't enough focus on water management in the Murrumbidgee region, compared to engagements in the Darling and Murray regions • education and employment opportunities in the water sector would help advance Aboriginal people's involvement in water, especially providing career pathways for young people. There was support for the establishment of a River Ranger Program • Aboriginal youth can play an important role in water management and there is a need to build capacity of youth through knowledge transfer and learning from elders • Aboriginal people should be involved in decision making around water and play an active role in water management • sought clarity on the roles and responsibilities in water management including which entities will hear out Aboriginal people concerns and issues • suggested that Aboriginal Waterway Assessment Program should be done in other parts of the Murray and Murrumbidgee regions • concern about water reforms which led to the separation of land and water entitlements.

Next steps

The Draft Murrumbidgee and Murray regional water strategies will be placed on public exhibition for six weeks from 11 April 2022. Additional public engagement will take place during this time and written submissions will be accepted. Further engagement will be conducted once outcomes and submissions from the public exhibition period have been reviewed and before the regional water strategies are finalised.

Attachment 2

Glossary

Term	Definition
Access licence	<p>An access licence entitles its holder to take water from a water source in accordance with the licence conditions.</p> <p>Key elements of an access licence are defined in section 56(1) of the NSW <i>Water Management Act 2000</i> as:</p> <ul style="list-style-type: none"> (a) <i>specified shares in the available water within a specified water management area or from a specified water source (the share component), and</i> (b) <i>authorisation to take water:</i> <ul style="list-style-type: none"> (i) <i>at specified times, at specified rates or in specified circumstances, or in any combination of these</i> (ii) <i>in specified areas or from specified locations (the extraction component).</i> <p>An access licence may also be referred to as a water access licence or a WAL.</p>
Allocation	<p>The specific volume of water licence holders can access. The amount of water allocated to licence holders varies from year to year based on the type of licence, size of their individual entitlement, dam storage levels, river flows and catchment conditions.</p>
Alluvium, alluvial	<p>Loose unconsolidated soil or sediment that has been deposited by surface water (such as rivers and floods).</p>
Anabranch	<p>A stream/channel that branches off from a river and re-joins it further downstream.</p>
Aquifer	<p>Geological structure or formation, or landfill, that can hold water.</p>
Basic landholder rights	<p>Where landholders can take water without a water licence or approval under section 52, 53 and 55 of the NSW <i>Water Management Act 2000</i>.</p> <p>There are three types of basic landholder rights under the NSW <i>Water Management Act 2000</i>:</p> <ul style="list-style-type: none"> • domestic and stock rights—where water can be taken for domestic consumption or stock watering if the landholder’s land has river frontage or is overlying an aquifer • harvestable rights—where landholders can store some water from rainfall runoff in dams • Native Title Rights—anyone with a Native Title right to water, determined under the <i>Australian Native Title Act 1993</i>.
Basin Plan	<p>As a requirement of the <i>Water Act 2007</i>, the Murray-Darling Basin Authority was required to develop the Murray-Darling Basin Plan (Basin Plan) to manage the Basin as a whole connected system.</p> <p>The Basin Plan 2012 provides a coordinated approach to water use across the Murray-Darling Basin’s four states and the ACT, balancing environmental, social and economic considerations by setting water use to an environmentally sustainable level.</p>
Biota	<p>The total collection of animal and plant life of a geographic region or habitat.</p>

Term	Definition
Blackwater event	An event that occurs when flooding washes organic material into waterways where it is decomposed by bacteria, releasing carbon, depleting oxygen levels and giving water a black or tea-coloured appearance. The sudden decrease in oxygen can result in the death of fish and other organisms.
Catchment	A natural drainage area, bounded by sloping ground, hills or mountains from which water flows to a low point. Flows within the catchment contribute to surface water sources as well as to groundwater sources.
Cease-to-take rule	A requirement in water sharing plans that licence holders stop pumping when the river flow falls below a certain level.
Climate-independent water source	A source of water that does not depend on rainfall or streamflows for replenishment. Includes seawater desalination and recycled water.
Climate variability	Describes the way key climatic elements, such as temperature, rainfall, evaporation and humidity, depart from the average over time. Variability can be caused by natural or man-made processes.
Cold water pollution	An artificial decrease in the temperature of water in a river. It is usually caused by cold water being released into rivers from large dams during warmer months
Constraints	Under the Murray Darling Basin Plan, a constraint is a rule or structure which limits the volume and/or timing of the delivery of environmental water. Constraints can include physical structures (e.g. low-lying bridges), river management practices, and operational limits for river heights.
Constraints Management Strategy	The Murray–Darling Basin Authority Constraints Management Strategy investigates more efficient ways to deliver water to where it's needed, when it's needed; while avoiding or mitigating impacts to riparian landholders, communities and industries. It focuses on seven key areas in the Basin, proposing projects for addressing constraints. The constraints projects (excluding those in the Gwydir) are part of the package of projects submitted by states through the SDLAM process.
County Council	County Councils are regional utilities, constituted under the provisions of the <i>Local Government Act 1993</i> , that operate across multiple local government areas in NSW. County Council functions may include bulk water supply, water and sewerage services, floodplain management and weed biosecurity. There are 10 County Councils in NSW, four of which have bulk water supply functions.
Cultural flows	While the NSW <i>Water Management Act 2000</i> does not define cultural flows, the Murray Lower Darling River Indigenous Nations Echuca Declaration, 2007, defines cultural flows as: 'water entitlements that are legally and beneficially owned by the Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, natural, environmental, social and economic conditions of those Nations.'
Direct employment	Refers to employment directly arising from the demand for a specific product or service.
Effluent	Flow leaving a place or process. Sewage effluent refers to the flow leaving a sewage treatment plant. An effluent stream is one that leaves the main river and does not return.
Endangered ecological community	Ecological communities as listed in 'Schedule I' of the <i>Threatened Species Conservation Act 1995</i> or Schedule 4 of the <i>Fisheries Management Act 1994</i> .
End of system	The last defined point in a catchment where water information can be measured and/or reported.

Term	Definition
Entitlement	The exclusive share of the available water that a licence holder can take, subject to allocations.
Environmental asset	Natural features that contribute to the ecosystem of a region.
Environmental water	Water allocated to support environmental outcomes and other public benefits. Environmental water provisions recognise the environmental water requirements and are based on environmental, social and economic considerations, including existing user rights.
Eutrophication	Eutrophication is the process by which a body of water becomes saturated with minerals and nutrients, leading to excessive plant and algal growth. Algal blooms and low-oxygen waters can kill fish and aquatic flora and reduce fish habitats.
Evapotranspiration	The combined effect of evaporation and transpiration.
Evaporation	The process by which water or another liquid becomes a gas. Water from land areas, bodies of water and all other moist surfaces is absorbed into the atmosphere as a vapour.
Extraction limit	A limit on the long-term average volume of water that can be extracted from a source.
Fish passage	The free movement of fish up and down rivers and streams.
Floodplain	Flat land bordering a river or stream that is naturally subject to flooding and is made up of alluvium (sand, silt and clay) deposited during floods. Floodplain harvesting is the collection or capture of water flowing across floodplains.
Freshes	Freshes are where the surface water flow is of sufficient size and duration to 'reset' river reaches. Resetting includes improving water quality, clearing sediment build-up to enhance instream habitat, redistributing sediment to enable normal geomorphic processes, redistributing nutrients to enable normal levels of instream productivity and encouraging instream biota to disperse and/or breed.
General security licence	A category of water access licence under the <i>NSW Water Management Act 2000</i> . This category of licence forms the bulk of the water access licence entitlement volume in NSW regulated rivers and is a low priority entitlement—that is, receives water once essential and high security entitlements are met.
Gross Regional Product	A measure of the market value of all goods and services produced in a region within a period of time. Gross regional product is a similar measure to gross state product and gross domestic product.
Gross value added	A measure of the value of goods and services produced in an area, industry or sector of an economy. Gross value added is a similar measure to gross regional product.
Groundwater	Water located beneath the ground in the spaces between sediments and in the fractures of rock formations.
Groundwater dependent ecosystem	Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.
High flows	Also called bankfull events, these reshape the channel, creating habitats such as pools, bars and benches.

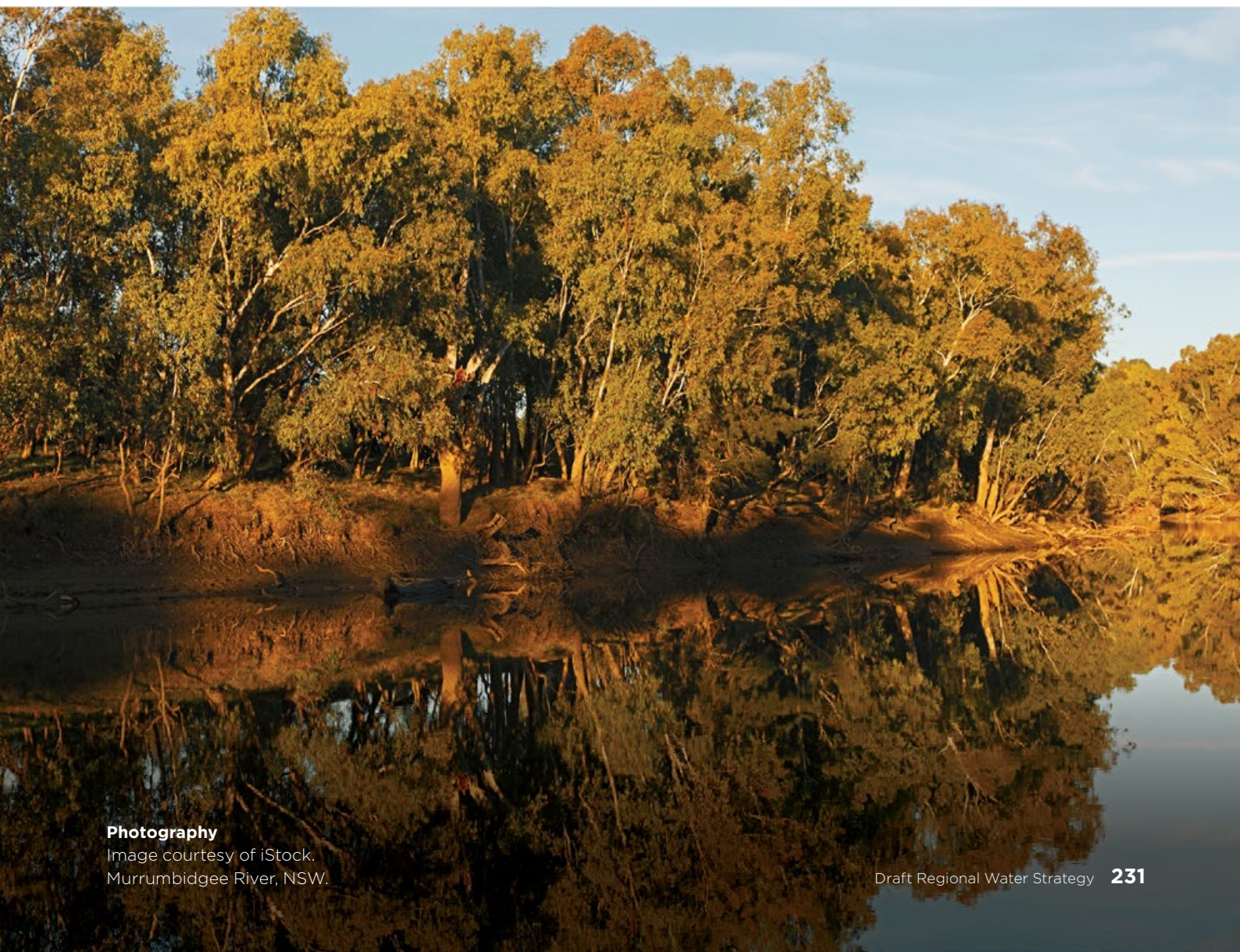
Term	Definition
High security licence	A category of water access licenses in regulated rivers implemented under the NSW <i>Water Management Act 2000</i> . Receives a higher priority than general security licences but less priority than essential requirements in the available water determination process. Many high security licences are held by water users that have inflexible water demands, such as those growing permanent plantings and mining companies.
Hydrologic stress	Refers to the level of extraction in a river system. In NSW, 'high hydrologic stress' is defined as 70-100% average annual river flow extracted; and 'medium hydrologic stress' as 40-60% flow extracted.
Hypoxic Blackwater	Hypoxic blackwater events refer to occasions when dissolved oxygen concentrations in water are very low. These events occur when floodwaters leach organic matter from leaf litter, plants and soil resulting in water that is very high in dissolved organic matter (blackwater). This organic matter is consumed rapidly by microbes resulting in oxygen being used faster than it can be replenished. Hypoxic conditions place high stress on aquatic biota and can lead to fish kills.
Indirect employment	Jobs that are created by other businesses to support the primary employment sector.
Irrigation Corporation	Irrigation corporations are private companies that hold water licences and approvals on behalf of their shareholders. They are authorised to supply water under an operating licence granted under the <i>Water Management Act 2000</i> .
Inflows	The amount of water coming into a surface water source or groundwater source.
Joint organisation	An entity formed under the <i>Local Government Act 1993</i> to perform three principal functions in a region: strategic planning and priority setting, intergovernmental collaboration and shared leadership and advocacy. Each joint organisation comprises at least three member councils and aligns with one of the State's strategic growth planning regions.
Local water utilities	Generally, these are council owned and operated utilities that provide water supply and sewerage services to local communities.
Managed aquifer recharge	Intentional recharge of water to aquifers through infiltration or injection for subsequent use or environmental benefit.
Non-revenue water	Water that has been produced and is 'lost' before it reaches the customer. Losses can be real losses (through leaks, sometimes also referred to as physical losses) or apparent losses (for example through theft or metering inaccuracies).
Non-stationarity	<p>A data sample, which shows upwards and downwards trends but does not have a long-term trend is a stationary series. For climate data, the datasets need to extend beyond the limited observational records to assess stationarity.</p> <p>Stationarity is a property of an underlying stochastic process, and not of observed data. All natural systems are non-stationary, but when the non-stationarity is not substantial and the process can be accurately represented by a comparatively simple stationary stochastic model then it is considered to be stationary. In contrast, non-stationarity can simply be defined as processes that are not stationary and that have statistical properties that are deterministic functions of time.</p>
Operational rules	The procedures for managing releases and extractions of water (surface and groundwater) to meet the rules of relevant legislation and policy, for example water sharing plans and long-term water plans.

Term	Definition
Paleoclimate data	Refers to climate records prior to instrumental records. Various environmental indicators can be used to reconstruct paleoclimate variability extending back hundreds of thousands of years in time. These indicators include marine and terrestrial deposits, tree rings and ice cores.
Permanent plantings	Crops that are not replanted after a growing season. These crops generally require more than one growing season to be productive. Examples include grapes, citrus fruits and almond trees. These are different from annual (or broadacre) crops, which are harvested within 12 months of planting and require replanting to produce a new crop.
Per- and polyfluoroalkyl substances (PFAS)	PFAS are manufactured chemicals used in products that resist heat, oil, stains and water. PFAS are contained in many common household products, such as paints and pesticides, and in legacy firefighting foams. The use of PFAS by Australia's Defence Force was phased out in 2004, however, the release of PFAS into the environment has become a concern as these chemicals can persist in humans, animals and the environment.
Ramsar Convention	The Convention on Wetlands of International Importance (Ramsar Convention) is an international treaty to halt the worldwide loss of wetlands and conserve those that remain. Australia has 66 Wetlands of International Significance listed under the convention.
Recharge	Groundwater recharge is a hydrologic process where water drains downward from surface water to groundwater. Groundwater is recharged naturally by rain, floods and snow melt and to a smaller extent by drainage directly from surface water (such as rivers and lakes).
Recycled water	Water that has been treated to a 'fit for purpose' standard for a specific application as per the Australian Guidelines for Water Recycling.
Refugia	Ecological refuges (or refugia) are places that naturally provide protection for plants and animals from threats, such as drought, fire, diseases and invasive species.
Regional Plan	The Department of Planning and Environment has developed regional plans for nine regions across NSW to help support future community needs. They set regional planning priorities and provide a framework for regional and local planning decisions. Regional plans include plans for housing, jobs, community infrastructure and a healthy environment.
Regulated river	A river system where flow is controlled via one or more major man-made structures (e.g. dams and weirs). For the purposes of the NSW <i>Water Management Act 2000</i> , a regulated river is one that is declared by the Minister to be a regulated river. Within a regulated river system, licence holders can order water which is released from the dam and then taken from the river under their water access licence.
Resilience	Resilient water resources as those that are able to withstand extreme events, such as drought and flood, and/or adapt and respond to changes caused by extreme events.
Riparian	The part of the landscape adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within them.
Salinity	The concentration of sodium chloride or other dissolved minerals in water.
Snowy Scheme	The Snowy Mountains Hydro-electric Scheme (Snowy Scheme) is one of the most complex integrated water and hydroelectric power schemes in the world. The Snowy Scheme is operated and maintained by Snowy Hydro Limited, a company owned by the Australian Government.

Term	Definition
Snowy Water Licence	The Snowy Water Licence (the licence) defines Snowy Hydro Limited's rights and obligations in relation to water in the Snowy Scheme. The licence allows Snowy Hydro Limited to collect, divert, store, and release water by and from the works of the Snowy Scheme for the 75-year term of the licence. The licence also defines the rules for releases into the Murray and Murrumbidgee rivers and imposes environmental flow release obligations on Snowy Hydro Limited for the benefit of the Snowy River and other montane rivers (the rivers of the Snowy Mountains).
Special activation precinct	A dedicated area in a regional location identified by NSW Government to become a thriving business hub.
Stochastic climate datasets	Stochastic climate datasets are extended climate sequences that are synthesised using statistical methods applied to observed data of rainfall and evapotranspiration and can include paleoclimatic data. These extended sequences include a more complete sample of climate variability, part of which describes more severe drought sequences.
Storage	A state-owned dam, weir or other structure which is used to regulated and manage river flows in the catchment. There are also a range of storages owned by local water utilities. Also refers to the water bodies impounded by these structures.
Stormwater	The runoff of water generated from rainfall, from land to natural waterbodies, such as creeks, rivers and the sea. It includes surface flow and flow within conduits.
Supplementary flow	Where a surplus flow from rain events cannot be captured in storages, such as dams and weirs, and this water is not needed to meet current demands or commitments, then it is considered surplus to requirements. Reaches or zones of regulated rivers are typically unregulated for a short period of time.
Supplementary licence	Where a surplus flow from rain events cannot be captured in storages or weirs, and this water is not needed to meet current demands or commitments, then it is considered surplus to requirements and a period of Supplementary Access is announced. Supplementary Water Access Licence holders can only pump water against these licences during these announced periods. Other categories of licence holders may also pump water during these periods.
Surface water	All water that occurs naturally above ground including rivers, lakes, reservoirs, creeks, wetlands and estuaries.
Sustainable diversion limit	Sustainable diversion limits apply to defined resource units, which are specified in the Basin Plan. They specify how much surface water or groundwater, on average, can be used in the Murray-Darling Basin by towns, communities, industry and farmers. These limits are written into law in NSW through water sharing plans.
Sustainable Diversion Limit Adjustment Mechanism	A mechanism included in the Basin Plan to adjust sustainable diversion limits in the southern Basin. The mechanism is a way to achieve similar or better environmental outcomes for rivers, wetlands and wildlife using less water. The adjustment mechanism can be achieved through supply, including constraints, or efficiency measures. Supply projects aim to improve water infrastructure and operating rules and efficiency projects improve water delivery systems.
Synthetic datasets	Data that is artificially created using algorithms and not obtained by direct measurement or generated by actual events.
Transmission losses	Water, from an accounting perspective, that is considered lost. This water has been lost through surface water seeping into the ground or evaporation.

Term	Definition
Transpiration	The process where plants absorb liquid water through their roots and then lose water vapour (gas) through pores in their leaves.
Tributary	A smaller river or stream that flows into a larger river or stream. Usually a number of smaller tributaries merge to form a river.
Unregulated river	<p>These are rivers or streams that are not fully controlled by releases from a dam or through the use of weirs and gated structures. However, in some catchments there are town water supply dams that control flows downstream.</p> <p>Water users on unregulated rivers are reliant on climatic conditions and rainfall.</p> <p>For the purpose of the NSW <i>Water Management Act 2000</i>, an unregulated river is one that has not been declared by the Minister to be a regulated river.</p>
Wastewater	<p>Water that is an output of or discharged from a particular activity; for example, from domestic, commercial, industrial or agricultural activities.</p> <p>The chemical composition of the wastewater (compared to the source) will be contaminated.</p>
Water accounting	The systematic process of identifying, recognising, quantifying, reporting, assuring and publishing information about water, the rights or other claims to that water, and the obligations against that water.
Water reliability	Refers to how often an outcome is achieved. It is often considered to be the likelihood, in percentage of years, of receiving full water allocations by the end of a water year for a licence category. For example, a 60% reliability means that in 60% of years a licence holder can expect to receive 100% of their licensed entitlement by the end of the water year. Other measures of volumetric reliability could also be used; for example, the percentage allocation a licence holder could expect to receive at a particular time of the year as a long-term average. Reliability may also refer to how often an acceptable water quality is available. A reliable water supply gives some clarity to water users and helps them plan to meet their water needs.
Water resource plan	A plan made under the <i>Australian Water Act 2007</i> that outlines how a particular area of the Murray–Darling Basin’s water resources will be managed to be consistent with the Murray–Darling Basin Plan 2012. These plans set out the water sharing rules and arrangements relating to issues such as annual limits on water take, environmental water, managing water during extreme events and strategies to achieve water quality standards and manage risks.
Water rights	The legal right of a person to take water from a water source such as a river, stream or groundwater source.
Water security	<p>Water security in the context of regional water strategies refers to the acceptable chance of having town water supplies fail. This requires community and government to have a shared understanding of what is a ‘fail event’ (for example, no drinking water or restrictions below a defined level for longer than a defined period, or unacceptable water quality) and the level of acceptability they will pay for.</p> <p>The NSW Government’s guidance around an appropriate security of supply for sizing town water supply head-works is the 5/10/10 rule. Under this approach, the total time spent in drought restrictions should be no more than 5% of the time, restrictions should not need to be applied in more than 10% of years and when they are applied there should be an average reduction of 10% in water usage. This allows full demand to be met in most years and also allows for water restrictions to be implemented infrequently to conserve supplies.</p>

Term	Definition
Water sharing plan	A plan made under the NSW <i>Water Management Act 2000</i> which sets out the rules for sharing water between the environment and water users, and between different water users, within whole or part or restrictions below a defined level for longer than a defined period, a water management area or water source.
Water source	Defined under the NSW <i>Water Management Act 2000</i> as 'The whole or any part of one or more rivers, lakes or estuaries, or one or more places where water occurs naturally on or below the surface of the ground and includes the coastal waters of the State.' Individual water sources are more specifically defined in water sharing plans.
Water trade	The process of buying and selling water entitlements and water allocations.
Water year	In NSW, the water year runs from 1 July to 30 June.
Wetland	Wetlands are areas of land where water covers the soil—all year or just at certain times of the year. They include swamps, marshes, billabongs, lakes, and lagoons. Wetlands may be natural or artificial and the water within a wetland may be static or flowing, fresh, brackish or saline.



Photography

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Murrumbidgee River, NSW.



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