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Draft Regional Water Strategy

Murrumbidgee: Shortlisted Actions – Consultation Paper

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Cover image Image courtesy of Destination NSW. Snowy Mountains, NSW.

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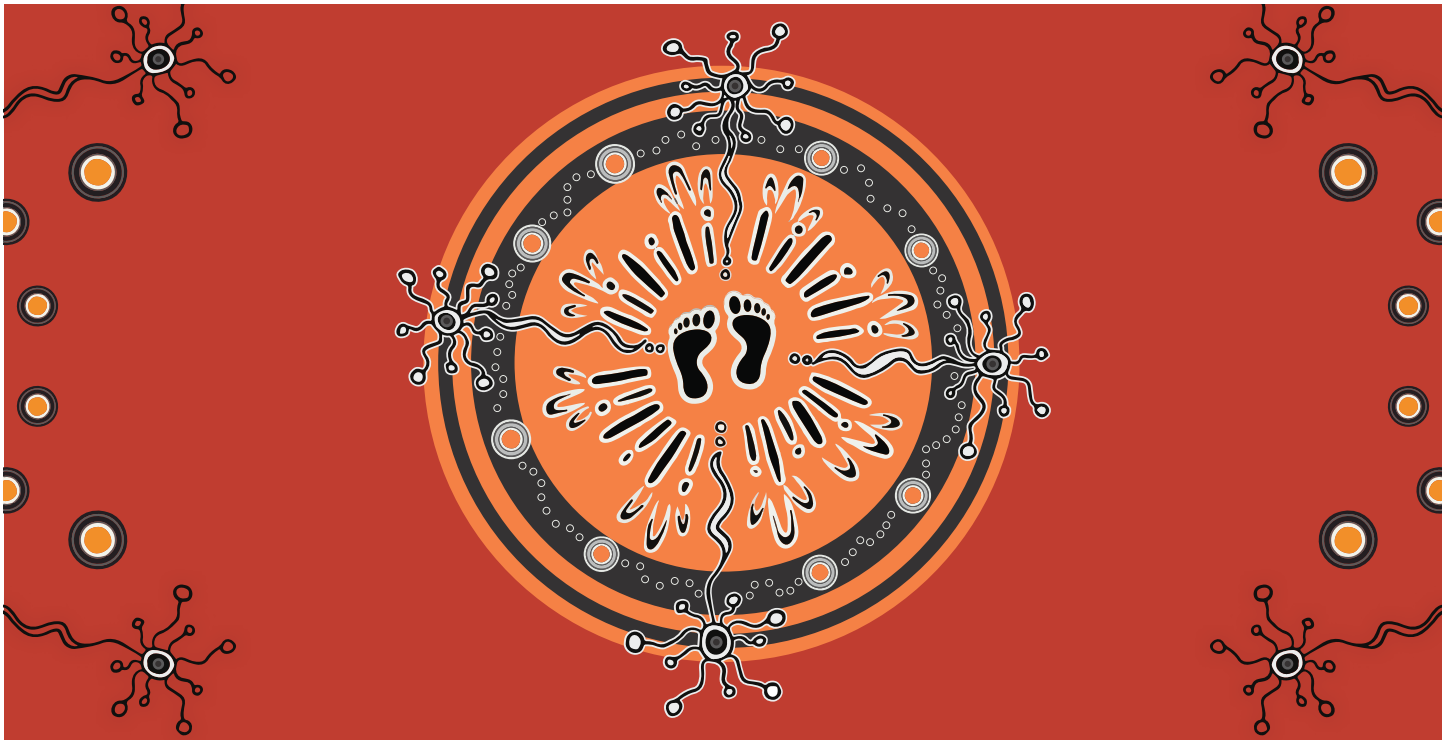


Acknowledging First Nations people

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

Today, they practice the oldest living culture on earth.

The NSW Government acknowledges the Barapa Barapa, Mutthi Mutthi, Nari Nari, Ngarigu, Ngunnawal/Ngunawal, Wadi Wadi, Wemba Wemba, Wiradjuri, Wolgalu and Yita Yita people as having an intrinsic connection with the lands and waters of the Murrumbidgee Regional Water Strategy area. The landscape and its waters provide the First Nations people with essential links to their history and help them maintain and practice their traditional culture and lifestyle.

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

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

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

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

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

Artwork by Nikita Ridgeway.

Contents

Snapshot

The Murrumbidgee region

262,000
NSW population
(ACT 454,499 (2021 Census))

84,000
km² area
(ACT 2,358 km² area)

Key regional centres include:
Wagga Wagga, Griffith and Queanbeyan
(Canberra)

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

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, Balranald and Bungendore

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

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 Wetlands, mid-Murrumbidgee Wetlands, lower Murrumbidgee (Lowbidgee) Floodplain including Gayini Nimmie-Caira
Threatened and vulnerable native species including 12 fish species, 6 frog species and 44 bird species

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

Gross Value Added (2020–21): **$16.7 billion**

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

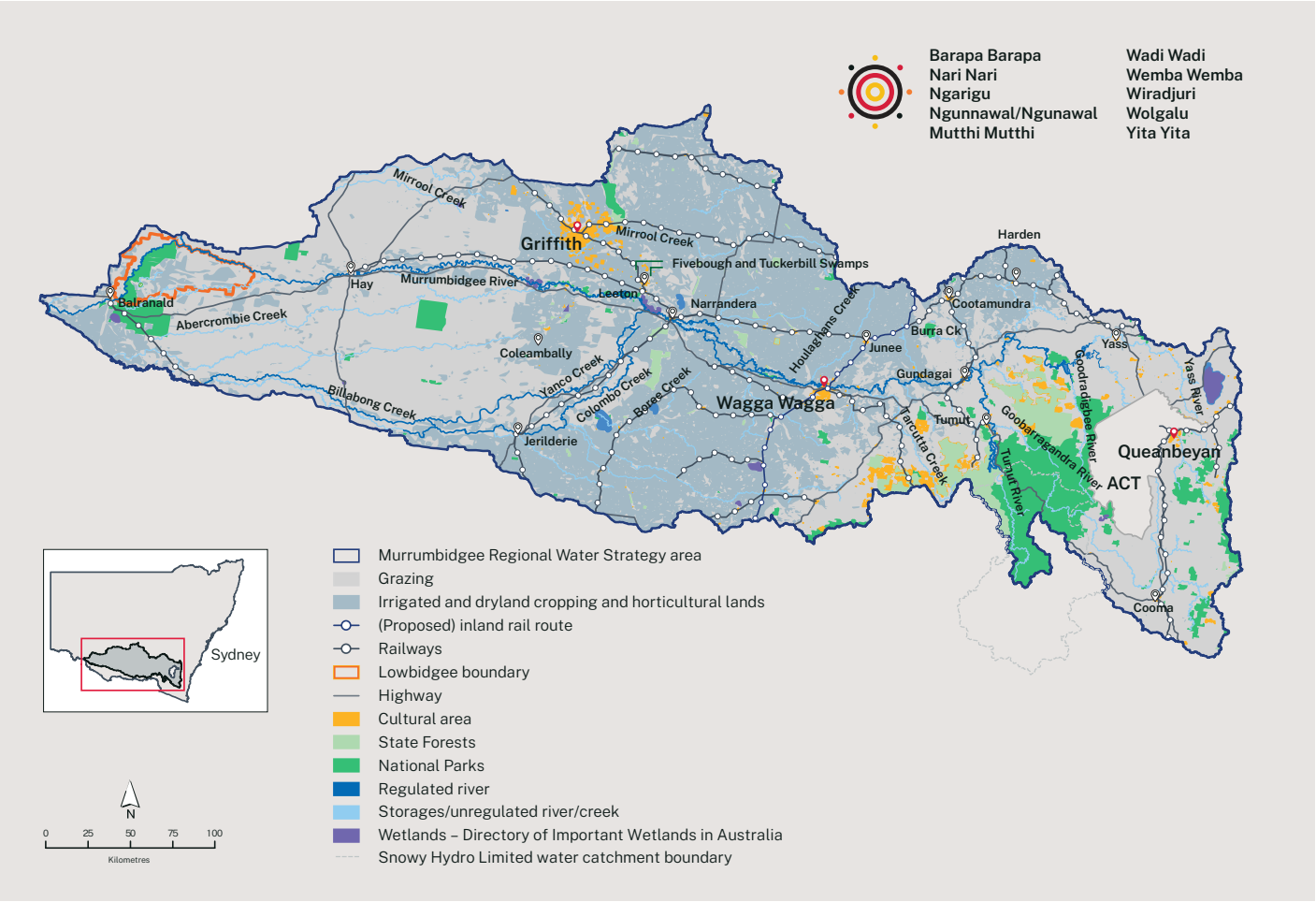
(ACT Gross State Product $48.7 billion – 2022/23)

The Murrumbidgee Regional Water Strategy region (Figure 1) lies towards the geographic bottom of NSW and has the third longest river in Australia. It includes stunning natural landscapes that change from alpine terrain in the east to riverine plains in the west. The region is home to many thriving regional centres and communities, productive agricultural land, hydroelectricity, and nationally important wetlands such as Fivebough and Tuckerbil wetlands.

The region is located within the traditional lands of the Barapa Barapa, Mutthi Mutthi, Nari Nari, Ngarigu, Ngunnawal/Ngunawal, Wadi Wadi, Wemba Wemba, Wiradjuri, Wolgalu and Yita Yita nations. These nations have been caretakers of the Murrumbidgee for over 60,000 years.

The Murrumbidgee region is part of the broader 'southern connected Basin', linked hydrologically and through water management arrangements to the Murray River and, by extension, to Victoria and South Australia. The region also receives inflows from the Snowy Scheme in accordance with the Snowy Water Licence.

Figure 1. Map of the Murrumbidgee region



Environmental significance of the Murrumbidgee region

Water is a significant feature of the Murrumbidgee region's landscape and environment. Environmental assets play a crucial role in the region's liveability and in providing recreational and tourism opportunities.

The region's river systems, floodplains, aquifers, swamps and wetlands provide habitat for many aquatic species, including birds and native fish. The lower Murrumbidgee floodplain (known as the Lowbidgee) is a significant feature in the region, supporting the second largest red gum forest and colonial waterbird breeding sites in Australia. The Murrumbidgee is home to 2 internationally important wetlands and other nationally important wetlands and swamps. The Murrumbidgee waterways support several native aquatic species listed as threatened or endangered in NSW, including the Murray cod, Macquarie perch, Murray crayfish and Southern bell frog. The rivers and wetlands in the mid and lower Murrumbidgee play an important role in supporting groundwater-dependent ecosystems.

Addressing the environmental challenges facing the Murrumbidgee region

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

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

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

Image courtesy of James Maguire, NSW Department of Climate Change, Energy, the Environment and Water. Tala Lake, NSW.

What is the purpose of this consultation paper?

1

Image courtesy of James Maguire, NSW Department of Climate Change, Energy, the Environment and Water. Piggery Lake, NSW.

The NSW Government is developing 13 regional water strategies that 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 first draft of the Murrumbidgee Regional Water Strategy, including a long list of options to address regional challenges, was released in April 2022.[1] The feedback we received on the first draft was compiled in the *Draft NSW Murray and Murrumbidgee Regional Water Strategies: What We Heard* report.[2]

After public consultation on the draft strategy, the NSW Department of Climate Change, Energy, the Environment and Water (the department) considered all feedback, and in December 2022, published baseline hydrological modelling results using the new climate data alongside updated regional challenges.[3] Further consultation was held in October and November 2023 to gather stakeholder views on this additional and revised information.

This consultation paper considers the feedback from stakeholders and additional research to finalise the identification of the key challenges in the region and proposes actions to address these challenges. The detailed process is described in the *Options assessment process: Overview*.

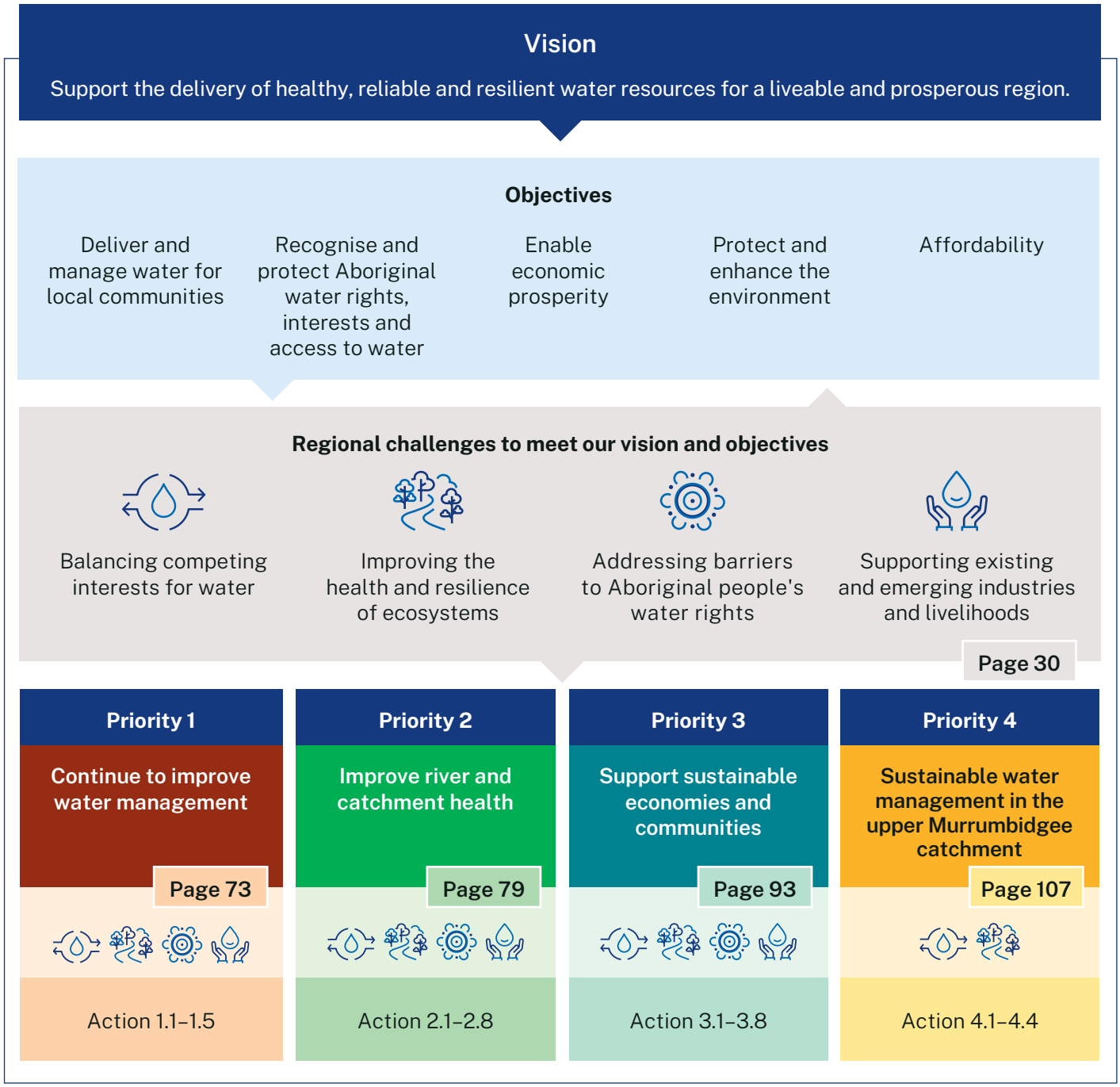
This consultation paper presents the outcomes of this work, summarised in Figure 2.

No decisions have been made on the shortlist of proposed actions. The purpose of this consultation paper is to seek your views on what the best actions are to set the Murrumbidgee region up for the future before a final strategy and an implementation plan are developed.

Image courtesy of Destination NSW. Tumut River Walk, Tumut.

1. Full descriptions of the region, its water resources and water needs are provided in the draft strategy report and long list of options report. These reports can be viewed and downloaded at: www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murrumbidgee/murrumbidgee-regional-water-strategy
2. More information about the *Draft NSW Murray and Murrumbidgee Regional Water Strategies: What We Heard Report* (December 2022): www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murrumbidgee/murrumbidgee-regional-water-strategy
3. The results of baseline hydrological modelling for the draft NSW Murray and Murrumbidgee regional water strategies are detailed in the *Draft NSW Murray and Murrumbidgee Regional Water Strategies Climate and hydrological modelling report* (December 2022), including key implications for water resources in the NSW Murray region. Releasing this base set of results is intended to inform public understanding and discussion about the range of potential climate challenges the water resources of the regions may face into the future. The report is available at: www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murrumbidgee

Figure 2. Proposed water security challenges and priorities for the Murrumbidgee region



Why are we developing regional water strategies?

Across NSW, valuable and essential water resources are under pressure. A more variable climate, as well as changing industries and populations, mean we face difficult decisions and choices about how to balance the different demands for this vital resource to manage water efficiently and sustainably into the future. The regional water strategy process identifies these risks and seeks to understand how we can manage and be best prepared for these future uncertainties and challenges.

In addition to understanding and managing future pressures, there are opportunities to consider the role water resources will play in sustaining regional economies, improving liveability and making sure each region remains a great place to live, work, play and visit.

The NSW Government's strategic investments and actions identified through regional economic development strategies are critical to realising this vision. However, all these activities rely on access to water.

The regional water strategies program is helping to provide the evidence base needed to support existing investments, identify new opportunities and sustain successful regional industries of the future.

The regional water strategies will include a wide range of tools and solutions to help better use, share, store and deliver water to ride the highs and lows of water availability and change how water is managed in the future.

Image courtesy of Destination NSW. Yass River, NSW.

How do regional water strategies align with other water strategies?

Alignment with state-wide strategies and programs

The NSW Water Strategy, together with the 13 regional water strategies and 2 metropolitan water strategies that underpin it, will form the strategic planning framework for water management in NSW. The NSW Water Strategy was developed in parallel with the draft regional water strategies. The NSW Water Strategy guides the strategic state-level actions that need to be taken, while the regional water strategies will prioritise how those state-wide actions – as well as other region-specific, place-based solutions – should be staged and implemented in each region (Figure 3).

As part of the NSW Water Strategy, the NSW Government is delivering other state-wide strategies and programs including:

- the NSW Aboriginal Water Strategy – co-designed with Aboriginal people to identify measures to deliver Aboriginal people's water rights and interests in water management
- the NSW Groundwater Strategy – to ensure sustainable groundwater management across NSW
- the Town Water Risk Reduction Program – to identify long-term solutions to address challenges and risks to providing water supply and sewerage services to regional towns in collaboration with local councils
- a new state-wide Water Efficiency Framework and Program – to reinvigorate water use efficiency programs in our cities, towns and regional centres.

The NSW Water Strategy and the draft Murrumbidgee Regional Water Strategy also complement other whole-of-government strategies, including government commitments to Net Zero[4] and the State Infrastructure Strategy.[5]

The draft Murrumbidgee Regional Water Strategy also aligns its actions and recommendations with the goals and directions set out in the relevant regional plans (Riverina Murray Regional Plan 2041,[6] draft Far West Regional Plan 2041[7] and the draft South East and Tablelands Regional Plan 2041[8]) to support growth and development enabled through the Inland Rail Project, South Jerrabomberra Regional Jobs Precinct, Wagga Wagga Special Activation Precinct, South-West Renewable Energy Zone and Snowy 2.0.

By providing a coordinated approach to support the range of NSW Government policies we aim to build resilience in regional communities. Our aspiration is to adopt a place-based framework that is flexible and adaptive to changing circumstances and enable government and regional communities to work together to ensure the Murrumbidgee region is a great place to live, work, and visit.

4. More information about the *NSW Net Zero Plan* (2020) is available at: www.energy.nsw.gov.au/nsw-plans-and-progress/government-strategies-and-frameworks/reaching-net-zero-emissions/net-zero
5. More information about the *NSW SIS (State Infrastructure Strategy)* (2022) is available at: www.infrastructure.nsw.gov.au/expert-advice/state-infrastructure-strategy/
6. More information about the *NSW Riverina Murray Regional Plan 2041* (2023) is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/riverina-murray-regional-plan-2041
7. More information about the *Draft Far West Regional Plan 2041* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/far-west
8. More information about the *Draft South East and Tablelands Regional Plan 2041* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/south-east-and-tablelands

Figure 3. State and regional water strategies: priorities and objectives

NSW Water Strategy core objectives	NSW Water Strategy strategic priorities	Regional water strategy objectives
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 Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes	**Recognise and protect Aboriginal people's water rights, interests and access to water –** including First Nations 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
	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
Contribute to a strong economy	**Priority 7** Enable a future focused, capable and innovative water sector	**Aligned with all** regional water strategy objectives

Affordability – identify least cost policy and infrastructure options

Alignment with the National Water Initiative

Over the last 20 to 30 years there have been significant changes to the way water is managed in the Murray–Darling Basin and the Murrumbidgee region.

The National Water Initiative (NWI),[9] with commitment from all state and territories, provides for the sustainable, equitable and efficient allocation of water. It aims to achieve better economic, cultural, social and environmental outcomes.

Assessments are undertaken every 3 years by the Productivity Commission under the *Water Act 2007* (Commonwealth) to track the progress of all Australian governments in achieving the objects, outcomes and timelines of the 2004 Intergovernmental Agreement on a National Water Initiative.[10]

All states and territories are working together to renew and modernise the NWI to account for changes in knowledge and technology, and:

- to better consider climate change and extreme events
- improve First Nations involvement and influence in water management
- improve the provision of safe and reliable drinking supplies.

The draft Murrumbidgee Regional Water Strategy aligns with the opportunities identified by the Productivity Commission's 2020 assessment through specific actions relating to climate change, improving First Nations and Aboriginal communities' involvement in water management and town water quality and security.

Alignment with the Basin Plan

The *Basin Plan 2012*[11] aims to achieve a healthy and sustainable Murray–Darling Basin by managing the Basin as a connected system. The aim of the Basin Plan is to bring the Basin back to a healthier and sustainable level of take, while continuing to support farming and other industries for the benefit of the Australian community.

Similar to this, the NSW regional water strategies program aims to enable forward planning for sustainable water management in the Murrumbidgee region for the benefit of local communities, industry and the environment. These initiatives, which would be realised through actions proposed in the draft Murrumbidgee Regional Water Strategy may result in changes to NSW water sharing plans or water resource plans or be delivered through targeted programs and projects.

Table 1 outlines the alignment of the draft Murrumbidgee Regional Water Strategy with the key elements of the Basin Plan. The actions outlined in the draft Murrumbidgee Regional Water Strategy align with Basin Plan requirements and ensure that the interests of NSW communities are at the forefront of our strategic water planning.

9. More information about the *NWI (National Water Initiative)* is available at: www.dcceew.gov.au/water/policy/policy/nwi
10. More information about the *Intergovernmental Agreement on a National Water Initiative* is available at: www.dcceew.gov.au/water/policy/policy/nwi
11. More information about the *Basin Plan 2012* is available at: www.mdba.gov.au/water-management/basin-plan

Table 1. Alignment of the draft Murrumbidgee Regional Water Strategy with the Basin Plan

Basin Plan key elements	Alignment with regional water strategies
Setting limits on how much water can be used through water resource plans and sustainable diversion limits (SDL)	Any actions under the draft Murrumbidgee Regional Water Strategy will need to be implemented within the legislative requirements set by the Basin Plan, including the level of take in accordance with the SDL. Actions implemented in the strategy may impact future reviews of NSW water resource plans.
Effective delivery of water through adequate infrastructure	The draft Murrumbidgee Regional Water Strategy is not proposing any significant changes to the extensive water infrastructure asset portfolio. However, the strategy outlines continuing NSW support for programs run with partner governments to improve delivery of water throughout the Murrumbidgee River system.
Ensuring adequate volumes of water are set aside for the environment and used effectively and efficiently	The draft NSW Murrumbidgee Regional Water Strategy does not propose changes to the volumes of water set aside for the environment. However, it does propose investigations into new and upgraded infrastructure (not currently considered by the Sustainable Diversion Limit Adjustment Mechanism (SDLAM)) that efficiently deliver water to significant ecological assets, as well as improvements to funding arrangements for NSW-held environmental water entitlements. Due to timing, proposed action 2.1 is not considered for Basin Plan water recovery purposes (e.g. SDLAM).
Managing and monitoring water quality in the Basin	The draft NSW Murrumbidgee Regional Water Strategy includes proposed actions to improve water quality through support for targeted land and waterway management initiatives, investigations into addressing cold water pollution and improved input by water utilities in new development approvals that may impact water quality.
Enabling fair and transparent water trading across the Basin	The proposed actions set out in the draft Murrumbidgee Regional Water Strategy work within the water trading rules set by the Basin Plan.
Enforcing compliance with the Basin Plan	The actions set out in the draft Murrumbidgee Regional Water Strategy comply with the requirements of the Basin Plan. The draft strategy does not propose any additional compliance measures beyond current arrangements.
Allowing for flexibility and changes through adaptive management	Each regional water strategy will be reviewed regularly to allow changes in the way water is managed over the long term. This will enable adaptive management to occur and continuous improvement of the long-term strategic management of water in the Murrumbidgee region.

NSW Alternatives to Buybacks Plan

The NSW Government remains committed to delivering the Basin Plan in full, in partnership with the Australian Government and other Basin governments. However, we have been clear that this must be done in a way that minimises socio-economic impacts and allows regional communities to prosper.

The purchase of water rights by the Australian Government (i.e. water buybacks), as a mechanism to meet the water recovery targets under the Basin Plan, has the potential to cause significant socio-economic impacts. This has been consistent feedback received from stakeholders throughout the southern parts of the Basin.

Analysis suggests that irrigation areas in the southern Basin, such as in the regulated NSW Murray and Murrumbidgee river systems, are likely to be more vulnerable to the impacts of water buybacks due to the reliance on surface water resources, the volume of entitlement in the area and the extent of irrigation infrastructure networks.

To minimise the risks to our Basin communities and industries from large scale water buybacks by the Australian Government, we have developed the NSW Alternatives to Buybacks Plan.[12] The plan explains how we will deliver existing projects and bring forward new projects to contribute to water recovery in ways that have less socio-economic impacts.

The Plan seeks to achieve 2 outcomes:

- maximise the environmental outcomes achieved via the Sustainable Diversion Limit Adjustment Mechanism (SDLAM) that accounts for 605 gigalitres (GL)
- maximise recovery towards the 450 GL of additional environmental water from investment in infrastructure, projects and rules-based changes.

While the Plan does not eliminate the prospect of water buybacks in NSW, it outlines the NSW Government's strategy to provide a tangible reduction in the volume of water required to be purchased by the Australian Government to meet recovery targets.

Basin Plan Review

The Murray–Darling Basin Authority (MDBA) will review the Basin Plan in 2026. This is a requirement of the Commonwealth *Water Act 2007* and provides an opportunity to reflect on how the Basin Plan is working. It also enables exploration of responses to the impacts of climate change, and ways to support the Basin into the future.

The MDBA have released its Roadmap to the 2026 Basin Plan Review[13] confirming their focus on 4 key themes: climate change, sustainable water limits, First Nations, and regulatory design.

The NSW Government is engaged actively with the MDBA and other Basin governments in the review.

12. More information about the *NSW Alternatives to Buybacks Plan* is available at: water.dpie.nsw.gov.au/about-us/how-water-is-managed/alternatives-to-water-buybacks-plan
13. More information on the Basin Plan Review is available at: www.mdba.gov.au/publications-and-data/publications/roadmap-2026-basin-plan-review

Alignment with water market reforms in the Murray–Darling Basin

The Australian Competition and Consumer Commission (ACCC) inquiry into the water market recommended that governments with responsibility in managing the Murray–Darling Basin focus on 4 major areas for reforming the water market:

- governance of the Basin water markets
- market integrity and conduct
- trade processing and water market information
- market architecture.

In response, the Australian Government released the *water market reform: final roadmap report* (the Roadmap). The Roadmap includes 23 recommendations to drive water market reform to improve community trust and confidence in the Basin's water markets and to improve compliance in all jurisdictions. All Basin Ministers signed a funding agreement to progress implementation of priority recommendations of the Roadmap to 30 June 2024.[14]

The work to address the Roadmap recommendations remains a priority for the NSW Government. However, an additional action under the draft Murrumbidgee Regional Water Strategy is not needed as this work is already underway.

Implementation of actions under the draft Murrumbidgee Regional Water Strategy will be undertaken in a manner that aligns with or complements new water market and trade reforms as necessary.

Alignment with state-wide disaster and extreme event planning

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

- reduce water security/drought risks, which can also be inputs to local and state-wide disaster planning
- mitigate flooding through natural or hard infrastructure – for example actions in regional water strategies relating to catchment revegetation or potential alterations to dams may also influence flood behaviour and can be investigated in flood risk management studies in accordance with the *Flood Risk Management Manual (2023)* which can then inform local or state disaster planning
- mitigate the secondary effects of disasters – for example, actions in regional water strategies to address fish kills and water quality, can also inform state disaster planning.

Local and state-wide disaster and extreme event planning will be covered in the state disaster mitigation plan and local Disaster Adaptation Plans currently under development by the NSW Reconstruction Authority.[15] The Authority will collaborate with councils to develop local Disaster Adaptation Plans, so communities and stakeholders can identify the disaster risks and vulnerabilities unique to their regions.

The Authority is currently also leading the review and updating of the NSW Recovery Plan, last updated in late 2021.

The new NSW Recovery Plan will be a practical, action-oriented document, supported by a robust training program and will outline the responsibilities, authorities and mechanisms for disaster recovery in NSW.

Further information relating to local council and state agency roles and responsibilities in relation to flooding is included in a breakout box under Priority 3: Support sustainable economies and communities.

14. See www.dcceew.gov.au/water/policy/markets for updates on progress implementing the recommendations from the Roadmap.
15. State-wide disaster planning is primarily the responsibility of the NSW Reconstruction Authority, which was established in response to the 2022 Flood Inquiry. This is currently in development and will take a prevent, prepare, respond and recover approach. Further information is available at: www.nsw.gov.au/departments-and-agencies/nsw-reconstruction-authority

The regional water strategy's response to flooding

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

Further improvements to flood risk mitigation have been considered through the 2022 NSW Flood Inquiry and the NSW Government's response to the inquiry.[16]

Flooding and flood risk management are discussed under Challenge 4: Supporting existing and emerging industries and livelihoods.

Two proposed actions in this consultation paper are intended to complement holistic flood management taking place through the following:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data
- proposed action 2.4: Support the development and implementation of Murrumbidgee and Billabong Creek Floodplain Management Plans and address floodplain structures.

Regional water strategy modelling and flood analysis

Regional water strategies are underpinned by climate data and modelling that improves our understanding of past climate conditions and plausible climate futures, providing a more accurate picture of extreme climate events.

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

The regional water strategies have deliberately modelled a dry climate change scenario to stress-test the system (see section 'Regional water strategies are backed by new climate data' on page 20). Using this, together with the paleoclimate informed dataset (which represents climate without human induced climate change), allows us to test the resilience of adaptation options to a wide range of drying conditions. There is still a chance that we could see climate change outcomes outside of the range we have tested, including a wetter scenario. If this eventuates it would be a trigger to review the regional water strategies.

Understanding flooding involves different hydrological approaches that consider short term weather events and hydraulic flood models that require a detailed understanding of the shape of the floodplain and the features that influence flood behaviour. These models are purpose-built to support an understanding of existing flood risk and how this may change with changes in climate, development and landscape. Regional water strategy modelling data operates on longer timescales and so is not appropriate for short term, event-scale flood analyses.

16. More information about the *2022 NSW Flood Inquiry* and the NSW Government's response to the inquiry is available at: www.nsw.gov.au/nsw-government/projects-and-initiatives/floodinquiry

Alignment with local water utility strategic planning

Regional water strategies are region or catchment wide strategic plans. They set regional strategic directions to achieve water security across multiple councils and the entire catchment. Local water utility strategic planning identifies the local risks to water services and actions to address those risks.

The modelling undertaken through development of the draft Murrumbidgee Regional Water Strategy does not replace any analysis undertaken as part of councils' existing strategic planning.

Through the Safe and Secure Water Program, the NSW Government is co-funding:

- development of local water utility strategic planning across the state, recognising the importance of strategic planning to finding solutions to address risks and provide services at adequate standards
- investment in infrastructure to address high priority water security risks for local water utilities
- joint organisation-led regional water supply strategies to help councils identify, analyse and plan regional town water supply solutions.

Since 1 July 2022, a new regulatory and assurance framework has applied to local water utilities in regional NSW. It covers local government councils exercising water supply functions under Division 2 of Part 3 (Chapter 6) of the *Local Government Act 1993*, and utilities exercising water supply functions under the *Water Management Act 2000*. The regulatory and assurance framework is designed to ensure local water utilities manage risks effectively and strategically. Participation by local water utilities is voluntary.

In 2021, the NSW Department of Climate Change, Energy, the Environment and Water committed to ensuring that those local water utilities progressing an integrated water cycle management (IWCM) strategy would not be disadvantaged by the new strategic planning framework. The department continues to engage with all local water utilities that are currently developing an IWCM Strategy, including those funded under the Safe and Secure Water Program.

Image courtesy of Destination NSW. Wagga Wagga Township, NSW.

Regional water strategies are backed by new climate data

To improve our strategic water planning, new climate datasets have been developed for the regional water strategies program. These datasets provide a more comprehensive understanding of the climate variability in the Murrumbidgee region beyond the recorded historical data.

Three climate datasets have been used to understand the key regional challenges and to assess the effectiveness of actions:

1. historical climate data: 130+ years of observed rainfall, temperature and evaporation records collected by the Australian Bureau of Meteorology
2. long-term historical climate data: 10,000 years of stochastically-generated climate data developed using paleoclimatic information from The University of Adelaide
3. dry future climate scenario: modified version of the long-term historical climate data, scaled up or down using the NSW and Australian Regional Climate Modelling (NARCliM) climate projections (version 1.0). These scaling factors compare the baseline period of 1990–2009 with climate projections for the periods 2020–2039 and 2060–2079. These scaling factors have been applied to every climate timeseries used in the modelling.

Combined, these datasets provide a range of plausible future climate futures that cover a range of wet and dry sequences.[17]

Why a dry future climate scenario has been used

Climate change has been considered in the regional water strategies options assessment process by using a dry future climate change scenario. The dry future climate change scenario[18] is the SRES A2, which represents a high carbon emissions scenario and therefore results in higher projected climate change impacts on the region.[19] This is not a forecast of how climate change is expected to eventuate, but it is one possible future outcome.

This scenario assumes that governments around the world will not take any action to reduce carbon emissions. This scenario may not occur as many governments, businesses and communities around the world are already acting on climate change. Using a dry scenario helps to plan strategically and focus on the key challenges facing a region.

Considering the dry future climate scenario together with the 2 other climate scenarios – the historical scenario and the stochastically-derived long-term historical scenario – is appropriate for this type of strategic-level assessment. It allows assessment of the full range of risks to the water system and helps build understanding of how different options might work under a range of future climate conditions. We will need to complete more refined assessments of climate change risk when we implement many of the regional water strategies actions. These additional assessments will be based on the planning horizon for each action and the latest climate science.

It should be noted that this new climate data and hydrological modelling is not appropriate for operational decisions made under water sharing plans, such as calculating available water determinations, and it will not be used for these purposes.

Our climate science is continuously improving. The climate modelling used to develop the draft Murrumbidgee Regional Water Strategy is an important first step to better understand the region's climate and the potential vulnerability of our towns, communities, industries and the environment to a more variable and changing climate. We know that the future climate is uncertain, and work is progressing to further enhance understanding of the region's climate and how it affects our vital water resources, including groundwater.

17. For further details about the new climate data and modelling, refer to www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies
18. The scenario uses the regionally downscaled factors from the NARCLiM 1.0 Project to adjust the long-term past climate scenario rainfall and evapotranspiration data. Further information on the NARCLiM 1.0 Project is available on the NSW Government, AdaptNSW website: www.climatechange.environment.nsw.gov.au/climate-projections-used-adaptnsw
19. The SRES A2 assumes a 2°C warming over the regional water strategy planning horizon.

What the future climate could look like in the Murrumbidgee region

The future climate in the Murrumbidgee region is uncertain. It may be similar to what was experienced in the past or it may be more variable. Analysis of different climate scenarios indicates that there could be hotter and longer droughts, higher evaporation rates and more unpredictable rainfall events and variable river flows.

Ongoing planning for uncertainties and continued refinement of water-related risks in the Murrumbidgee region is essential.

More extreme events

Droughts **could become more frequent** and rainfall events **could potentially be more intense**.

Changing rainfall patterns

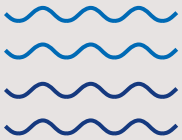
Shifts in seasonal rainfall could occur, with a tendency for **possible decreases in annual rainfall** – in the upper Murrumbidgee catchment, by 2079 average winter rainfall **may possibly drop by 20%**. Average autumn rainfall **may possibly drop by 11%**, with very little reduction in summer and spring rainfall – in the regulated Murrumbidgee, by 2079 average winter and spring rainfall **may possibly drop by 17 to 18%.** Late summer rainfall **may potentially increase by over 30%**.

Higher temperatures

Potential for higher minimum and maximum temperatures, more hot days, less cold nights, decreased snowfall and snowmelt and **potentially more severe fire conditions** in the future.

Changes in river flows

On average, total volume of water flowing each year in the regulated and unregulated rivers **could reduce**.



Higher evapotranspiration

Average evapotranspiration could potentially increase by up around 4%, across the year.

Image courtesy of Destination NSW. Goobarragandra River, Tumut.

We want to hear from you

Developing an effective and lasting strategy requires input from communities, towns and industries across the Murrumbidgee region.

Your feedback is sought on the key regional water-related challenges and proposed actions in this document.

The feedback received on the consultation paper will help to finalise the draft Murrumbidgee Regional Water Strategy and Implementation Plan.

The final strategy will identify a range of solutions – from policies, plans and regulation through to new technologies and infrastructure – that could mitigate water-related impacts across the region and support thriving regional communities. The strategy will bring together these solutions in an integrated package that is:

- based on the best evidence
- designed to respond to the Murrumbidgee region's water needs
- directed towards creating new opportunities for the region
- focused on delivering the objectives of the regional water strategies and the NSW Water Strategy.

Assessing benefits and impacts of actions on Aboriginal people and communities

Aboriginal communities across NSW have provided strong feedback that they need specific information on how the shortlisted actions will affect them.

Several of the shortlisted actions will have potential impacts on, or provide benefits to, Aboriginal people and Aboriginal communities. Currently, not enough evidence about these potential impacts and benefits is available to provide a full assessment of the shortlisted actions. Until the department undertakes a more detailed analysis of the specific actions that remain in the final regional water strategy shortlist, some of this information will not be available. Some of the additional analysis may be identified for early action in the strategy's implementation plan, whereas other work will progress as part of the strategic business case for specific options.

At this stage of the process, the types of questions that Aboriginal communities are likely to have about each of the proposed actions are being identified and recorded. The department is also considering what information communities will need to make informed decisions about how specific actions will affect them.

Once the detailed analysis required to progress preferred actions has been undertaken, that information will be shared with Aboriginal communities and their feedback will be sought. That evidence may help to refine a preferred action or identify risks in progressing with an action.

What we have heard so far

2

Image courtesy of Destination NSW. Murrumbidgee River, Wagga Wagga.

During the development of the draft Murrumbidgee Regional Water Strategy we publicly exhibited and conducted targeted consultation on:

- the draft Murrumbidgee Regional Water Strategy and long list of options from April to May 2022
- the draft Murrumbidgee Regional Water Strategy: Discussion Paper: Draft regional challenges from October to November 2023
- the draft NSW Murray and Murrumbidgee Regional Water Strategies Climate and hydrological modelling from October to November 2023.

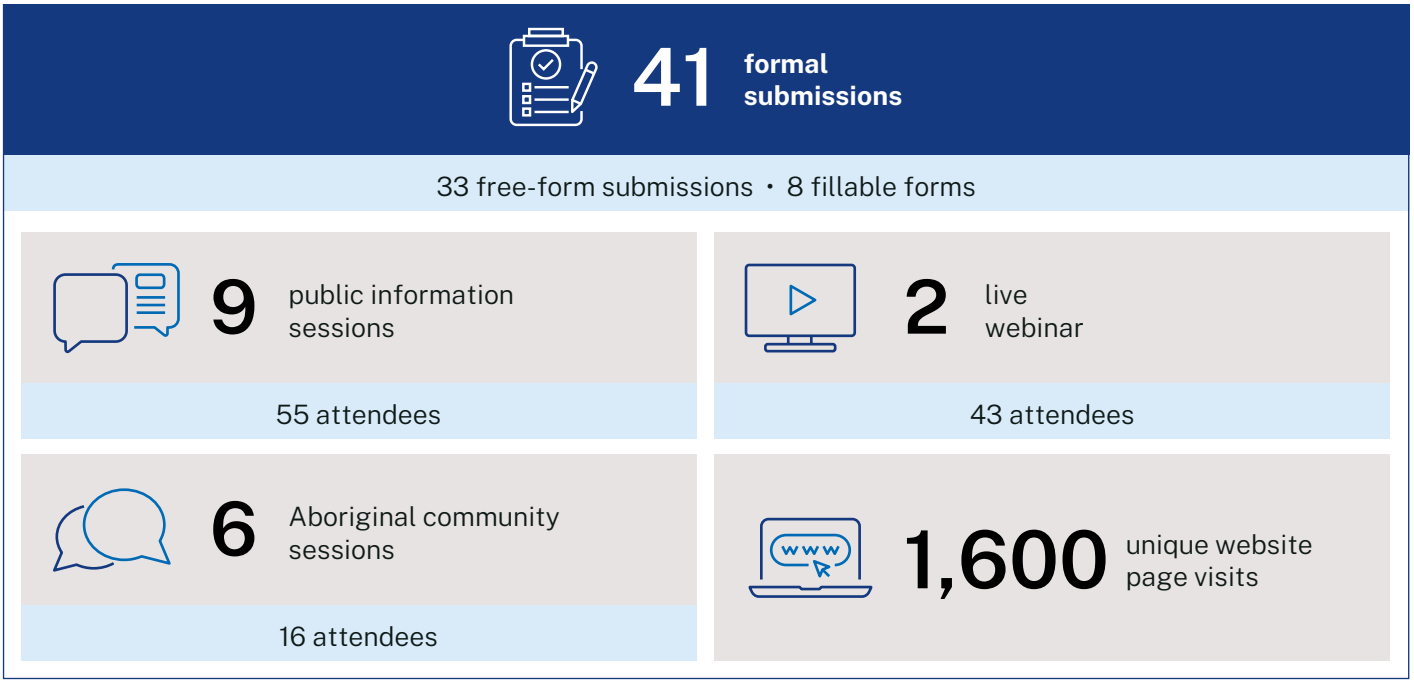
These consultations were held in tandem with that for the development of the NSW Murray Regional Water Strategy.

Feedback from the public exhibition held in 2022 (Figure 4) and targeted consultation sessions held in 2023 (Figure 5) were compiled into community consultation reports, which have been published on the department's website.[20]

The reports highlight how the feedback we received has informed the next steps in the development of the draft Murrumbidgee Regional Water Strategy.

Public consultation 1

Figure 4. Stakeholder engagement during the first public exhibition period (2022)



In the first round of stakeholder consultation (2022), there was general support for the development of the Murrumbidgee Regional Water Strategy, but some stakeholders suggested that insufficient consultation had been undertaken in developing the draft strategy.

Feedback was also received that the next phase of the Murrumbidgee Regional Water Strategy should be accompanied by an open, transparent and broad-scale consultation process to ensure that all stakeholder voices are heard, and that a broad cross-section of the community should be represented in the discussion. This consultation paper has been developed in response to this recommendation.

Stakeholders encouraged the department to continue progressing the development of the NSW Water Strategy and regional water strategies. Since then, the NSW Water Strategy and several other regional water strategies have been finalised.

20. More information about the *Draft Murrumbidgee Regional Water Strategy* (2022) is available at: water.dpie.nsw.gov.au/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murrumbidgee

Summary of feedback received during 2022 stakeholder consultation:

Climate data sets and modelling

- Concerns about using a 'worst-case scenario' approach to modelling, including a suggestion the strategies consider wet future conditions as well as dry.
- Support for making data, information and modelling publicly available for transparency and to understand how it has been applied to the strategies.
- Concern that incomplete modelling makes it difficult to assess risk and impact.

Improving water-related opportunities for Aboriginal people

- Strong support for improving opportunities for Aboriginal people in water management and recognising Aboriginal cultural, spiritual ties and locations and connection to Country.
- Suggestions to consider how operational challenges and costs associated with managing Aboriginal water allocation could be addressed.
- Concern Aboriginal people are separated from water policy, management and decision making.

Strategy development and implementation

- Support for aligning the regional water strategies with government commitments, water management plans, policy, reform priorities and legislation.
- Support for further consultation with the community and stakeholders during the development and implementation of the strategy was highlighted.
- Concerns about fatigue from the scope and speed of water reforms that have significant social and economic impacts experienced by the regions as a result of water recovery under the Basin Plan.

Environmental health, ecosystems and water quality

- Strong support for improving environmental and economic outcomes, including addressing the impacts of climate change.
- Concern about water quality issues in the region, with bushfires and flooding impacts raised as contributors to water quality.
- Concerns regarding SDLAM projects and the Reconnecting River Country Program impacting on riparian land and inundation of productive agricultural land.
- Suggestion to assign additional water allocations to protected areas for effective ecosystem conservation and to review environmental water delivery rules.

Water security, availability and use

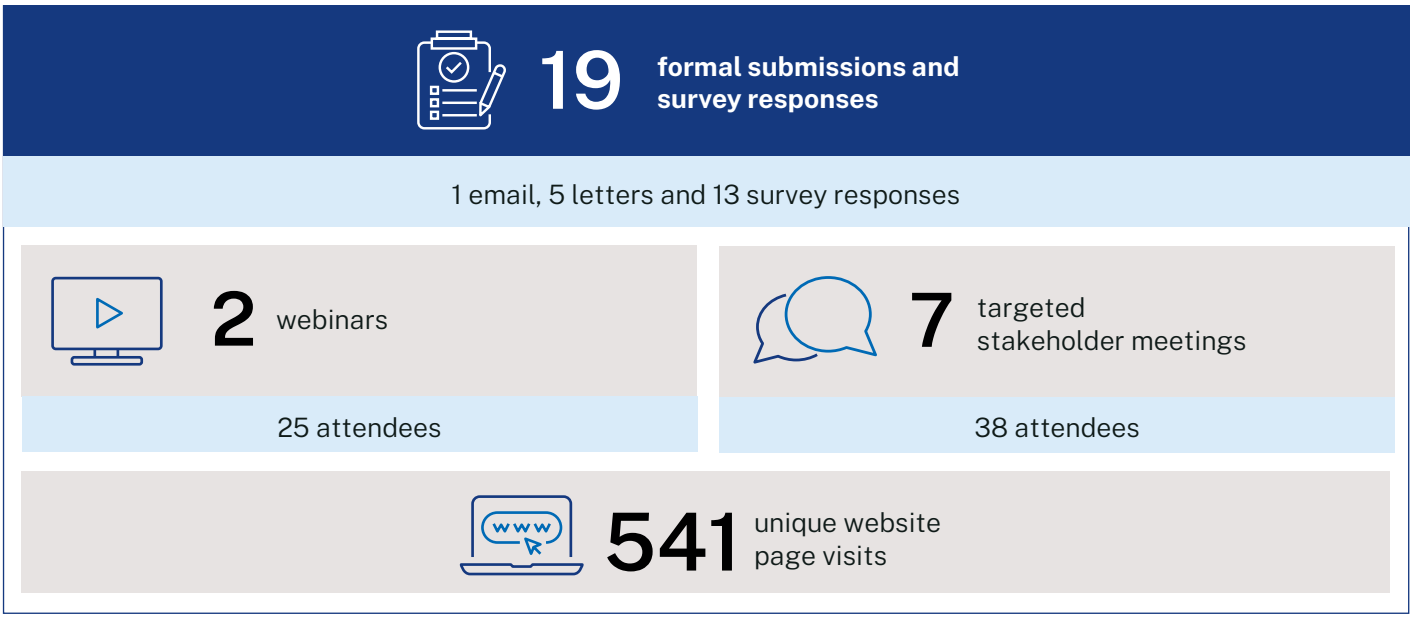
- Wide support to understand people's behaviours and assumptions around water availability and use, including during drought.
- Support for options to better understand people's behaviours and assumptions around water use.
- Suggestion to emphasise the importance of food and fibre in the strategy.
- Concern about the ability to meet town water demand as populations grow.
- Concerns around the socio-economic impacts on communities of past Australian Government water buybacks and the need for greater recognition in the strategies around these.

Land and water management and planning

- Strong agreement to acknowledge the inter-connectedness of the Murrumbidgee and Murray regions.
- Strong calls for improvements in inter-jurisdictional water sharing and management.
- Important to understand how the Snowy Water Licence Review interacts with the strategy.

Public and targeted consultation

Figure 5. Stakeholder engagement during public and targeted consultation (2023)



During the webinars and targeted consultation sessions (2023), stakeholders were concerned about the use of the dry climate scenario in the modelling and how significant evapotranspiration will be in the Murrumbidgee region if this scenario eventuates. Stakeholders also wanted further information about the selection of the 3 climate scenarios used in the hydrological modelling.

Support was received for increased water security for towns and general water security users. Improving the health of the environment and ecosystems, was considered important. There was also strong support for establishing a more integrated planning approach across jurisdictions.

Summary of feedback received during 2023 stakeholder consultation

Challenge 1: Ensuring resilient water supplies for regional centres, towns and communities in a changing climate

- Support for installing off-river stream infrastructure and using recycled water.
- It was noted the Common Planning Assumptions can underestimate population projections and this should be considered in the modelling.
- Wanting to understand the impact of climate change of current town water security was also raised.
- Concerns about the security of town water in areas around Canberra, particularly with population growth.
- Support to reflect interactions between NSW and the Australian Capital Territory (ACT) in the strategy.
- Concerns around the potential for further Australian Government water buybacks and the need to find alternative measures to avoid further buybacks.

Challenge 2: Improving the health and resilience of aquatic and floodplain ecosystems

- Concern about the impact of flow reductions on water-dependent fish, plants and other ecosystems.
- Suggestion to develop water management plans for protected areas.
- Some stakeholders expressed concern about the Reconnecting River Country Program due to potential environmental and economic impacts.
- Concern that reductions in inflows are impacting the health of the upper Murrumbidgee catchment.
- Improving the flow regime for the upper Murrumbidgee River is important.

Challenge 3: Addressing barriers to Aboriginal people's water rights and access

- It was acknowledged water is an essential part of Aboriginal people's culture and there is a need to provide greater access to cultural water and ensuring involvement in water management and decision making.
- Listening to Aboriginal people who have lived sustainably with the environment was considered important.
- Establishing support for the operation and maintenance of ageing water infrastructure on Traditional Owner's land was considered important.

Challenge 4: Supporting agriculture and emerging industries

- Balancing the water needs of the irrigation sector was considered important, as was encouraging more adaptive irrigated industries.
- Suggestion for the strategy to acknowledge potential water trading arrangements between the ACT and NSW.
- Recognition of agriculture to the local economy in the upper Murrumbidgee catchment was considered important.

Since the public and targeted consultation in 2023 the draft Murrumbidgee Regional Water Strategy has undergone further development which has resulted in significant changes to the key challenges. The amended challenges are presented in Section 3 of this consultation paper.

Image courtesy of Destination NSW. Tumut, Kosciuszko.

Where should we focus first?

3

Image courtesy of Destination NSW. Wagga Wagga, NSW.

The vision for the Murrumbidgee region is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous region.

The Murrumbidgee region is endowed with surface water and groundwater for towns, recreational use, cultural and environmental needs, and industry. Due to the region's highly variable climate, groundwater is an important water source for the region.

As experienced over the last 2 decades, severe droughts can be followed by significant rainfall events and flooding. These extreme events pose challenges for the region, its water resources and all water users.

Like other regions across Australia, the Murrumbidgee region will likely face a more variable and changing climate in the future. We need to prepare now to do more with less water and make smarter decisions about our water use and management. We need to be armed with better knowledge and information to ensure we protect our most critical water needs.

This strategy identifies 4 key challenges that are immediate priorities for the region:

- **Balancing competing interests for water.**
- **Improving the health and resilience of ecosystems.**
- **Addressing barriers to Aboriginal people's water rights.**
- **Supporting existing and emerging industries and livelihoods.**

Addressing these challenges will help to meet the vision and objectives set for the draft Murrumbidgee Regional Water Strategy.

Image courtesy of Destination NSW. Agricultural Tours Riverina, NSW.

Challenge: Balancing competing interests for water

In the Murrumbidgee region, there are many, often competing, interests for water including, town water supply, the environment, electricity generation, irrigated agriculture, tourism and cultural needs.

The Murrumbidgee region borders the Australian Capital Territory (the ACT) and is highly connected to the NSW Murray region. This makes it important to acknowledge and consider cross-border interests in the development of the Murrumbidgee Regional Water Strategy.

Balancing the interests of such diverse water uses and stakeholders is made possible by many, complex, interrelated governance and institutional arrangements, that are overseen by multiple governments at state and federal levels.

Improving how water is shared and managed within these arrangements, is often complicated and requires collaborative and inclusive approaches that address the diverse needs of stakeholders.

For example, changes to the way water are shared by and delivered to NSW water users may require consultation and potentially consent of other governments. Further complications arise from the multiple tributaries that are influenced by highly variable and often different climate drivers and weather events. Growing regional centres and the changing nature of water and land use practices further strain available water supplies.

Image courtesy of Museum of Riverina, Wagga Wagga City Council. Flooding at Wagga Wagga, NSW.

Water sources are fully allocated limiting growth of existing and emerging industries

In the Murrumbidgee region, the use of groundwater and surface water is limited by sustainable diversion limits (SDLs).[21] The Basin Plan limits the amount of water that can be taken for towns, industries, landholders and other uses that are not licenced.

Long term annual average extraction limits (LTAAEL) are also set out in relevant NSW water sharing plans. These LTAAELs include licenced water access entitlements and basic landholder rights; they do not include other activities that are included in SDLs such as plantations and other unlicenced water use.

Given this, supporting economic growth and industry development in the Murrumbidgee region will be challenging. For example:

- for existing industries, a change in water needs must be met through either a more efficient or innovative use of water or through the acquisition of licences via the water market
- for new industries reliant on water, acquisition of water access licences or an alternative water supply contract is critical.

The separation of land and water and the introduction of trading markets were created in response to the *National Water Initiative 2004* and in part to systems being fully allocated.

This allows for water to be traded, temporarily or permanently, to where it is wanted or to the highest value use. These markets have been in operation for 20 years. As demonstrated through the ACCC's review into water markets, there are opportunities to adjust the market system to become more flexible in meeting the water needs of businesses.

Another challenge is that the potential benefits of any new water infrastructure seeking to increase supply capacity will be constrained, as long-term water diversions are not permitted to increase under the SDLs.

The Australian Government held a strategic water purchase tender process from 23 March – 19 May 2023 to meet the outstanding Bridging the Gap water recovery targets in NSW and Queensland under the Basin Plan. Delivery of SDLAM projects remains ongoing and whether the 605 GL offset can be met will only be determined by the Murray–Darling Basin Authority (MDBA) when it conducts its reconciliation process in 2026.

The *Water Amendment (Restoring Our Rivers) Act 2023* commenced in December 2023 and allows the Australian Government to use voluntary water purchases, or buybacks, to contribute to the Basin Plan's 450 GL target of additional environmental water. Whilst the NSW Government supports the full implementation of the Basin Plan, we do not support buybacks due to potential unacceptable socio-economic risks. To address this risk, we have developed the NSW Alternatives to Buybacks Plan,[22] which details how we will deliver on existing and new projects to protect our Basin communities and industries from large scale water buybacks. Further details are provided in the Alignment with the Basin Plan section on page 14.

21. More information about sustainable diversion limits is available at: www.mdba.gov.au/water-use/water-limits/sustainable-diversion-limits
22. More information about the *NSW Alternatives to Buybacks Plan* is available at: water.dpie.nsw.gov.au/about-us/how-water-is-managed/alternatives-to-water-buybacks-plan

Sustainable diversion limits

Sustainable diversion limits (SDLs) represent the long-term average amount of water that can be used for consumptive purposes. In general, they are based on the amount of water being taken just prior to the Basin Plan coming into effect (2009) minus the shared and local reductions needed to reduce long-term water use to sustainable levels. They apply to each SDL resource unit (based generally on catchments for surface water and hydrogeology and planning boundaries for groundwater).

Compliance with the SDL is determined at the end of the water year by the Inspector General of Water Compliance. Where an exceedance of the SDL[23] in a resource unit is determined by the Inspector General, and the state does not have a reasonable excuse, the state may be required to place limits on water take to bring the level of take back within the limits required by the SDL.

Eleven of 20 NSW water resource plans (WRPs) are accredited, including the Murrumbidgee groundwater and surface water WRPs, 8 are with the MDBA for accreditation and the Namoi Surface Water is awaiting resubmission. The formal assessment of SDL compliance by the Inspector-General of Water Compliance will commence for the accredited WRPs for water year 2024/25.

NSW is committed to working as quickly as possible with the MDBA to get all water resource plans accredited. It is important to note that existing NSW water sharing plans ensure that rules and limits are in place, and the department reports on compliance with SDLs each year to the MDBA.

Investigating potential underuse of surface water against sustainable diversion limits in the Murrumbidgee region

Stakeholders have raised and supported the need to develop a better understanding of people's behaviours and assumptions around surface water availability and use, including investigating existing water management rules and behaviours that may be leading to underuse in the region. This issue requires further analysis. A working group consisting of industry stakeholders and NSW and Australian government agencies has been established to explore water-related issues, including the issue of potential underuse.

Image courtesy of Destination NSW. Wagga Wagga countryside, NSW.

23. For surface water SDL resource units, an exceedance occurs when the cumulative balance on the relevant Register of Take is a debit amount equal to or greater than 20% of the SDL

Water is not always considered in land use planning processes

Water resources are not always considered early in the planning process, which can create inefficiencies and challenges in capitalising on the broader regional opportunities these changes and investments could bring.

The Riverina Murray Regional Plan 2041,[24] draft Far West Regional Plan 2041[25] and draft South East and Tablelands Regional Plan 2041[26] highlight that access to water is critical for some land uses, but is not always considered upfront in the planning process.

This can lead to population and industry growth in areas without enough water available, which creates greater pressure on stressed water resources.

A better understanding of water availability in the Murrumbidgee region will provide more guidance to manage growth within towns such as Queanbeyan-Palerang, Yass Valley and Wagga Wagga Council towns. It will also provide guidance on suitable locations for industry growth and new development. Ensuring water resources are integrated better in the strategic planning process through effective government collaboration is essential to optimise the use and sharing of water and enable the growth of towns in a fully allocated system.

To address this challenge in the Murrumbidgee region, the following action is proposed:

- proposed action 1.5: Improve consideration of water in strategic planning processes. See page 77.
- proposed action 4.4: Addressing sustainable population growth pressures in the upper Murrumbidgee catchment. See page 112.

Image courtesy of Destination NSW. Borambola Winery, Wagga Wagga.

24. More information about the *NSW Riverina Murray Regional Plan 2041* (2023) is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/riverina-murray-regional-plan-2041
25. More information about the *draft Far West Regional Plan 2041* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/far-west
26. More information about the *draft South East and Tablelands Regional Plan 2041* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/south-east-and-tablelands

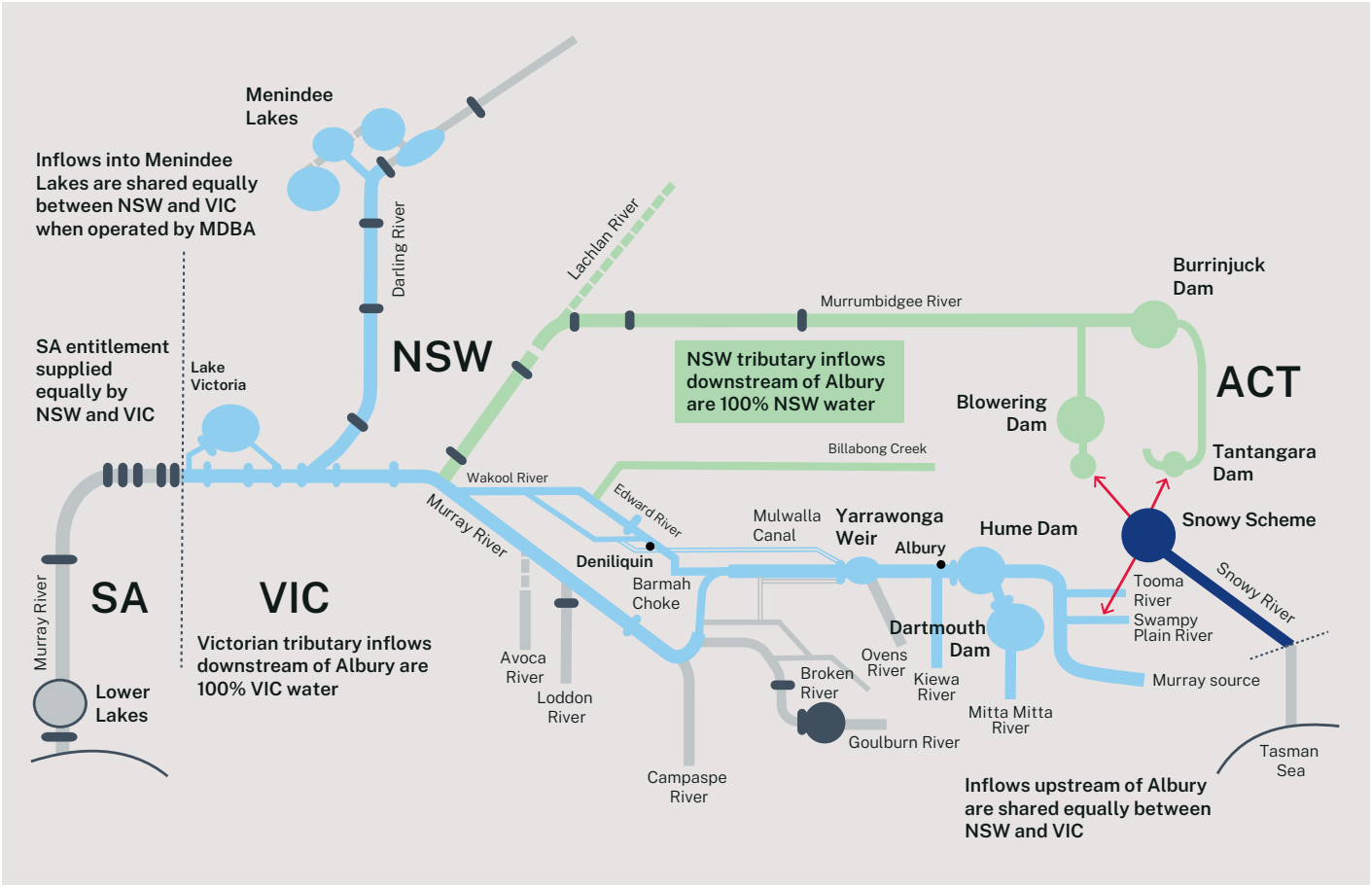
Cross-border influences and complexities

The Australian Capital Territory (ACT) is located wholly within the upper Murrumbidgee subregion. In the hinterland surrounding the ACT are the NSW city of Queanbeyan and the towns of Bungendore, Yass and Murrumbateman, which have strong employment and economic links with the ACT. This means that much of the growth in these centres is driven by factors within the ACT. As such, there is a need for close ties between NSW and the ACT to effectively manage growth pressures across the upper Murrumbidgee.

The water resources of the ACT and NSW are also interlinked, with significant parts of the ACT water supply reliant on catchments in NSW. Further, the NSW city of Queanbeyan draws its water from the ACT supply network. The water management of the area is equally complex and involves multiple federal, state/territory and local government agencies and legislation and agreements.

The Murrumbidgee region forms part of the southern connected Basin (Figure 6). Managing water across regions in the southern connected Basin is complex. Interstate agreements and rules govern how water in the Murrumbidgee River catchment is shared, traded and delivered between NSW, Victoria and South Australia, including rules for water released from the Snowy Scheme.

Figure 6. Schematic of the southern connected Basin.



Water is managed and shared under the *Water Management Act 2000* with specific rules for water sharing set out in respective surface water and groundwater water sharing plans.[27]

During public consultation, strong representation was received for improving inter-jurisdictional water sharing and management, noting the complexity of interstate agreements and rules that impact both the ACT and the Murrumbidgee region.

27. More information about water policy and planning is provided in the *Regional Water Strategies Guide* available at: water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/rhs-cta/regional-water-strategies-guide-and-fact-sheets

Delivery constraints and changing water use patterns in the regulated Murrumbidgee River create challenges for management of the system

The region's water resources underpin key economic drivers, including agriculture and other water dependent industries, and the sustainable management of water resources will be critical to economic prosperity in the Murrumbidgee region.

The mix of industry and crops in the region is changing, with horticulture expanding and value-added agricultural industries expected to grow over the next 20 years. This is likely to drive further changes in water use patterns.

In addition, the delivery of both consumptive and environmental water during periods of peak demand is a challenge. Water delivery is impacted by the long distance from storages to end users and channel constraints that lie between headwater storages and end-users. A lack of mid-system water storage further compounds this issue.

A changing climate is expected to make water delivery even more challenging. As a result:

- there is the chance that delivery shortfalls against peak-period demands may occur that could result in losses to crops or failure to achieve environmental watering event-based objectives
- periods of peak regulated flows from Blowering Dam leading to overbank flows, erosion and bank stability issues in the Tumut River
- storage volume imbalances between Burrinjuck and Blowering Dams can occur, meaning that the ability to harvest future inflows is not optimised. This could also exacerbate supply shortfalls and deliverability issues during peak demand periods
- delivery of water through the regulated system is not optimised.

Delivery and system shortfalls

When the required volume of water cannot be delivered to users when and where it is needed, it is called a shortfall. Delivery shortfalls occur when water orders (the volume of water required by water users) are not fully met. System shortfalls occur when the combined capacity of the system (storage and conveyance) is unable to supply all downstream requirements over the full season.

Some of the factors that can impact water delivery include climate, trade, demand patterns and river channel capacity, and infrastructure constraints.

Temporary water restrictions can be placed on water users in the event of a shortfall occurring and would be implemented by WaterNSW. These restrictions are very rare. However, changes in climate, timing and location of demand and land use, combined with the river system's capacity to carry volumes of water, mean these events are increasing in probability.

To address this challenge in the Murrumbidgee region, the following action is proposed:

- proposed action 3.8: Manage delivery risks in the regulated Murrumbidgee River. See page 106.

Inundation of low-lying lands is impacting productivity and livelihoods

Low-lying areas including wetlands, floodplains and private lands can be inundated by regulated flow deliveries for both environmental and consumptive purposes. During public consultation landholders indicated that, at times, more than 30% of their productive land can be unusable due to inundation. However, rivers currently connect to wetlands and floodplains less often than is needed to maintain healthy ecosystems due to river regulation and extraction. Constraints in delivering water for the environment restrict the effective use of this water, contributing to the continual decline of the health of Country, including the species depending on these environments to survive.

While stakeholders in general support restoring this balance, some have expressed concerns that sometimes they are managing their farming operations on a daily basis, depending on the flows of the adjoining river. This has led to concerns about the impact on productivity and uncertainty in their business arrangements.

As a result, stakeholders are calling for better flow notification systems and more consultation in relation to water management practices that directly impact their ability to manage and maintain the productivity and sustainability of their land.

This issue can be further compounded by additional factors including the need for pre-releases from dams during flood events and energy sector requirements that rely upon hydroelectricity generation.

Balancing the needs of landholders to use and access their land with fluctuating flow deliveries requires ongoing consultation and collaboration to identify long-term, enduring, and cost-effective solutions.

These challenges are likely to be exacerbated by future climate change-driven extreme events, such as changing precipitation patterns, increased evapotranspiration, longer dry periods and more intense floods.

Details about the Reconnecting River Country Program, which focuses on relaxing or removing constraints on the delivery of water for the environment in the Murrumbidgee region, can be found in Challenge 2: Improving the health and resilience of ecosystems on page 44.

To address this challenge in the Murrumbidgee region, the following actions are proposed:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data. See page 75.
- proposed action 2.8: Implement the Reconnecting River Country Program in the Murrumbidgee region. See Page 91.

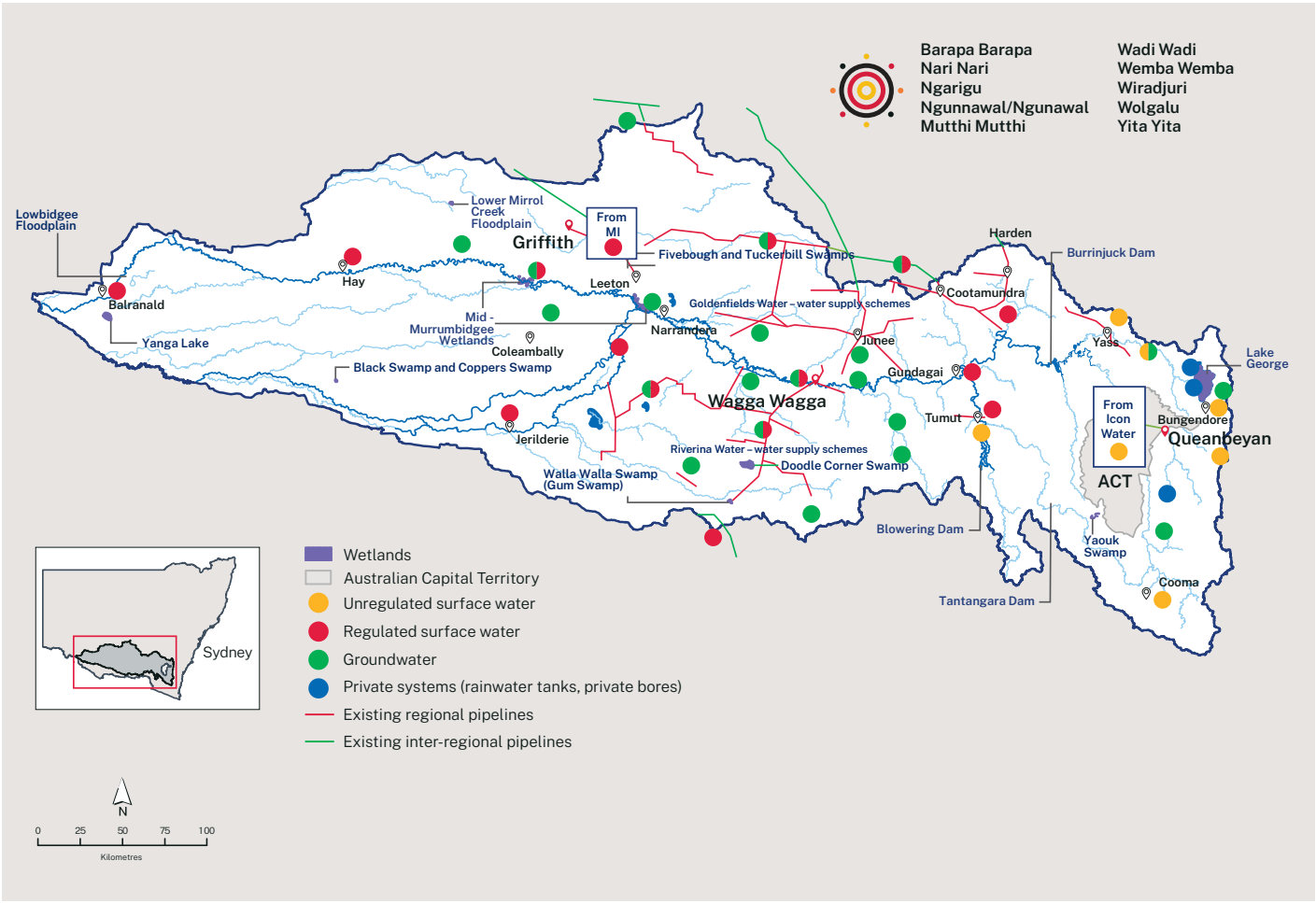
There are water security and quality risks for regional centres, towns and communities

Many of the towns in the Murrumbidgee region rely exclusively on surface water. However, groundwater forms a part of the supply to many towns, including Wagga Wagga and Bungendore (Figure 7), where further supplies from aquifers are not possible.

Regional areas are becoming increasingly attractive places to work and live, and significant population growth is expected over the next 20 to 40 years, which will increase town water supply demands. In particular, the Queanbeyan-Palerang area,[28] Yass Valley and Wagga Wagga are forecasted to have high growth rates.[29] Growth requirements for Wagga Wagga would most likely need to be met through surface water supplies and demand management initiatives, while for Bungendore, Yass and Murrumbateman there are active discussions with the ACT Government about extending the Icon Water network.

28. Our modelling assumed population projections for Queanbeyan at 85%.
29. Our modelling assumed population projections for Yass at 38% and 24% for Wagga Wagga.

Figure 7. Murrumbidgee town water supply sources and town water supply linkages



Growing populations and a changing climate resulting in severe droughts in the Murrumbidgee region could place towns and communities at risk of future shortfalls.

Our new modelling suggests that the risks of town water supply shortfalls[30] from surface water in the Murrumbidgee region are generally very low under historic climate conditions.

However, these risks are likely to increase under the dry future climate scenario and with growing populations (Table 2 and Table 3). The modelling shows the probability of shortfalls will vary across the region, with Tumut, Gundagai, Morundah, Hay and Balranald modelled to have much less severe shortfalls than Jugiong, Jerilderie and Wanganella.[31] Under a dry future climate scenario supply shortfalls for Jerilderie could double by 2061–79.

30. A shortfall is the number of days where a town's surface water supply is less than an identified level of demand (e.g. 5%, 10%, 25%, 50% and 75%).
31. A detailed description of the climate scenarios and other results for town water supply shortfalls are presented in the *NSW Murray and Murrumbidgee climate and hydrological baseline modelling report* (May 2024). The report is available at: water.dpie.nsw.gov.au/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murrumbidgee

Table 2. The number of days with town water supply shortfall with a probability of 1 in 1,000 years

Town	Demand	Dry future climate change scenario		
Current demand				
	No population growth	At least 10% of demand not met	At least 25% of demand not met	At least 50% of demand not met
Balranald	Current population	92	70	30
Gundagai	Current population	0	0	0
Hay	Current population	30	30	4
Jerilderie	Current population	221	185	120
Jugiong*	Current population	226	168	87
Morundah	Current population	0	0	0
Tumut	Current population	63	31	30
Wanganella	Current population	218	150	74
Future population demand (2061)				
	Population growth over 40 years period (%)	At least 10% of demand not met	At least 25% of demand not met	At least 50% of demand not met
Balranald	No population growth	No changes		
Gundagai	No population growth	No changes		
Hay	No population growth	No changes		
Jerilderie	6%	277	227	127
Jugiong*	No population growth	No changes		
Morundah	9%	0	0	0
Tumut	No population growth	No changes		
Wanganella	No population growth	No changes		

Note: *Jugiong is the offtake point for Goldenfields water supply network to Cootamundra, Young, Harden, Wallendbeen and a range of individual customers.

The upper Murrumbidgee subregion, with its unregulated rivers and creeks, faces risks due to its reliance on rainfall and exposure to short, intense droughts. This poses threats to water users in the upper Murrumbidgee, especially when this is the sole source of supply, impacting towns such as Cooma, Batlow, Yass and areas in Queanbeyan-Palerang.

Yass has experienced some significant supply restrictions in the past. This requires further consideration through the relevant local water utility strategic planning process. There are also risks if releases are not made from Tantangara Dam when there are no inflows to the dam.

Table 3. The number of days with town water supply shortfall in the upper unregulated Murrumbidgee under a Dry future climate change scenario with a probability of 1 in 1000 years

Town	Demand	Dry future climate change scenario		
Current demand				
	No population growth	At least 10% of demand not met	At least 25% of demand not met	At least 50% of demand not met
ACT/ Queanbeyan	Current population	0	0	0
Cooma	Current population	50	48	40
Yass	Current population	0	0	0
Future population demand (2061)				
	Population growth over 40 years period (%)	At least 10% of demand not met	At least 25% of demand not met	At least 50% of demand not met
ACT/ Queanbeyan	85%	125	116	91
Cooma	No population growth projected	No changes		
Yass	38%	0	0	0

Note: Further results can be found in the *Draft NSW Murray and Murrumbidgee Regional Water Strategies Climate and hydrological modelling report*.[32]

These assessment results are a high-level comparative assessment to identify where town water supply shortfall risks occur across the region. They are not appropriate for detailed purposes like secure yield analyses or other strategic planning which is the responsibility of and done by local water utilities (LWU).

The department provides specific guidance to LWUs under its Regulatory Assurance Framework on achieving the outcome of understanding water security for effective strategic planning. LWU strategic plans incorporate a secure yield study to identify the capacity and sizing of headworks infrastructure to meet the required levels of service.

32. water.dpie.nsw.gov.au/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murrumbidgee

Regional water strategy town water supply shortfall analysis vs town water security analysis

Town water supply shortfall analyses, used by the NSW Government in the regional water strategies program, assess the difference between the available supply in a water source at the point of extraction against the climate adjusted demand of the local water utility. A supply shortfall will exist on a day when the demand is greater than the available supply. These assessments do not factor in customer levels of service (LoS)[33] nor water restriction rules imposed by local water utilities on customers. The aim is to understand, at a high level, where vulnerabilities in town water supplies might exist across a region.

This is a different assessment to town water supply security analyses that are undertaken by individual local water utilities. These security analyses are about understanding how town water demands for defined customer levels of service (LoS) can be met under a range of water availability conditions by the local water utility's supply headworks. Town water security analyses are often referred to as 'secure yield' analyses, being the maximum annual demand that can be supplied from the headworks whilst meeting the nominated LoS and its operating environment (licence and works approval conditions, water sharing plan rules, etc).

As such, these 2 kinds of analyses are used for different purposes with the town water supply security analyses considering customer requirements at a far greater level of detail, leading to a more nuanced understanding of water supply risks by individual local water utilities.

The results of the modelling coupled with the implications of projected population growth and the levels of local water utility licence entitlements held by each council will have varying implications for councils and local water utilities in the region.

We will work with them to understand what the information means for their local area. Consideration of the new climate modelling data and future water availability risk will be important to understand shortfall risks and assess the performance of regional water strategy options.

To address this challenge in the Murrumbidgee region, the following actions are proposed:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data. See page 75.
- proposed action 3.5: Consider an enduring level of supply to support regional towns and centres. See page 103.
- proposed action 3.6: Improve public access to climate information and water availability forecasts. See page 103.
- proposed action 4.4: Addressing sustainable population growth pressures in the upper Murrumbidgee catchment. See page 112.

33. LoS incorporates frequency, duration and severity of TWS restrictions with an underlying principle of 'not to run out of water.

Changes in land use are impacting water quality

Land management has a direct effect on water quality in downstream waterways. Local water utilities have highlighted concerns that wastewater discharges from intensive agricultural farming and processing operations and poor catchment health collectively reduce the quality of raw water supplies. This creates significant challenges for supplying clean water to towns. There is a need to improve coordination of legislation and regulations for inter-related issues such as land management and water quality.

There is a known contamination of pre- and polyfluoroalkyl substances (known as PFAS) in the East Wagga groundwater borefield further east of the supply location used by Riverina Water.

The Australian Defence Force used Aqueous Film Forming Foam (AFFF) products to suppress liquid fuel fires from approximately 1970 to 2004.

In September 2023, the Australian Defence Force advised that PFAS has been detected in new sampling points 650 m from Riverina Water's town water supply bore, moving quicker than previously anticipated. This proximity of this positive sample result has triggered an action plan by the Department of Defence. In response, Riverina Water has switched mainly to surface water rather than relying on groundwater access. This places greater pressure on Riverina Water's comparatively small surface water entitlement that normally meets about a quarter of its total annual needs. Solutions to this issue will require local-scale responses.

To address this challenge in the Murrumbidgee region, the following actions are proposed:

- proposed action 2.6: Encourage best practice land management. See page 89.
- proposed action 4.2: Support (on-going) river restoration in the upper Murrumbidgee catchment. See page 110.

Image courtesy of Destination NSW. Berrima, NSW.

Challenge: Improving the health and resilience of ecosystems

Development has changed flow variability, reduced water quality, and altered the distribution of water throughout the catchment. These factors are impacting the health and resilience of the region's ecosystems. The challenge is to maintain and restore the region's water-dependent ecosystems by using water effectively during wet, moderate and dry periods.

There has been extensive work in recent decades to improve ecosystem health in the southern regions. Since 2004, through water sharing plans, the Basin Plan and other initiatives, the NSW Government and other Basin governments have introduced an environmental flow regime to restore healthy flows. Water for the environment is managed through a combination of planned and held environmental water, and environmental watering works to enhance floodplain inundation at key environmental sites informed by the long-term water plan.[34]

While these reforms and initiatives have addressed many of the fundamental issues, some challenges remain that are impacting the health and resilience of riverine ecosystems and important species and ecosystems under stress.

Altered flows are affecting ecosystem health

Water infrastructure, river regulation and water extraction have influenced flow variability, water quality and the distribution of water throughout the catchment. Despite extensive reform initiatives[35] to improve water for the environment, the challenges of an altered flow regime continue to affect ecosystems in the Murrumbidgee region.

The current flow regime of the Murrumbidgee region is very different to predevelopment conditions, with the degree and type of hydrological change varying within the catchment.

Headwater and re-regulating storages (Tantangara, Blowering and Burrinjuck dams and others) have resulted in:

- declines in medium and high-flow frequencies
- change to the seasonality of flows
- regulated flow patterns being more common with a sizeable loss in natural flow variability, reduced inundation of wetlands and floodplains and decreased long-term average flows, especially from Berembed and Gogeldrie weirs
- bank erosion and stability issues in areas of the Tumut River
- significant reductions in flow volumes in the upper Murrumbidgee and montane rivers.

These outcomes have affected communities of vegetation, waterbirds, fish and other aquatic animals (such as platypus and turtles), including some threatened species.

Climate modelling estimates that under a dry climate future there could be further changes to flows in the Murrumbidgee region, with significant decreases in flows compared to those seen under the historical climate (Figure 8).

A future with reduced flow could constrain attempts to restore the health of key environmental assets along the Murrumbidgee system, including the mid-Murrumbidgee wetlands.

However, under a repeat of the long-term historical climate scenario, there could be a future with similar water availability to the lived experience, which would ease the pressure on key ecological assets and functions.

34. More information about the *Murrumbidgee Long-Term Water Plan* is available at www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/murrumbidgee
35. Initiatives established through the *Murray–Darling Basin Plan* since 2004 and programs such as Reconnecting River Country Program and the Snowy Water Inquiry.

Figure 8. Effect of climate scenario on mean (average) annual flow at several locations on the upper Murrumbidgee River from upstream (left) to downstream (right)

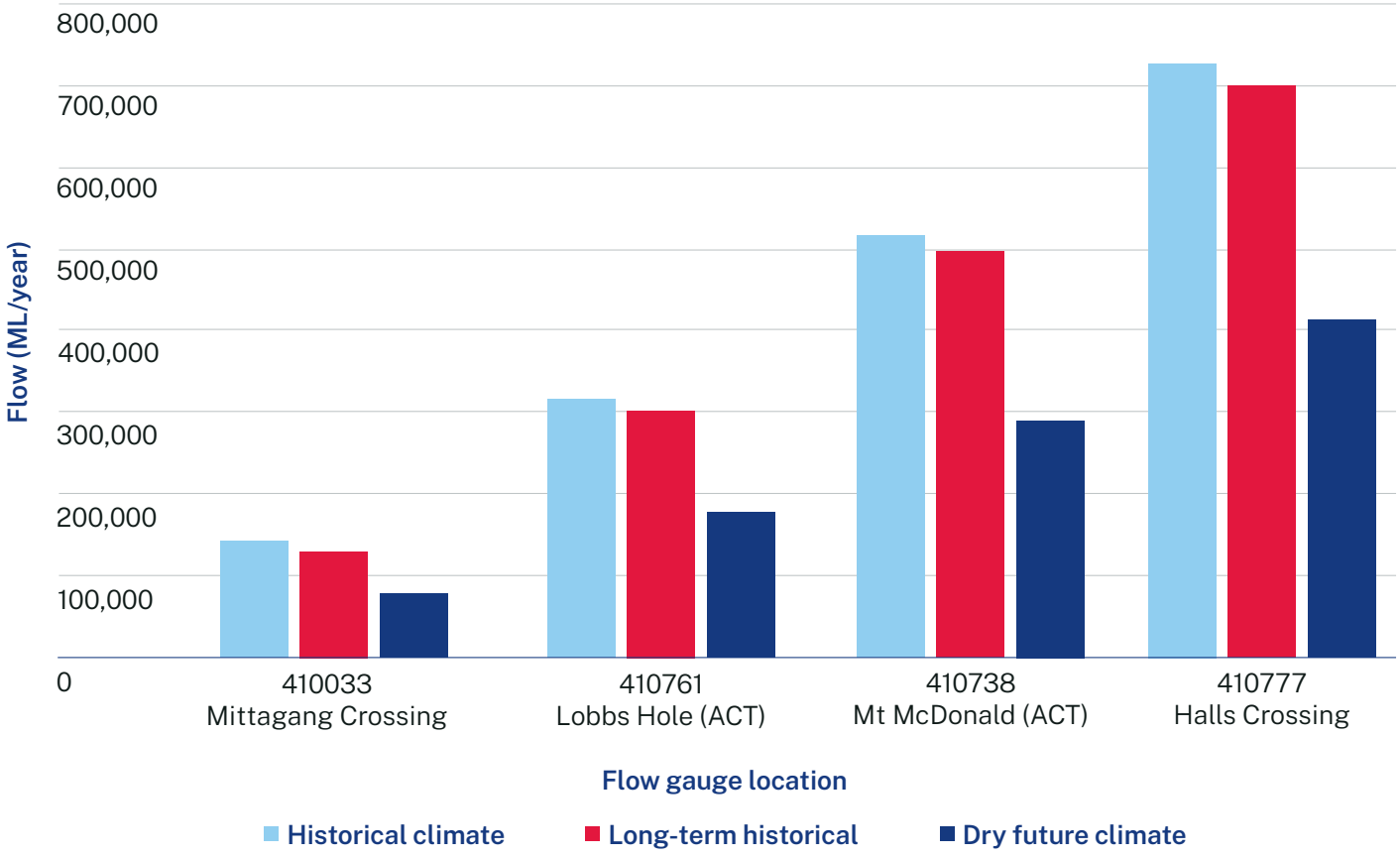


Image courtesy of Destination NSW. Tumut, Kosciuszko.

Addressing altered flows and improving water for the environment

Sustainable Diversion Limit Adjustment Mechanism (SDLAM) program

SDLAM is a program designed to achieve similar or improved environmental outcomes in the Southern Murray–Darling Basin for rivers, wetlands and wildlife using less water as part of the Basin Plan.

Five SDLAM projects across the southern NSW have received an additional $115 million and more time, until 31 December 2026, to deliver critical water infrastructure supporting the Murray and Murrumbidgee rivers, communities, wetlands and wildlife.

- Koondrook-Perricoota-Forest Project – mitigating third-party impacts of water releases on landholders adjacent to the forest and creating breeding opportunities for thousands of native waterbirds and fish in the wetlands. It includes building critical levees, replacing regulators and removing constraints to improve flows.
- Mid-Murray Anabranches Project – improving connectivity between the Murray and Edward rivers, and other surrounding creeks. It includes constructing new bridges and rock crossings, upgrading levees and access roads, as well as removing barriers to fish movement.
- Lower Murray: Locks 8 and 9 project – restoring and enhancing the river habitat across the interconnected Frenchmans Creek and Carrs, Capitts and Bunberoo Creek systems. It includes installing new regulators and fishways, upgrading fish passages and changing the operating principles for weirs 8 and 9 to reinstate a more variable watering regime.
- Murrumbidgee and Murray National Parks Project – improving the delivery of environmental water in the Yanga and Murray Valley (Millewa) National Parks. It includes building sills, upgrading regulators and removing earthen embankments including levees.
- Yanco Creek Modernisation Project – modernising infrastructure to enable smarter use of water in the Yanco Creek System. It includes replacing water regulators and constructing and restoring fish passages.

There are also additional projects outside of the SDLAM Acceleration Program. Work on these projects will not stop. We will continue to refine these projects and to seek the views of our community and industry.

The Reconnecting River Country Program[36]

This program aims to improve wetland and floodplain connectivity by striking a balance between economic, social, cultural and environmental outcomes across southern NSW. It forms part of the SDLAM program, which aims to achieve improved environmental outcomes using existing water for the environment.

The program focuses on relaxing or removing some of the constraints or physical barriers impacting the delivery of water for the environment in the Murrumbidgee.

The NSW Government will continue to collaborate with stakeholders to ensure issues are identified and a suite of tools developed to mitigate any potential effects before making changes to existing rules, policies or infrastructure. This may include new or upgraded infrastructure, easements or changes to river operating rules, which will be developed collaboratively with stakeholders as the program progresses. (See proposed action 2.8: Implement the Reconnecting River Country Program in the Murumbidgee region, page 91).

36. More information on the Reconnecting River Country Program is available at: www.dpie.nsw.gov.au/water/water-infrastructure-nsw/sdlam/reconnecting-river-country-program

Snowy Water Licence Review

The construction of the Snowy Scheme caused a significant decline in the health of the Snowy River and other montane rivers regulated by the scheme including the upper Murrumbidgee River. In response, the 1998 Snowy Water Inquiry resulted in the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID). The SWIOID established environmental flow rules that would see more water and higher flows delivered to the Snowy River from a new outlet at Jindabyne Dam. A portion of flows was also returned to a number of other montane rivers including the upper Murrumbidgee from Tantangara Dam. These environmental flows improved the health and condition of the Snowy River and a number of montane rivers.

Every 10 years, the Snowy Water Licence is subject to reviews under the *Snowy Hydro Corporatisation Act 1997* (Commonwealth), with the second review being completed in 2018 and the next scheduled to commence in 2027. These reviews focus on a range of administrative and technical issues including exploring better ways to deliver environmental flows.

The NSW Department of Climate Change, Energy, the Environment and Water is continuing to implement the actions of the 10-Year Snowy Water Licence Review in collaboration with the Snowy Technical Working Group (TWG). The TWG is made up of representatives from the Victorian, South Australian and Commonwealth Governments, the Murray–Darling Basin Authority and Snowy Hydro. An integrated water model of the Snowy, Murray and Murrumbidgee systems has been developed. This was used to analyse priority issues and assess potential changes to the Snowy Water Licence relating to water releases to the Murray and Murrumbidgee rivers (including the upper Murrumbidgee). This modelling is the first time an evidence-based tool has been available to test changes to licence rules. The department has completed ecological, social and economic studies to assess potential licence changes relating to improving outcomes from environmental flow releases to the Snowy River. The TWG is currently deliberating on a package of options. If agreed, some of the proposed options would also be applied to environmental releases into the upper Murrumbidgee.

To address this challenge in the Murrumbidgee region, the following actions are proposed:

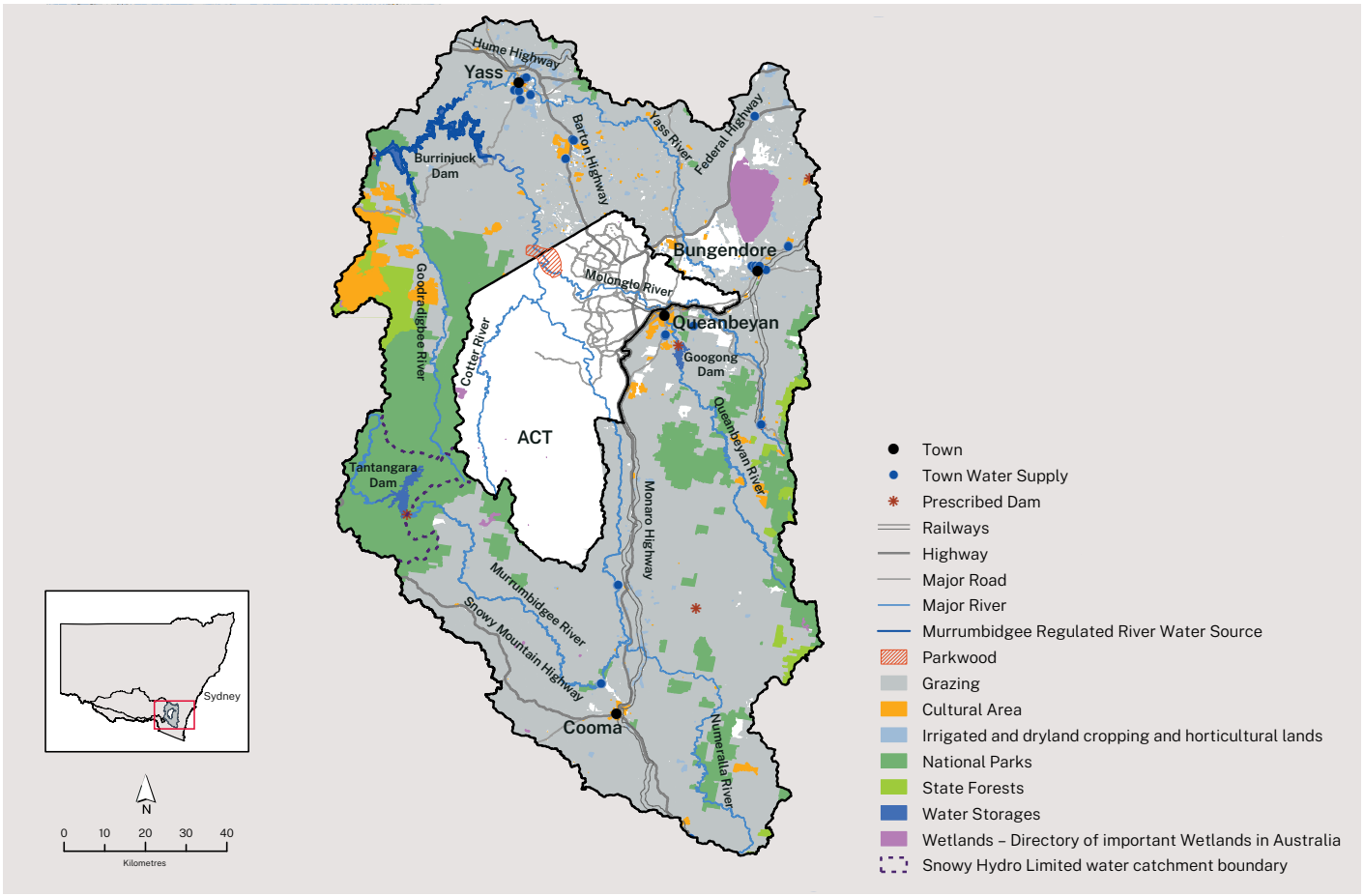
- proposed action 2.1: Rehabilitate ecological and culturally important sites within the mid and lower catchment. See page 83.
- proposed action 2.2: Encourage partnerships with the irrigation sector for environmental water delivery to public and private lands. See page 84.
- proposed action 2.8: Implement the Reconnecting River Country Program in the Murrumbidgee region. See page 91.
- proposed action 4.3: Investigate improvements to the flow regime of the upper Murrumbidgee River. See page 111.
- proposed action 4.4: Addressing sustainable population growth pressures in the upper Murrumbidgee catchment. See page 112.

Parts of the upper catchment are in poor condition

The upper Murrumbidgee River catchment (Figure 9) covers over approximately 14,000 km^2 and takes in urban, peri-urban and rural land. The region starts above Tantangara Dam and runs through NSW and the ACT to Burrinjuck reservoir.

The upper Murrumbidgee area holds unique ecological importance and is home to several iconic species, including endangered species such as the Trout Cod and Macquarie Perch, and vulnerable species such as the Murray Crayfish and Silver Perch as well as various waterbirds and frogs that are listed as threatened species.[37] Specifically, the upper Murrumbidgee River system is home to 2 of only 4 remaining natural populations of Macquarie Perch and Tantangara Creek houses the sole known remaining population of Stocky Galaxias, considered a critically endangered species.

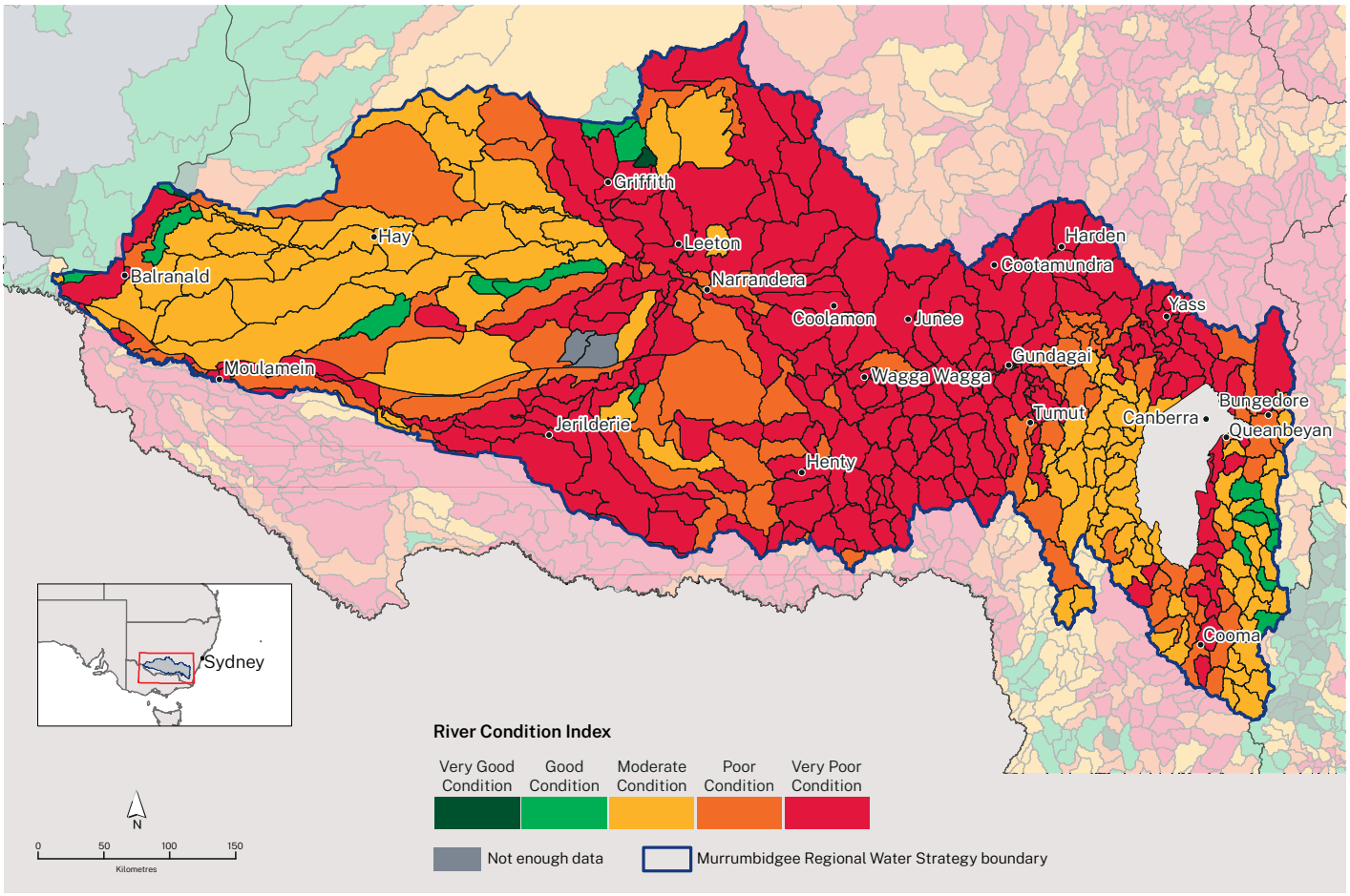
Figure 9. The upper Murrumbidgee catchment



Historical and current land and water management including the development of the Snowy Scheme, has impacted the ecology of the upper Murrumbidgee catchment resulting in altered stream flows, increased rates of sedimentation, weed infestations, poor biodiversity outcomes including declines in fish populations and loss of aquatic and riparian habitats. Some areas are in very poor condition as assessed under the department's *NSW River Condition Index*[38] (Figure 10).

37. www.dpi.nsw.gov.au/fishing/threatened-species/what-current
38. More information about the NSW River Condition Index is available at: water.dpie.nsw.gov.au/science-data-and-modelling/surface-water/monitoring-changes/nsw-river-condition-index

Figure 10. River Condition Index for Murrumbidgee



A significant cause of reduced flow in the upper Murrumbidgee River is the flow diversion created by Tantangara Dam, an integral component of the Snowy-Tumut Development of the Snowy Scheme. The dam led to massive reductions in flow, reducing the natural annual average flow from 300 GL/year to around 1%.[39] In a partial recognition of this issue, environmental flows were made available in 2002 through the Snowy Water Initiative Outcomes Implementation Deed (SWIOID). However, the volumes available (Table 4) are insufficient to provide for adequate winter and spring high flow events that are important for fish spawning and maintenance of a healthy river channel and riparian vegetation. The size of the dam outlet works also limits releases to around 1,500 ML/day, which is not large enough.

These reduced flow rates mean that the river cannot adequately flush sediments downstream, and large sand slugs, weed infestation and habitat simplification are all prevalent throughout the upper Murrumbidgee River, with a significant loss of biodiversity.

Table 4. Yearly allocations of environmental water, made available for releases from Tantangara Dam since 2012

Water year beginning	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Allocation (GL)	25.2	29.8	18.3	15.8	10	35.8	5.7	3.6	3.4	31.8	35.8	40.6

39. Pendlebury P., Erskine W., Olley J, Marchant R., & Brown P., 1997. *Expert Panel Environmental Flow Assessment of the Upper Murrumbidgee River*. Report to the NSW Environment Protection Authority, Queanbeyan.

Under the Snowy Water Licence and SWIOID, current environmental flow rules for the upper Murrumbidgee and other montane rivers require monthly flow release schedules to be set a year in advance and daily release schedules to be set before the start of each month, meaning it can be difficult to issue releases in response to natural events or requirements. Further, allocations may only be used in the year they are provided, not strategically carried over into potentially drier future years. These inflexibilities further restrict the effectiveness of the available water to deliver environmental outcomes.

Another flow-related challenge results from water being taken from the river, that was released from Tantangara Dam to achieve targeted environmental outcomes. Currently there are no long-term rules to restrict this practice. This activity impedes the achievement of desired ecological outcomes and needs to be permanently addressed in the water management framework.

Intense bushfires also create catchment and river-based challenges as loose soil, ash, debris and nutrients wash into watercourses and cause serious impacts such as fish deaths and contamination of town water supplies. Over periods lasting up to and exceeding a century, there can be significant declines in run-off volumes as forests regrow, which reduces river flows. The 2019–2020 bushfire season burnt around 5.6 million ha within NSW, including over 450,000 ha across the Snowy Valley and Snowy Monaro local government areas and led to declines in water quality and conditions for native fish.

To address this challenge in the Murrumbidgee region, the following actions are proposed:

- proposed action 4.2: Support (on-going) river restoration in the upper Murrumbidgee catchment. See page 110.
- proposed action 4.4: Addressing sustainable population growth pressures in the upper Murrumbidgee catchment. See page 112.

It could be more difficult to deliver water for the environment in the future

During dry periods less water may be available to be released for the environment. In some instances, there may be limited opportunities to maintain critical environmental needs such as refuge river pools, core wetland areas and seed banks in soil. Similar to consumptive water users, dry conditions also reduce the reliability of water entitlements held by NSW and Commonwealth environmental water holders.

The regulated Murrumbidgee River has a large volume of licenced environmental water (690 GL in registered entitlements is managed by the Commonwealth Environmental Water Holder and around 457 GL is managed by NSW).[40] These entitlements are managed for the benefit of the environment to deliver water to specific sites (such as wetlands) and support ecosystem functions.

Just like any other licence holder, the amount of water available to the environment through held environmental water entitlements and environmental water allowances varies year to year depending on water availability in storages. This variability is considered as part of the annual planning process by environmental water managers.[41] Under a dry future climate scenario, as with all other water entitlement holders, a future with lower water availability would constrain efforts to achieve environmental watering objectives and outcomes.

To address this challenge in the Murrumbidgee region, the following actions are proposed:

- proposed action 2.1: Rehabilitate ecological and culturally important sites within the mid and lower catchment. See page 83.
- proposed action 2.2: Encourage partnerships with the irrigation sector for environmental water delivery to public and private lands. See page 84.

40. Murrumbidgee River water sources, Environmental Water Register. Retrieved from www.dpie.nsw.gov.au/water/environmental-water-management-in-nsw/environmental-water-data/held-environmental-water-data/held-environmental-water-dashboard
41. The NSW and Commonwealth environmental water holders own and manage a total of 1147 GL of water entitlement which is approximately 32% of total regulated Murrumbidgee River entitlement. The majority of this water is in general security and supplementary entitlements.

Ecological communities are at risk

A number of ecological communities are at risk in the region.

Native fish are under stress from physical and operational barriers. The ability to sustain the native fish of the Murrumbidgee region is impaired by physical structures such as dams, weirs and floodplain infrastructure that do not have fishways and restrict the ability of native fish to move, breed and find ideal habitat.

Native vegetation has declined in condition and extent due to a reduction in flood frequency and duration and an increase in land clearing. Groundwater-dependent ecosystems (GDEs) would be at risk if groundwater is increasingly extracted due to a drying climate or for other reasons and if there is reduced recharge of groundwater from surface water. High priority GDEs are located in the catchment from the east of Wagga Wagga to the west at lower reaches of the catchment near Balranald. The Murrumbidgee alluvium is dominated by River Red Gum-Black Box and River Red Gum-Yellow Box woodland wetlands and Cumbungi rushland. These communities are generally characterised by having a high number of threatened species, endangered ecological communities and riparian corridors.[42]

A drier and more variable climate will increase the stress on ecological communities. Events such as intense bushfires can have serious effects. The 2019–20 bushfire had a severe effect on populations of the endangered Macquarie Perch from a loss of streamside vegetation that resulted in increased sediment loads and ash to wash into streams leading to loss of habitat and poor water quality (including low dissolved oxygen). After long droughts followed by floods, hypoxic (low oxygen) blackwater events can often occur that cause the death of fish and other aquatic animals (see breakout box below).

Water releases from Blowering and Burrinjuck dams combined can display temperature decreases of 10 degrees or more, which can extend more than 200 km downstream of the Tumut-Murrumbidgee confluence. Cold water pollution has a significant damaging impact on riverine ecological function, particularly in summer.

Every year, unscreened pumps in the Murrumbidgee region extract large numbers of native fish and other aquatic species such as crayfish and turtles. Adult fish, as well as juveniles, larvae and eggs, are diverted and isolated in irrigation channels.

Hypoxic blackwater and fish deaths

Large-scale hypoxic blackwater events, such as those that occurred in 2011, 2016 and 2022 are driven by biological processes, but are exacerbated by water resource developments and potentially a changing climate. These events caused widespread fish and crustacean deaths across the southern Murray–Darling Basin. However, fish deaths that are likely linked to hypoxic blackwater have been reported in the southern Basin and the Barwon–Darling since the late 1800s, so there is some evidence that such events have occurred prior to major water resource developments.[43]

Most large-scale hypoxic blackwater events happen after prolonged periods where floodplains have not been regularly inundated either due to prolonged dry periods, or due to water resource developments that restrict such inundation. This leads to extensive build-ups of organic material, such as leaf litter, which is then washed into the river during flood events – feeding a boom in microscopic organisms that consume the available oxygen. Temperature is a critical factor in hypoxic blackwater generation, as bacterial production increases with warmer temperatures. Another critical factor with hypoxia is that the oxygen carrying capacity of water physically decreases as water temperature increases, reducing available oxygen. This means that a warming climate is likely to increase the likelihood of these events.

WaterInsights data by WaterNSW[44] includes dissolved oxygen values for some river gauges in NSW, which can give an indication of the likelihood of a hypoxic blackwater event.

To address this challenge in the Murrumbidgee region, the following actions are proposed:

- proposed action 2.1: Rehabilitate ecological and culturally important sites within the mid and lower catchment. See page 83.
- proposed action 2.3: Mitigate the impact of infrastructure on native fish. See page 85.
- proposed action 3.3: Investigate innovative ways to improve runoff in water supply catchments. See page 99.

42. *Murrumbidgee Alluvium water resource plan description* available at www.mdba.gov.au/publications-and-data/publications/murrumbidgee-alluvium-water-resource-plan
43. More information on blackwater can be found at: water.dpie.nsw.gov.au/our-work/allocations-availability/drought-and-floods/hypoxic-blackwater
44. WaterNSW data can be found at: realtimedata.waternsw.com.au/water.stm

Challenge: Addressing barriers to Aboriginal people's water rights

Water is an essential part of Aboriginal people's culture and heritage but the current water management framework is not meeting the needs and aspirations of Aboriginal people.

There is limited understanding of the cultural significance of water to Aboriginal people

There is a limited understanding and acknowledgement of the spiritual connection Aboriginal people have to healthy waterways and important cultural sites.

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 surface water and groundwater connected systems.

Aboriginal people rely on the health of water and their waterways for well-being and continued practice of cultural traditions. If a site dries up or has ongoing poor water quality, the traditional story or meaning can be lost. When the cultural and spiritual values of water are sustained by providing water that is sufficient in both quantity and quality, then many other components of Aboriginal life will be healthy.

A significant number of cultural sites in the Murrumbidgee region are on floodplains and many cultural activities focus on floodplain areas. Development on floodplains, such as levees, has altered the passage of flows and resulted in some cultural assets that are disconnected from main waterways.

To address this challenge in the Murrumbidgee region, the following action is proposed:

- proposed action 2.7: Support place-based initiatives to deliver cultural outcomes for Aboriginal people. See page 90.

The current water management framework limits the ability of Aboriginal people to access water

While Aboriginal people currently can access rights to water through water use entitlements, the framework is complex and confusing and can be difficult to navigate. In addition, current water access rights may limit Aboriginal people's access to water for economic purposes and there are some remote Aboriginal communities that have limited access to clean drinking water.[45]

The current water management framework inhibits access to culturally significant areas and waterways and there is limited acknowledgement of the impact of current river operations on the environmental and cultural value of these sites.

Development of a policy framework around cultural flows is in its infancy in Australia.

Cultural flows are not provided for explicitly in the *Water Management Act 2000*, relevant water sharing plans or releases from the Snowy Scheme. In recent years, environmental water managers have made efforts to achieve cultural and ecological co-benefits[46] and Aboriginal people continue to contribute important knowledge to inform the management of water for the environment in the Murrumbidgee region. However, these efforts are distinct from how Aboriginal communities envision cultural flows where water is owned and managed by Aboriginal people and used as per the Echuca Declaration.[47]

The costs associated with accessing water are also prohibitive. While some licence and annual fees are waived, there are costs associated with purchasing and maintaining related water infrastructure such as pumps and pipes. Although governments have at times set aside funding to help Aboriginal people invest in water entitlements, these commitments have often been 'in principle' and many are yet to be implemented. This lack of funding to manage and access water is compounded when land is handed back to traditional owners.

To address this challenge in the Murrumbidgee region, the following action is proposed:

- proposed action 3.1: Support the development of new water-related Aboriginal business opportunities in the Murrumbidgee region. See page 97.

Image courtesy of Jody Orcher, NSW Department of Climate Change, Energy, the Environment and Water.
Walgalu Country out the back of Tumut, NSW.

45. Improved access to clean drinking water for remote Aboriginal communities is currently being addressed through the department's Aboriginal Communities Water and Sewerage Program. The Aboriginal communities in the region that are part of the Aboriginal Communities Water and Sewerage Program include: Brungle, Three Ways and Balranald Reserve Endeavour Drive.
46. More information can be found at: www.environment.nsw.gov.au/topics/water/water-for-the-environment/murrumbidgee/annual-environmental-water-priorities-2023-24
47. The National Cultural Flows Research Project is working to secure a future where First Nations' water allocations are embedded within Australia's water planning and management regimes, to deliver cultural, spiritual and social benefits as well as environmental and economic benefits. Further information is available at: www.culturalflows.com.au/

There are restrictions with the Aboriginal cultural water access licencing framework

In NSW, Aboriginal people can apply annually for an individual Aboriginal cultural water access licence.[48] If granted, this licence can provide up to 10 ML/year of water for cultural purposes,[49] but it cannot be associated with commercial activities or provide direct or indirect economic benefit. Once the cultural project is completed the entitlement is removed. The *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* is the only water sharing plan to have granted a high security (Aboriginal cultural) access entitlement.

Some culturally significant sites in the Murrumbidgee region have been identified and assessed for water management strategies. Through the Aboriginal Waterways Assessment Program,[50] several sites have been assessed in the upper Murrumbidgee catchment by traditional owners.

The Murrumbidgee Long-Term Water Plan recognises 7 cultural sites: Coolamatong (Lambie Gorge), the Wiradjuri Reserve to Gobba Beach, Koondan, Nap Nap Burial Ground, Dippo Ceremonial Ground, Toogimbie Indigenous Protected Area and Gayini Nimmie-Caira.[51]

Cultural water access licence provisions are being reviewed

The NSW Government recognises First Nations/Aboriginal people's rights to water. We aim to embed water for First Nations/Aboriginal people in the water planning and management regime in NSW to deliver cultural, spiritual, social, environmental and economic benefit to communities.

While there are provisions for accessing water for cultural purposes in NSW,[52] these do not currently meet the needs and obligations of First Nations/Aboriginal people to care for Country or achieve the cultural water flows and water management aspirations set out in the 2007 Echuca Declaration.

In addition, policy settings limit the use of cultural water entitlements so that no direct economic benefit can be gained and are silent on secondary economic benefit. Only 7 cultural water entitlements have ever been issued, with only 2 remaining in use today.

The Aboriginal Water Program (AWP) is delivering several initiatives to give greater recognition to Aboriginal people's water rights and interests, including clarifying the purposes for which cultural water can be used. Several other key pieces of work also provide the foundation for the way forward, including the National Cultural Flows Research Project.[53]

In early 2023, the Cultural Watering Plan project[54] conducted an expression of interest process for a pilot program. A large number of applications were received, of which 6 were selected to participate in the program. The AWP team has been working with these diverse Aboriginal community groups across NSW to develop Cultural Watering Plans for their communities. The plans address the significance of cultural water, explore options for water access and ownership, and establish monitoring mechanisms. The findings will be used to guide reviews of existing water policy and planning frameworks, and to bridge gaps in how we communicate with First Nations/Aboriginal people.

The NSW Government will keep working with First Nations/Aboriginal people and organisations and apply the processes developed in *A Pathway to Cultural Flows in Australia*.[55]

48. 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.
49. Cultural purposes include: drinking, food preparation, washing and watering domestic gardens, as well as for Aboriginal cultural uses such as manufacturing traditional artefacts, hunting, fishing, gathering, recreation and ceremonial purposes.
50. For further details see www.mldrin.org/what-we-do/aboriginal-waterways-assessment/
51. Department of Planning, Industry and Environment (2020). *Murrumbidgee Long-Term Water Plan, Part A: Murrumbidgee catchment.*
52. More information about Cultural water access for Aboriginal people is available at: water.dpie.nsw.gov.au/our-work/projects-and-programs/aboriginal-water-program
53. More information about National Cultural Flows is available at: www.culturalflows.com.au
54. More information about Cultural Watering Plan project is available at: water.dpie.nsw.gov.au/plans-and-programs/aboriginal-water-program/cultural-watering-plans
55. More information about the Pathway to Cultural Flows in Australia is available at: www.mdba.gov.au/node/6339

There are limited opportunities for Aboriginal people to participate in water management

A historic lack of water entitlements held by Aboriginal people is a significant obstacle for representation in decisions concerning water management that advance the economic and social needs of Aboriginal people.

Aboriginal people have raised concerns that water management in the region and across NSW is largely seen as an allocation problem between agriculture, towns and environment. It is thought this approach overlooks the interests, values, knowledge and rights of Aboriginal people and their cultural obligation to Country, including their understanding that waterways are living ecosystems that need to be cared for and protected.

There is concern from Aboriginal people that our understanding of the extent of culturally significant sites within the region is limited and needs to be better considered in water management decisions. There is also concern about limited understanding of how cultural obligations to care for land and water connect across communities and language groups, extending to downstream communities, throughout catchments and over connected surface and groundwater systems.

Increasingly it is acknowledged that Aboriginal knowledge and experience needs to be recognised as an essential element to managing natural resources in Australia. However significant gaps remain. Opportunities are still limited for Aboriginal people to co-manage activities or participate in water-related decision-making processes because:

- consultation timeframes and processes do not allow the time needed to adequately meet Aboriginal cultural governance processes. This erodes trust and prevents important relationships between Aboriginal people and water managers being established
- the complex set of state and federal laws and systems around water management is often not explained in a culturally appropriate manner
- there are a lack of resources and support for Aboriginal people and Aboriginal community groups to enable their engagement in water management processes
- monitoring, evaluation and reporting do not include Aboriginal input in design, implementation and assessment.

While governments are committed to improving engagement with Aboriginal people and communities, significant progress is still needed before it can be considered a mature, knowledge sharing partnership.

To address this challenge in the Murrumbidgee region, the following action is proposed:

- proposed action 1.4: Foster ongoing arrangements for participation of local Aboriginal people in water management. See page 76.

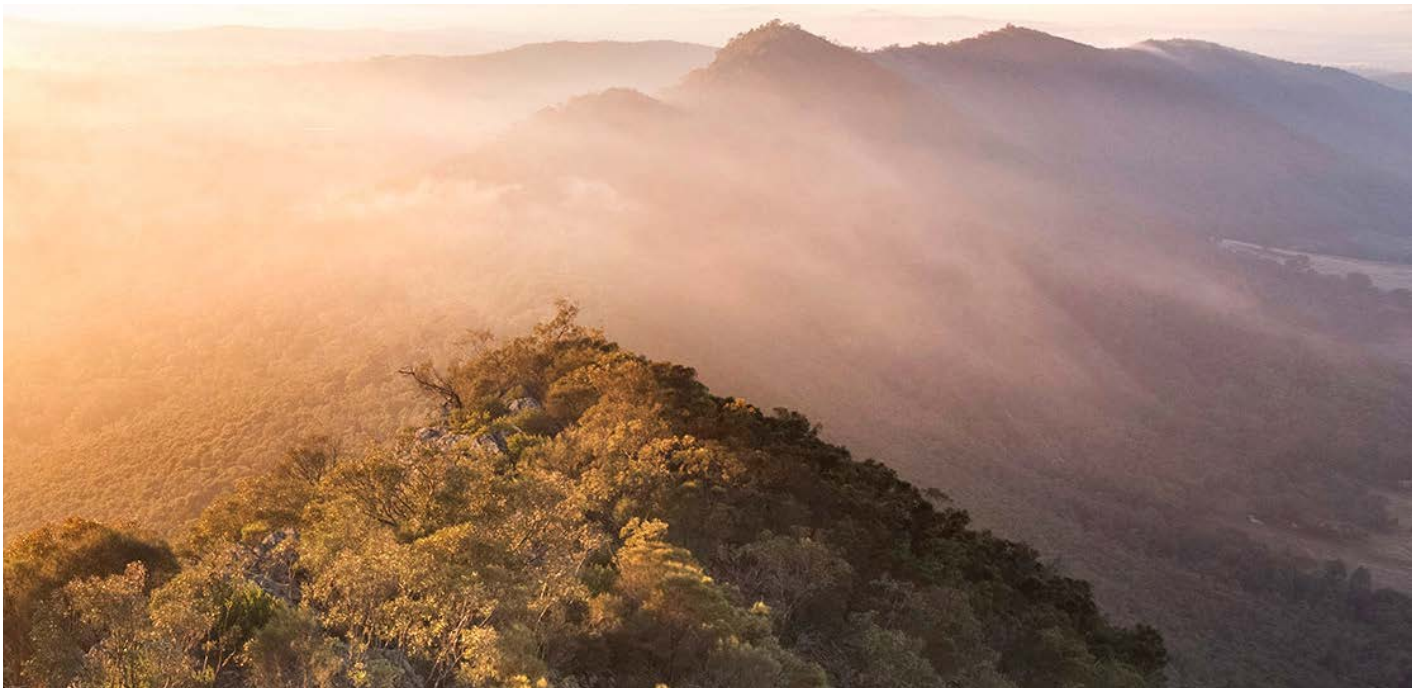


Image courtesy of Destination NSW. The Rock Nature Reserve – Kengal Aboriginal Place, Wagga Wagga.

NSW Water Strategy[56] prioritises Aboriginal people's water rights

The NSW Government recognises systemic issues need to be addressed at a state-wide level to better enable the exercise of First Nations/Aboriginal people's rights and access to water. This is reflected in Priority 2 of the NSW Water Strategy, which recognises First Nations/Aboriginal people's rights and values and aims to increase access to and ownership of water for cultural and economic purposes.[57]

Actions being taken under the NSW Water Strategy are:

- 2.1 Strengthen the role of First Nations/Aboriginal People in water planning and management
- 2.2 Develop a state-wide Aboriginal water strategy
- 2.3 Provide Aboriginal ownership of and access to water for cultural and economic purposes
- 2.4 Work with First Nations/Aboriginal People to improve shared water knowledge.

Draft NSW Aboriginal Water Strategy

The NSW Government is developing a draft NSW Aboriginal Water Strategy in collaboration with First Nations and Aboriginal people. The strategy will empower First Nations and Aboriginal people to contribute to water management and planning decisions and identify ways to increase water rights.

We listened to Aboriginal communities, Traditional Owners and representative organisations through discussions on water strategies and planning, identifying 6 important principles that matter to Aboriginal people:

- culture
- health and well-being
- caring for Country
- meaningful engagement
- economic benefit
- shared cultural and environmental benefits.

Feedback will be sought on the draft strategy in 2024 through peak Aboriginal organisations and Regional Aboriginal Water Committees. The NSW Aboriginal Water Strategy will be finalised and published in mid to late 2024.

56. *NSW Water Strategy* available at: water.dpie.nsw.gov.au/our-work/plans-and-strategies/nsw-water-strategy
57. More information about Priority 2 of the NSW Water Strategy is available at: water.dpie.nsw.gov.au/plans-and-programs/nsw-water-strategy/toward-2050/priority-2

Image courtesy of Destination NSW. Wagga Wagga Centre and the Museum of the Riverina, NSW.

Challenge: Supporting existing and emerging industries and livelihoods

Agriculture, agribusiness and hydroelectricity are the major water-reliant industries in the Murrumbidgee region. The region's water resources also support indirect water users, including tourism and manufacturing. Patterns of land use have been changing and industries are expected to grow over the next 20 years. While there is potential for future development in high value industries, a shortage of reliable water supplies may hinder this growth. A key challenge for the region is to support new and existing industries within the context of a variable and changing climate and fully committed water resources.

Less reliable surface water may impact water reliant industries that are important to the regional economy

The Murrumbidgee region forms part of a region known as Australia's 'food bowl' with a reputation as one of Australia's premium agricultural areas due to its contribution to the country's agricultural production and economy. The diverse landscape, climate and transport links in the region support a wide range of agricultural industries that rely on the region's water resources.

Water use by annual crops in central and eastern Murrumbidgee region local government areas varies significantly between wet and dry years. Although total water use for industries is bound by the sustainable diversion limits, changes within and between industries – including the growth of permanent plantings in the western parts of the Murrumbidgee region – is altering the geographical use of water in the catchment, trade patterns and seasonal water demand.[58]

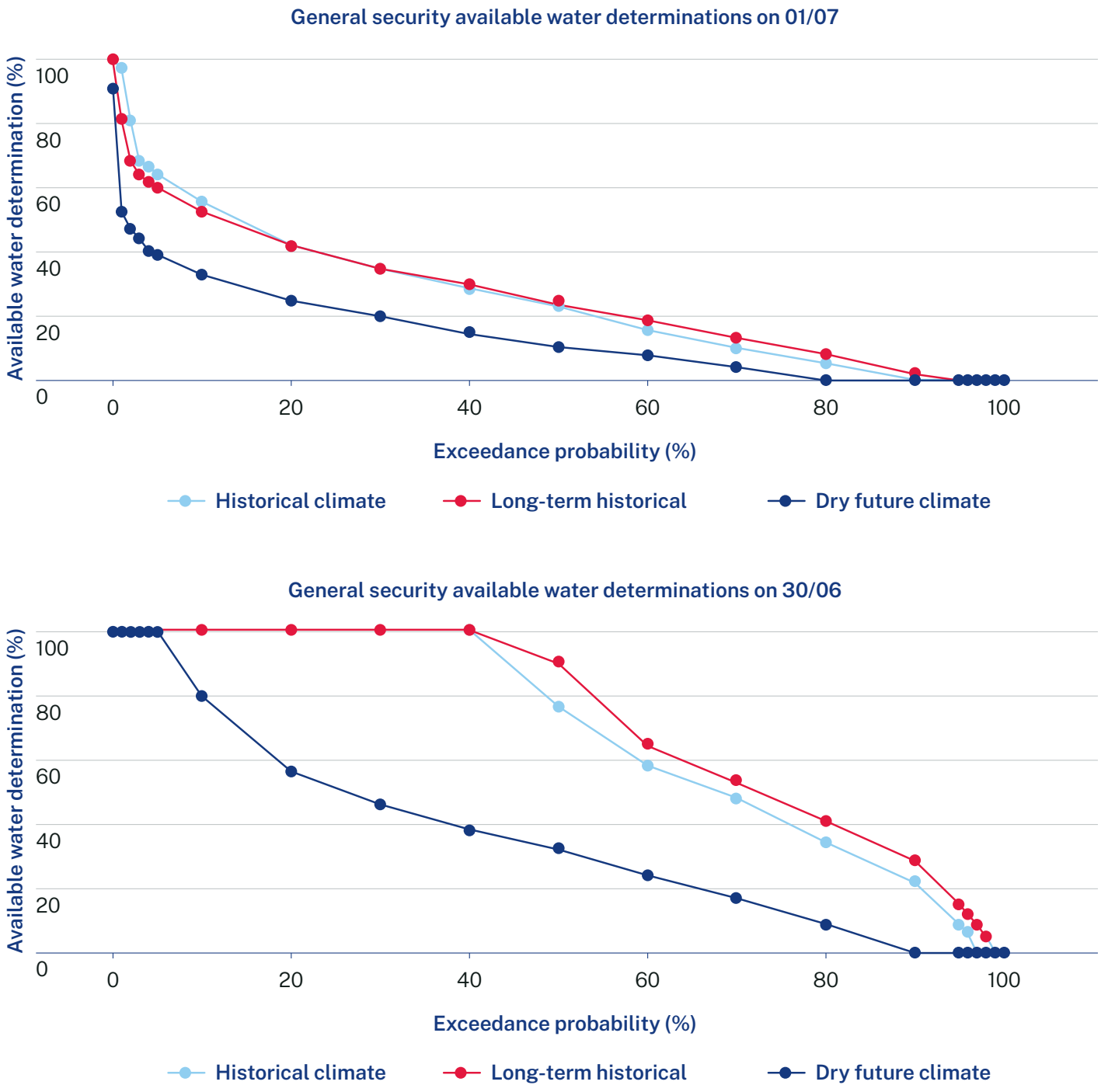
Attracting new, high-value industries and supporting economic diversification is a strong focus for the Murrumbidgee region. Access to reliable water is important to achieving a more diverse employment and economic base. The Inland Rail Project and other initiatives will enable the region to leverage its position along nationally significant rail and road corridors, encouraging further industry development and job growth. The Wagga Wagga Special Activation Precinct will help stimulate economic growth and investments made by the NSW Government, while the South Jerrabomberra Regional Jobs Precinct will leverage the region's established industries to grow existing businesses and attract new businesses.

The new climate data and modelling highlights that with the current rules and infrastructure under a dry future climate scenario, general security allocations may be significantly reduced compared to the historical climate scenario – both at the start of the irrigation season and end-of-year (Figure 11).

Reduced allocations at the beginning of the irrigation season would mean that irrigators would be less likely to plant annual crops. Combined with less water added to accounts throughout the year, this would likely constrain economic activity in the region.

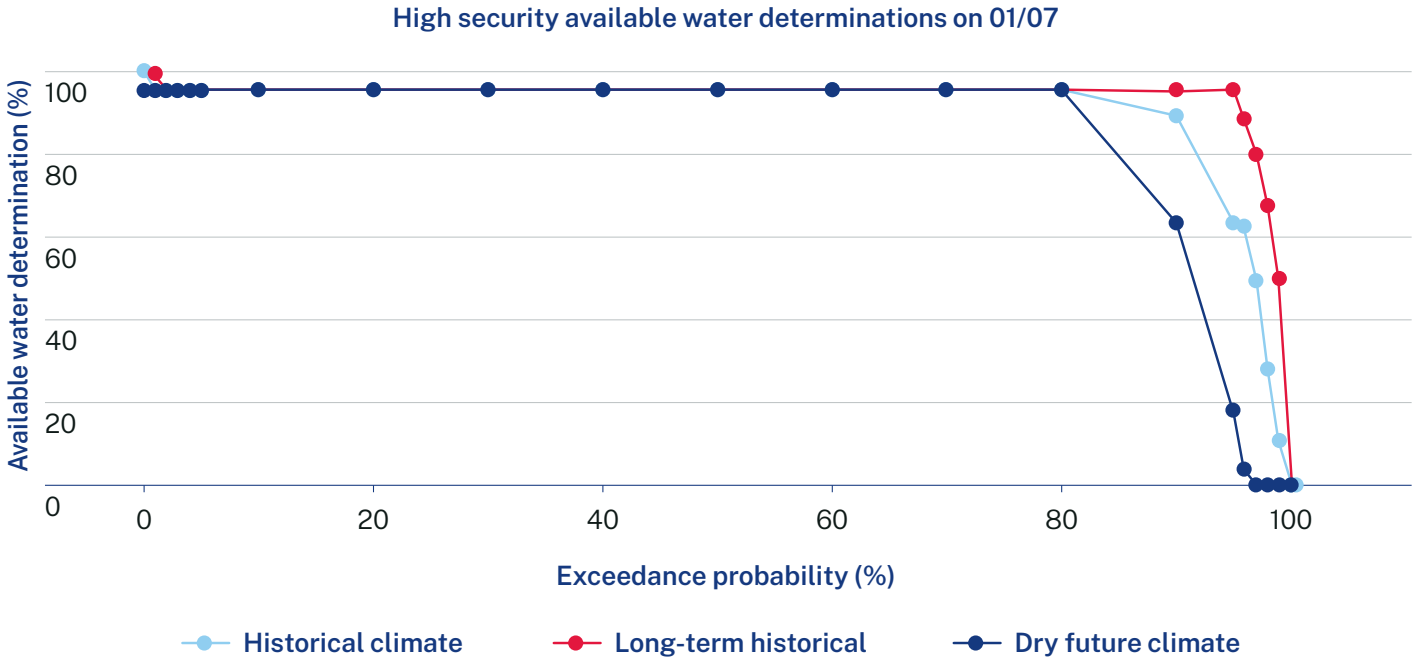
58. Department of Planning and Environment (2022). *Draft Murrumbidgee Regional Water Strategy*, www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murrumbidgee/murrumbidgee-regional-water-strategy

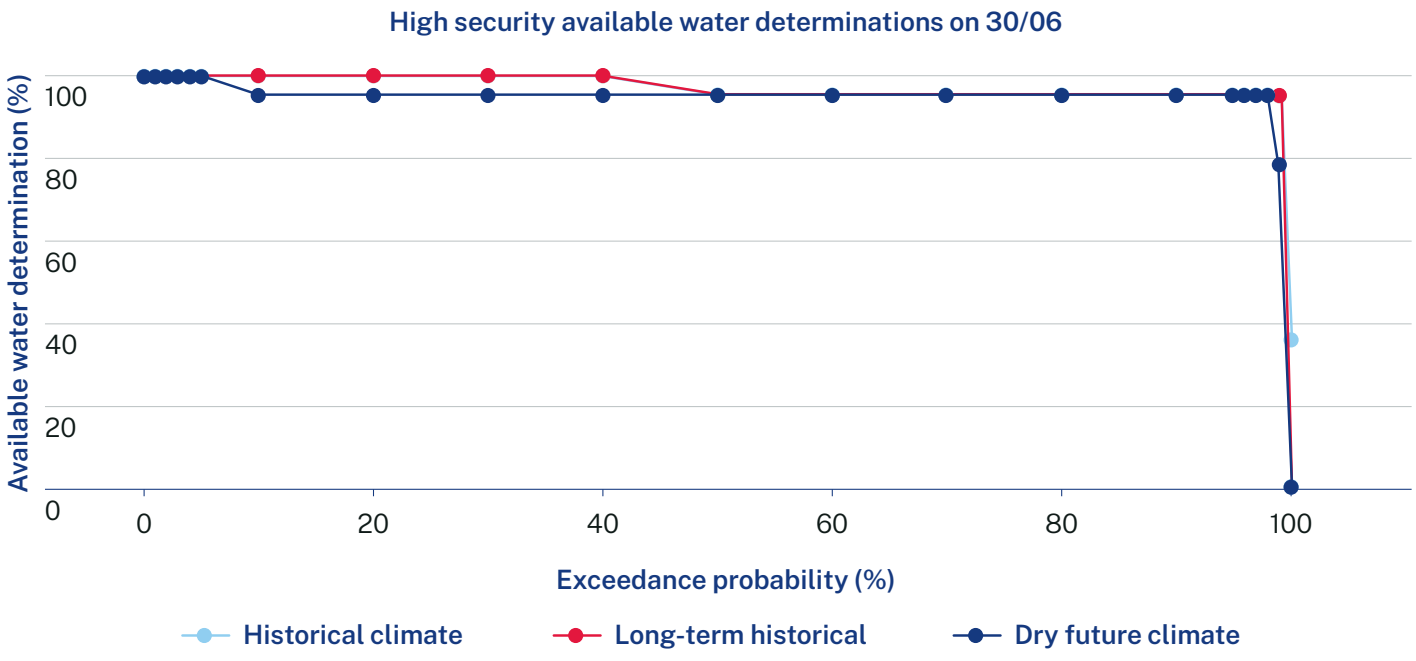
Figure 11. Impact of dry future climate scenario on Murrumbidgee general security available water determinations for 1 July (top) and 30 June (bottom)[59]



59. Note the results do not include carryover.

Figure 12. Impact of climate scenario on Murrumbidgee High Security available water determinations for 1 July (top) and 30 June (bottom)





For high security entitlements, opening allocations perform similarly across both the long-term historical climate and historic climate scenarios but are significantly reduced under a dry future climate. End-of-year allocations are similar for all 3 scenarios, albeit slightly reduced under a dry future climate indicating that reserves held in the system are sufficient (Figure 12).

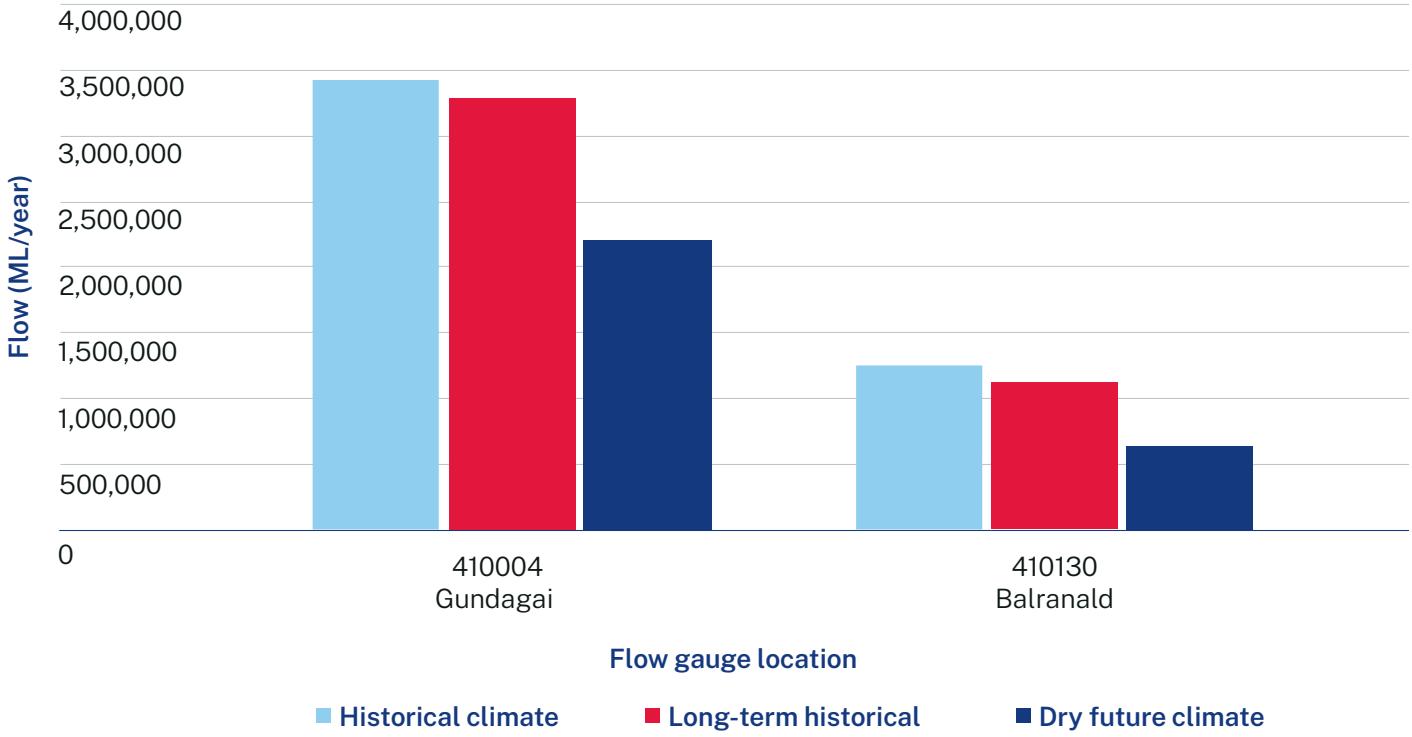
Despite the Murrumbidgee River being one of the most reliable river systems in inland NSW, climate change has the potential to constrain industry and economic growth across the region. Based on the results climate change may result in reduced water availability and increased uncertainty for the region's industries. Changes in temperature and seasonality has the potential to force changes to the type of crops that are suitable for the region. More extreme events, such as droughts, floods and bushfires, could cause large-scale economic and social losses for the agricultural sector and communities.

River flows would be reduced with a dry future climate. Our modelling estimated that under a dry climate future there will be significant decreases in median annual flows compared to those seen under the historical climate (Figure 13).[60] Results show:

- a 35% decrease in median annual flows at Gundagai
- a 49% decrease in median annual flows at Balranald.

A future with reduced flows could also constrain attempts to restore the health of key environmental assets along the Murrumbidgee River, including the Lowbidgee Floodplain, and fish populations within the main channel. Modelling for the upper Murrumbidgee indicates that median flows would be lower and cease-to-flow events more prevalent under the dry future climate scenario.

Figure 13. Impact of climate scenario on mean (average) annual flow in the Murrumbidgee at Gundagai and Balranald



The Snowy Scheme, critically important in energy generation and regional water management, is not immune to the potential ramifications of climate change on its operations and yield. A changing climate prompts the need to better understand the operation of the Snowy Water Licence provisions under different climate scenarios.

Limited understanding of future water availability and publicly available climate information can lead to poor investments, business decisions and drought and flood security planning. This can also constrain the uptake of opportunities in alternative water supplies.

A description of the climate scenarios and these and other results about water availability are presented in the NSW Murray and Murrumbidgee climate and hydrological baseline modelling report.[61]

60. NSW Department of Climate Change, Energy, the Environment and Water, *NSW Murray and Murrumbidgee climate and hydrological baseline modelling report*, available at www.dpie.nsw.gov.au/murrumbidgee-regional-water-strategy
61. NSW Department of Climate Change, Energy, the Environment and Water, *NSW Murray and Murrumbidgee climate and hydrological baseline modelling report*, available at www.dpie.nsw.gov.au/murrumbidgee-regional-water-strategy

To address this challenge in the Murrumbidgee region, the following actions are proposed:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data. See page 75.
- proposed action 3.6: Improve public access to climate information and water availability forecasts. See page 103.

Crop vulnerability assessments

The impacts of climate change are likely to disrupt primary industries in many ways including changes to agricultural productivity, crop yields and pasture availability as well as changes in the spread of pests, weeds and disease.

Understanding the extent of these changes and the associated vulnerability of primary industries is critical for managing risks and making sound adaptation decisions. At the same time, climate change may offer new opportunities for producers. Understanding the timing and nature of potential opportunities is essential for producers to prepare to maximise any benefit.

The NSW Department of Climate Change, Energy, the Environment and Water, under the NSW Climate Change Research Strategy,[62] is undertaking crop vulnerability assessments to address this issue. Through a consistently applied approach, with consultation and review by industry, the Vulnerability Assessment analyses potential climate change impacts and adaptation strategies for 28 commodities across cropping, extensive livestock, horticulture and viticulture, forestry and fisheries. The project also analyses the impacts of climate change on 14 related biosecurity risks that are relevant to each sector.

The Vulnerability Assessment has 2 key objectives:

- improve the understanding of climate change risks and impacts
- provide evidence of the value of adaptation strategies to reduce identified climate impacts.

The assessment applies a standard methodology across all commodities and the related biosecurity risks. This enables comparisons between commodities across NSW and aims to inform strategic industry planning and policy.

The assessment is being conducted in 4 stages:[63]

- identifying industry needs for, and current activities, in climate change risk and adaptation
- reviewing previous climate change impact and adaptation research and current activities for each industry
- developing a vulnerability assessment to capture climate change exposure risk and sensitivity of key primary producers
- conducting spatial and economic analysis to evaluate climate risk and adaptation options for primary industries.

62. More information available at: www.dpi.nsw.gov.au/dpi/climate/about-dpi-climate/climate-change-research-strategy
63. More information can be found at: www.dpi.nsw.gov.au/dpi/climate/about-dpi-climate/climate-change-research-strategy/project-6-vulnerability-assessment

There are gaps in our understanding of groundwater resources

Sustainable use of the region's groundwater sources (Figure 14) is critical to support towns, industries and the environment. During drought, reliance on groundwater can increase significantly to support the region's industries and communities.

Figure 14. Murrumbidgee groundwater sources

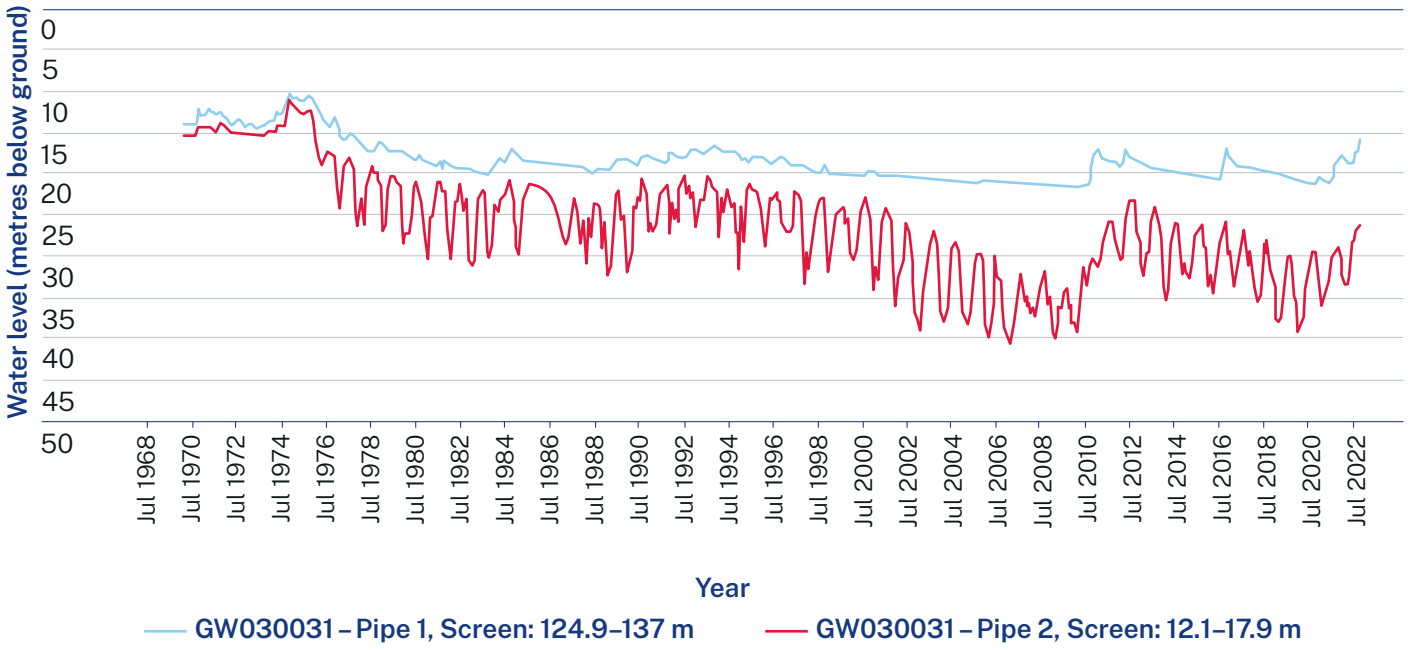
Note: The Billabong Creek Alluvial Groundwater Source is located in the Murrumbidgee region however challenges and proposed action relating to it are discussed in the NSW Murray Regional Water Strategy as it is managed under the *Water Sharing Plan for the Murray Alluvial Groundwater Sources*.

In the Murrumbidgee region there is a high reliance on groundwater use for agriculture for a range of grazing, dryland and irrigated cropping enterprises. It is primarily used when surface water is scarce and is strongly linked to climate conditions.

Some parts of the region have been affected by declining groundwater levels.

Wagga Wagga Alluvial, Lower Murrumbidgee Deep Alluvial, Kyeamba Alluvial and Mid Murrumbidgee Zone 3 Alluvial groundwater sources all show signs of short-term and long-term declines. Figure 15 highlights the decline of groundwater levels in the Wagga Wagga Alluvial from 1974 to 2017. It shows that groundwater levels can recover in response to widespread rainfall, as shown during the period 2009 to 2012.

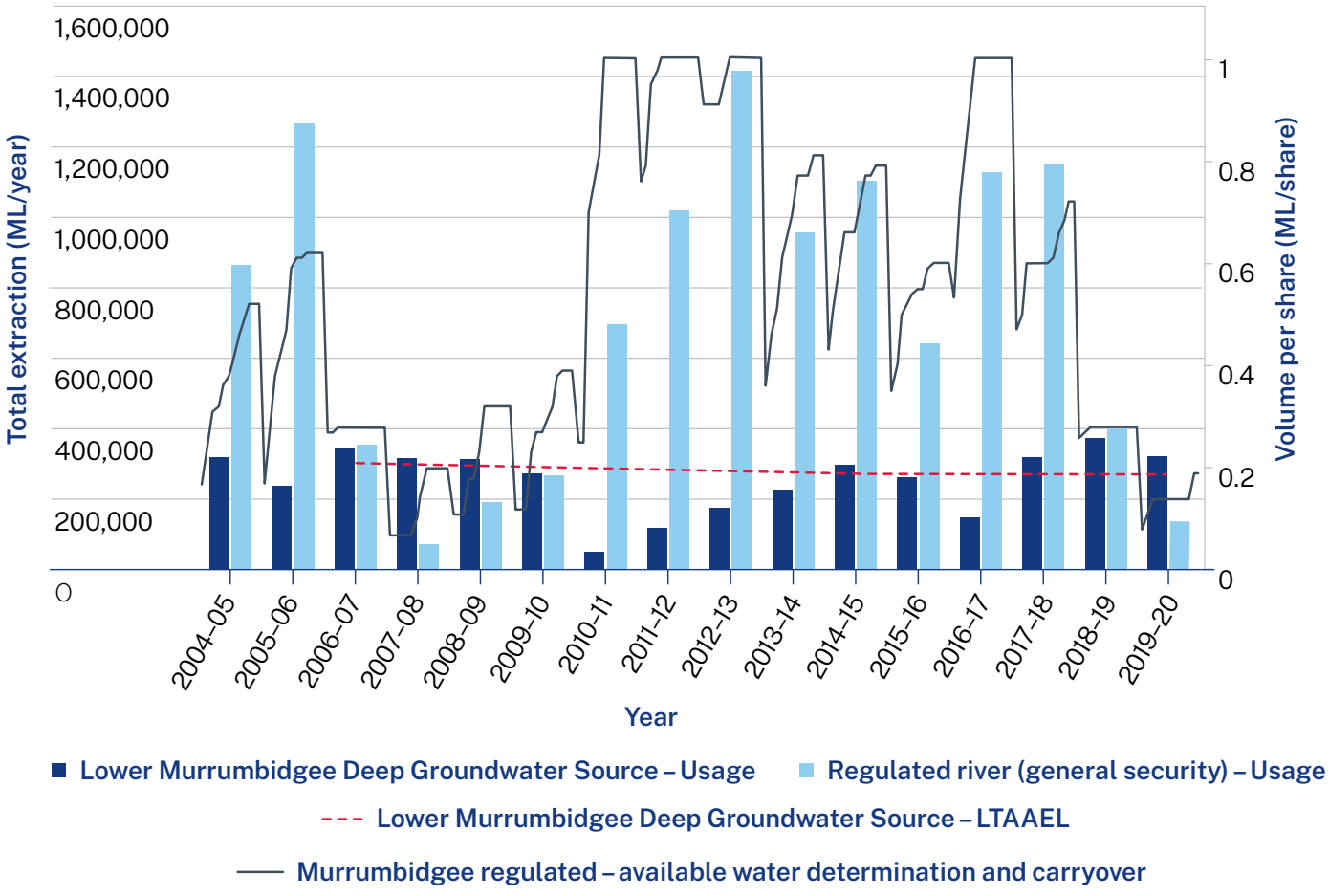
Figure 15. Hydrograph of monitoring bore GW030031 (Wagga Wagga Alluival)



Enhancing our understanding of the interaction between surface water and groundwater across the region will improve the management of these resources. The annual usage and surface water allocation for the Murrumbidgee Regulated River general security and Lower Murrumbidgee Deep Groundwater Source highlights how groundwater use can fluctuate from year to year and is often linked to climate conditions and the availability of surface water (Figure 16). Under the dry future climate scenario, lower surface water availability could increase the reliance on groundwater sources. Increased reliance on groundwater, particularly in areas of concentrated extraction could reduce groundwater access and constrain economic growth.

Image courtesy of James Maguire, NSW Department of Climate Change, Energy, the Environment and Water. Piggery Lake, NSW.

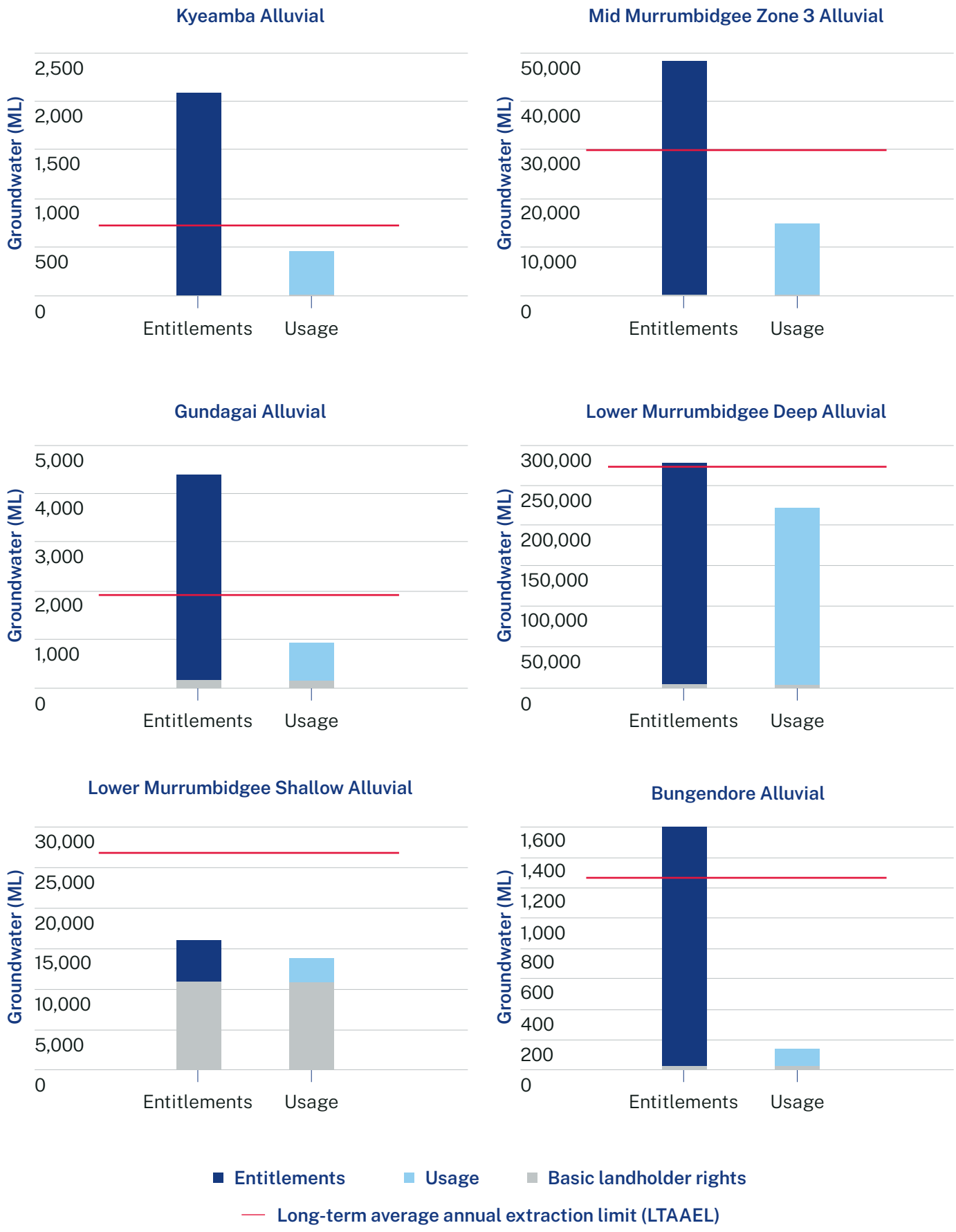
Figure 16. Comparison of surface water and groundwater usage in the Murrumbidgee region



During drought, demand for and pressure on the Murrumbidgee region's fully allocated alluvial groundwater sources (Figure 17) increases as groundwater is often used to supplement or replace surface water sources. Although knowledge of groundwater sources in the Murrumbidgee has improved, understanding future risks to groundwater systems under different climate projections and population growth scenarios is vital to support industries, ecosystems and towns.

Image courtesy of James Maguire, NSW Department of Climate Change, Energy, the Environment and Water. Tala Lake, NSW.

Figure 17. Average level of use and commitment (2015–2023) of alluvial aquifers in the Murrumbidgee region



Groundwater knowledge is built over years from investigation, research, metering and monitoring bore data and groundwater models. But the limited number of monitoring sites (compared to surface water) and the inherent complexity of the subsurface environment mean that there are gaps in our knowledge of groundwater.

The NSW Government has invested in monitoring and understanding groundwater systems over many decades.[64] However, these systems change over time in response to changes in groundwater use and the climate. Groundwater levels fall and recover seasonally with annual pumping cycles and over multi-year periods where they decline in dry years and recover in wet years. Groundwater models can be used to assess the long-term (decadal and multidecadal) trends in aquifer behaviour accounting for the impact of water extraction.

The models simulate the behaviour of aquifers over time, including recharge, contamination plumes, the movement of water and the take of water through bores and are needed for defining long-term sustainable levels of extraction for future reviews of water sharing plans. Continuing to invest in monitoring and updating of groundwater system models will need to be a priority.

There are also groundwater quality risks (Table 5) in the Murrumbidgee region. The groundwater quality in the alluvial aquifers in Murrumbidgee region is variable. The Shallow Groundwater Source experienced rising groundwater levels causing waterlogging and salinity in the past within the Coleambally and Murrumbidgee Irrigation areas. There is potential for this to occur in the future if not managed appropriately. Pollution from different land uses is an emerging threat to these systems and the ecosystems they support and better understanding of these changes and threats is needed to protect and manage the resource for the future.

Table 5 summarises challenges in each groundwater source and their related areas.

Image courtesy of James Maguire, NSW Department of Climate Change, Energy, the Environment and Water. Narockwell Rookery, NSW.

64. Read more about groundwater science undertaken by the NSW Government at: water.dpie.nsw.gov.au/our-work/science-data-and-modelling/groundwater-management-and-science

Table 5. Challenges in each groundwater source

Groundwater source	Challenges	Areas/towns affected/related
Mid Murrumbidgee groundwater sources (Gundagai Alluvial, Kyeamba Alluvial, Mid Murrumbidgee Zone 3 Alluvial & Wagga Wagga Alluvial)	Contamination of groundwater (such as PFAS in Wagga Wagga Alluvial Groundwater Source) Increased demand for town water supply	
Bungendore	Salinity issues	Bungendore, stock and domestic uses, and irrigation
Lower Murrumbidgee (Shallow)	Variable salinity both vertically and laterally	
Lower Murrumbidgee (Deep)	Variable salinity both vertically and laterally Requires treatment of manganese and Iron for town water supplies Large seasonal drawdowns	East of Hay Generally unsuitable for irrigation west of Hay
Lachlan Fold Belt	Relatively limited with some areas of intense groundwater utilisation due to locally favourable groundwater availability and water quality Presence of GDEs	
Yass Catchment	Significant levels of utilisation in the past. Bores with low yields	Yass Catchment Rural subdivisions within commuting distance of Canberra

To address these challenges in the Murrumbidgee region, the following actions are proposed:

- proposed action 1.1: Improve understanding and management of groundwater sources. See page 75.
- proposed action 2.5: Continue to invest in modelling to improve groundwater knowledge in the Murrumbidgee region. See page 88.
- proposed action 3.2: Reduce uncertainty in groundwater security for regional towns and industry. See page 97.

Predicting and managing floods is difficult

Floods are a vital natural process that support the region's ecosystems, providing benefits such as groundwater recharge, lateral connections between rivers, wetlands and floodplains, nutrient and carbon exchanges, and breeding cues for wildlife. They also fill our dams. Floods are also responsible for the productive soils valued by landholders on the Murrumbidgee's floodplains.

In the Murrumbidgee region, the flat landscape at the western end of the region can experience significant flooding. The construction of Burrinjuck Dam from 1907 has reduced flooding but, despite the dam (last raised in 1995) there have been major floods in 2012 and 2022.

Burrinjuck Dam provides a high degree of flood protection to downstream communities when the storage is low. However, in wetter years when dam levels reach full supply there is very limited capacity to mitigate flood events as the dam cannot store water above the Full Supply Level. Floodwaters entering from upstream must therefore be released with only limited reduction in flood peak heights. This can make it difficult to manage floods and has potentially significant impacts to people and businesses by creating risks to safety and well-being, disrupting communities, damaging infrastructure, and causing major financial and economic losses.

To address these challenges in the Murrumbidgee region, the following actions are proposed:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data. See page 75.
- proposed action 2.4: Support the development and implementation of Murrumbidgee and Billabong Creek Floodplain Management Plans and address floodplain structures. See page 87.

Image courtesy of Museum of Riverina, Wagga Wagga City Council. Flooding at Wagga Wagga, NSW.

Drought and flood risk mitigation planning roles and responsibilities

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

Drought mitigation planning

Under the Regulatory and Assurance Framework for local water utilities, local water utilities (LWUs) must demonstrate that their local strategic water planning addresses water security, including drought planning. The NSW Department of Climate Change, Energy, the Environment and Water supports local councils to undertake this strategic planning, including guidance to LWUs to assist them to achieve this.

Flood mitigation planning

The MDBA and state governments manage major storages in the River Murray system, with the aim to making sure dam structures remain safe during floods.

WaterNSW operates state-owned dams during a flood event in line with the *WaterNSW Act 2014*, its operating licence and the Water Sharing Plan/works approvals that outline how dams are operated during floods, along with airspace operation rules. Snowy Hydro also plays a role in dam operation during floods through the Blowering Airspace Deed.

The department's Biodiversity, Conservation and Science group is primarily responsible for providing flood risk management advice to government and supporting local councils to meet their flood risk management planning responsibilities for urban communities. These activities are undertaken in line with the NSW Flood Prone Land policy and the NSW Flood Risk Management manual and its supporting toolkit, and the Floodplain Management Program.

The department's Water group is responsible for the development, review and replacement of rural floodplain management plans under the *Water Management Act 2000*. These plans coordinate development on declared floodplains by establishing management zones and setting clear and consistent rules and assessment criteria for each zone. The plans also identify and protect flood-dependent ecological and cultural assets and identify risks to life and property from the effects of flooding. Work is underway to replace the historical floodplain management plans in the Murrumbidgee region with 2 floodplain management plans and associated declared floodplains. This work is anticipated to be completed by 2025.

The NSW Reconstruction Authority is currently developing a State disaster mitigation plan and supporting local councils to undertake local and regional disaster planning. The State disaster mitigation plan will:

- identify potential strategies and actions for reducing the impact of disasters
- assess and consider the impacts of climate change on disasters
- determine priority projects for regions to mitigate the impact of disasters.

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

Other disaster planning and response roles

Under the *State Emergency and Rescue Management Act 1989* and *NSW State Emergency Service Act 1989*, the NSW State Emergency Service is the emergency management lead agency.

Under the *NSW Reconstruction Authority Act 2022*, the NSW Reconstruction Authority is also responsible for reconstruction and recovery following disasters and other emergencies, including:

- facilitating, coordinating and directing the recovery, planning and rebuilding of affected communities, including repairing and rebuilding land and infrastructure and other development
- balancing constraints to enable a focused, timely and expedited recovery of affected communities.

The department's Water group plays a support role during emergency incidents including drought and flooding, by providing technical assistance and advice regarding emergency water security options or damaged local water infrastructure.

Other State agencies administer various funding and support programs to assist councils with disaster planning (such as the Regional Drought Resilience Planning Program administered by Regional NSW).

Addressing the challenges

4

Image courtesy of Gavin Hansford, NSW Department of Climate Change, Energy, the Environment and Water. Murrumbidgee Valley National Park, NSW.

To address the challenges in the Murrumbidgee region, the draft Regional Water Strategy identifies 4 regional priorities and proposes actions for each priority.

The regional priorities are:

1. Continue to improve water management
2. Improve river and catchment health
3. Support sustainable economies and communities
4. Sustainable water management in the upper Murrumbidgee catchment.

These priorities and proposed actions aim to improve the Murrumbidgee region's readiness to adapt to a more variable climate and support the difficult decisions needed to deliver healthy, reliable and resilient water resources for the region's future.

Image courtesy of Destination NSW. Leeton Township, NSW.

Priority 1

Continue to improve water management

Effective water resource management in the Murrumbidgee region requires a holistic and integrated evidence-based approach, involving the cooperation of various stakeholders, government bodies, and the community. Regular reviews and the flexibility to adjust management strategies to respond to evolving conditions are essential for long-term sustainability.

Continual improvement in management of water resources is required in the region to maintain ecosystem health, support agriculture and other industries, preserve cultural values, and to safeguard the well-being of communities that rely on the river.

Proposed actions under this priority focus on:

- continuing to incorporate best available evidence and climate data into the water management framework
- improving the way water and land planning processes are integrated
- fostering collaboration with Aboriginal groups.

The success of these actions will require working collaboratively with large water users in the region and updating rules based on the best available science and operational knowledge.

What is already happening

The NSW Government is investing in several initiatives to improve the management of both surface water and groundwater.

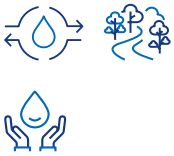
The **NSW Water Strategy** includes actions to improve water management, such as action 4.2 to review water allocation and water sharing in response to new climate information and action 4.4 to better integrate land use planning and water management.

The **NSW Aboriginal Water Strategy** will identify a program of measures to deliver on First Nation's water rights and interests in water management and is being developed with Aboriginal people and communities.

The NSW Government has developed a statewide **Groundwater Strategy** that identifies the key risks to our groundwater resources and the associated management challenges for NSW. The strategy sets out the actions required to respond to these challenges and provides a logical framework for funding of groundwater management reform work over the next 20 years.

Legend			
 Balancing competing interests for water	 Improving the health and resilience of ecosystems	 Addressing barriers to Aboriginal people's water rights	 Supporting existing and emerging industries and livelihoods

Table 6. Overview of proposed actions for Priority 1 – Continue to improve water management

Proposed action	Summary	Challenges addressed
Action 1.1 Improve understanding and management of groundwater sources	Improve water management by: • better understanding the water requirements of and potential risks to groundwater-dependent ecosystems • updating the approach to reviewing extraction limits • preparing a framework to act on declining groundwater levels • developing a regional water quality monitoring program.	
Action 1.2 Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data	The water sharing plans covering the Murrumbidgee region are due for renewal in 2025, 2026 and 2030. This provides an opportunity for new climate data to be considered in the reviews of these plans. This will allow a review of the drought rules, further investigate conversion of small portions of general security entitlements to high security and aspects of the surface water allocation and trading framework, as well as testing the adequacy of current flood operation rules.	
Action 1.3 Build climate evidence base for the next Snowy Water Licence Review	A detailed review of this licence will commence in 2027. This provides the opportunity to include varying climate change scenarios into an agreed inter-jurisdictional model package that could be the main source for testing changes to the Snowy Water Licence, water management policy and operational rules relating to the Snowy Hydro system.	
Action 1.4 Foster ongoing arrangements for participation of local Aboriginal people in water management	Support the Regional Aboriginal Water Committee in the Murrumbidgee region to ensure continued involvement in water management activities and decision making.	
Action 1.5 Improve consideration of water in strategic planning processes	Work across government to better integrate future strategic land use and water planning so that water resources can be considered upfront in future land use planning processes. This action would also consider projected population and industry growth trends and identify water-related gaps in the current land use planning framework in the Murrumbidgee region.	

Proposed action 1.1: Improve understanding and management of groundwater sources

Over the decades, the NSW Government has invested in improving understanding and management of groundwater systems.[65] However, these systems change over time in response to changes in groundwater use and the climate. There are also emerging threats to these systems and the ecosystems they support, such as pollution from different land uses.

These changes and threats need to be better understood to adapt groundwater management frameworks to protect and manage this valuable resource for the future. Continuing to invest in groundwater science and increasing knowledge of groundwater sources and their dependent ecosystems, water quality and changes to aquifers is critical to future management of this important resource.

This action could address and build upon the priorities and actions outlined in the NSW Groundwater Strategy including:

- developing and implementing an updated and adaptive approach to reviewing extraction limits for high- priority groundwater sources to ensure sustainable access to groundwater by consumptive users and the environment under a changing climate
- developing a groundwater level management framework with actions to manage any local water level decline (identified through water level and quality parameters) to provide sustainable access to groundwater by users and the environment
- developing and implementing an approach that provides clarity on the management of groundwater sources where the total entitlement is greater than the long-term average annual extraction limit
- continue to undertake research to better understand water requirements and the potential risks to groundwater-dependent ecosystems to inform management decisions
- developing a regional water quality monitoring program.

Filling these gaps in knowledge of groundwater systems would provide important information for groundwater system models and inform reviews of water sharing plans, water licensing and approval decisions, and land management.

Proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data

Current water sharing arrangements are based on the last 120 to 125 years of recorded data. This limits the understanding of how vulnerable the region could be to the climate variability experienced prior to when records began, or to future extreme wet and dry events under climate change.

The development of new climate data and modelling allows the NSW Government to update regulatory frameworks to be more responsive to a range of current and future climate conditions.

Understanding of the drivers of our current climate has increased over recent years. There is the opportunity to incorporate this knowledge into the way water is managed. A key element is incorporating this information into the review of the region's water sharing plans to improve the way the system is managed. This could support the refinement of current rules or the development of new rules to improve how the impacts of drought or the benefits of 'wet' years are handled. This may also support improvements in how water is shared, leading to greater certainty for water users.

The unregulated and regulated water sharing plans of the Murrumbidgee region are due for renewal in 2025 and 2026 respectively. This provides an opportunity to consider the new climate data in these reviews. The various groundwater water sharing plans covering the Murrumbidgee region are due for replacement in 2030 and the new climate data could be incorporated into these plans as well.

Using the new climate data set, this action would:

- review and update water sharing plans for the Murrumbidgee region
- review aspects of the surface water allocation framework to improve adaptability to climate variability including for 'wet', 'moderate' and 'dry' periods, discourage water over-ordering and cancelling orders at short notice, better facilitate trade, enhance understanding of future transmission and evaporation losses, further investigate conversion of small portions of general security entitlements to high security, investigate changes to carryover and identify opportunities to further improve transparency
- explore alternative mechanisms such as conversion factors for water trades (for example, a study to quantify volumetric impacts of trading water downstream)
- test the adequacy of current flood operation rules under different climate scenarios.

65. Read more about groundwater science undertaken by the NSW Government here: water.dpie.nsw.gov.au/our-work/science-data-and-modelling/groundwater-management-and-science

Proposed action 1.3: Build climate evidence base for the next Snowy Water Licence Review

Regulation of the Snowy Water Licence is legislated under the *Snowy Hydro Corporatisation Act 2002* and operated through the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) and licence. A review of the licence is undertaken every 10 years. A detailed review of the Snowy Water Licence will commence in 2027.

River system models have been integrated as part of the development of the draft Murrumbidgee and NSW Murray regional water strategies and further refined through the Snowy Water Licence Review Implementation Program. The work done to date is significant because it provides the first evidence-based climate tool to support decisions around the Snowy Water Licence.

However, for the licence review, the model requires further work to include varying climate change scenarios to understand the implications of a potentially drying climate. This would involve the development of inter-jurisdictional data sharing arrangements on model inputs and further model refinements to more accurately reflect current and expected future Snowy Scheme infrastructure and operations, observed conditions and better address uncertainty. For example, this work would result in an agreed inter-jurisdictional model package that could be the main source for testing changes to the Snowy Water Licence, water management policy and operational rules relating to the Snowy Scheme and downstream receiving river systems. This would include testing how climate change impacts water availability to the environment and downstream water users under different rules, policies or operational scenarios.

Proposed action 1.4: Foster ongoing arrangements for participation of local Aboriginal people in water management

Water is sacred to Aboriginal people. We know from years of discussions with Elders and other representatives that they need to have more of a say in guiding water planning, so their rights and cultural values are considered at the local level. The first step in improving Aboriginal people's involvement in water management is an effective governance, engagement and knowledge sharing arrangement. To be successful, the makeup and function of representative groups need to be determined and led by local communities.

The NSW Government established a Regional Aboriginal Water Committee in the Murrumbidgee region in 2023 to involve Aboriginal people in water management activities and decision-making.

One of the first roles of the committee is to contribute to the development of the NSW Aboriginal Water Strategy.

Other roles of the committee are to:

- empower Aboriginal communities to participate in water programs
- build new relationships across water
- ensure Aboriginal rights and values are considered in water planning, programs and projects
- enable exchange of water knowledge in regional communities
- assist departmental staff to identify those key stakeholders from a local Aboriginal community who should be engaged and consulted where required
- share appropriate knowledge to benefit water management
- work in partnership with the department and other water agencies to contribute to water policy review and development.

The committee will operate until 30 June 2025, with further funding needed for ongoing arrangements into the future.

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

Proposed action 1.5: Improve consideration of water in strategic planning processes

Water resources are not always considered upfront in broader strategic land planning processes. This can create inefficiencies and challenges around capitalising on the broader regional opportunities created by these processes and associated new investment. Poor coordination between strategic land and water planning can also impact existing water users and the environment and can lead to population and industry growth in areas with pre-existing water availability constraints. This can increase pressures on already stressed surface and groundwater resources.

There are opportunities to better integrate water resources in strategic planning processes that will also help to more closely integrate future iterations of the regional (land use) plans (draft South-East and Tablelands, draft Far West and Riverina Murray regional plans)[66] and future iterations of the regional water strategies.

During consultation we heard broad support for progressing this action, which has implications for both of urban and rural developments. There was also a suggestion to foster partnerships between government, stakeholders and communities, including inter-jurisdictional relationships to support better integration of these planning processes.

This action would:

- assess population growth trends and regional and local development trends, to identify spatial changes in water demand, growth in town water needs and sources of potential future flood risks – such as new developments
- discuss if and how to make decisions on which areas of the region should be elevated regarding water security risk due to being planned strategic growth areas or having a concentration of particular industries
- identify any water-related gaps in the current land use planning framework and assess the adequacy of the current land use planning controls to protect water resources, riverfront and riverine land uses
- assess current land uses and land use trends in the Murrumbidgee region to help identify spatial changes in industry water demand and identify potential sources of point and non-point source pollution risks
- review opportunities to disseminate information effectively to developers and councils about water availability and water quality in their areas and any known or identified risks to water resources, waterways and riparian corridors
- enable County Councils to be included in the development planning approval process as a service/utility provider so that they can respond appropriately to development applications
- conduct a long-term study of the impacts of climate variability and climate change on future water availability (both surface water and groundwater) to determine the impacts on water dependent industries in the Murrumbidgee region (both primary and secondary) – including those reliant on NSW town water supply systems. This study would make use of the new climate data and updated modelling.

Note that the regional water strategies are not proposing to prohibit particular land uses in NSW regional areas. Land use planning will continue to be managed under the *Environmental Planning and Assessment Act 1979 (EP&A Act)*.

66. For more information about the regional plans visit: www.planning.nsw.gov.au/plans-for-your-area/regional-plans

Impacts of historical mines on water quality

During the first public exhibition of the draft Murrumbidgee Regional Water Strategy, feedback was received about potential water quality impacts from historical mining operations near the Molonglo River.

Mining operations are regulated in NSW to ensure minimum impacts to land, waterways and aquifers[67] and all mining proposals are subject to the NSW Development Assessment.[68] Mines are required to close in a safe, stable, non-polluting way to ensure sustainable future land uses. However, in the past, different standards, regulations and community expectations have given rise to legacy mines that do not meet current standards. To address this, the Legacy Mines Program[69] focuses on public safety and improving the environment through remediation of historic and abandoned mines.

The Captains Flat (Lake George) Mine site is being rehabilitated under the Legacy Mines Program, with major soil remediation beginning soon. Studies are being undertaken into the feasibility of treating residual acid mine drainage and heavy metals, including zinc, seeping from the site to the Molonglo River.

Land uses and the *Environmental Planning and Assessment Act 1979*

The main statute governing land use planning in NSW is the *EP&A Act*. Other relevant legislation that affects land use includes the *Local Government Act 1993*, *Crown Land Management Act 2016*, *Aboriginal Land Rights Act 1983 (ALR Act)*, *Mining Act 1992*, *Biodiversity Conservation Act 2016 (BC Act)* and *Water Management Act 2000*. Federal statutes, such as the *Water Act 2007* and the *Environmental Protection and Biodiversity Conservation Act 1999*, also affect land use outcomes in the region.

Under the *EP&A Act* strategic planning occurs at the state, regional and local levels. Planning at the local level is primarily the responsibility of councils, while the NSW Government is responsible for ensuring that NSW's goals are achieved at the regional level, in partnership with councils.

In 2015, the *EP&A Act* was amended to legally require the preparation of regional plans, set out what the plans need to address and provide for their regular review.

Prior to the release of regional plans in 2017, there was no regional level framework for strategic planning. Since then, the strategic planning framework has been strengthened at the local level with the preparation of local strategic planning statements, which provide an opportunity for a council to set out the strategic vision for the future of the local government area. Each council in the Murrumbidgee region has a local strategic planning statement and a requirement to review the statement at regular intervals.

67. Department of Regional NSW. Mining, Exploration and Geoscience Compliance and Reporting, at www.regional.nsw.gov.au/meg/exploring-and-mining/compliance-and-reporting
68. The state policy that governs how mining, petroleum production and extractive material resource proposals are assessed and developed in NSW is Chapter 2 of the State Environmental Planning Policy (Resources and Energy) 2021 which can be found here: www.legislation.nsw.gov.au/view/html/inforce/current/epi-2021-0731#ch.2
69. Further information on the Legacy Mines program can be found at www.resourcesregulator.nsw.gov.au/rehabilitation/legacy-mines-program

Priority 2

Improve river and catchment health

Improving river and catchment health brings a range of benefits. It enhances water availability by promoting groundwater recharge, attenuating floods and maintaining base stream flows, promotes good water quality and supports biodiversity, cultural values and recreational opportunities.

To improve catchment health our management systems and decision-making processes need to use a holistic, whole-of-catchment approach.

Actions proposed under this priority focus on:

- coordinating efforts across stakeholder groups and supporting landholders to build awareness and capacity for best practice natural resource management and sustainable agriculture
- improving water resource health through better land management that considers Aboriginal knowledge and culture, to benefit users at local, whole-of-catchment and regional scale
- limiting or removing pressures and impacts directly related to water infrastructure.

What is already happening

The ***Murrumbidgee Long-Term Water Plan***[70] has been developed to describe flow regimes that are projected to maintain or improve environmental outcomes in the region. It identifies water management strategies for maintaining and improving the long-term health of the Murrumbidgee region's riverine and floodplain environmental assets and the ecosystem functions they perform. The **NSW Water Strategy** includes a commitment to consider long-term water plans to protect and enhance ecological systems.

The **Upper Murrumbidgee Catchment Network** (UMCN) addresses natural resource management issues including salinity, weed control, algal infestation of waterways and loss of natural vegetation.

The Natural Resource Commission is currently undertaking an independent review of the *Water Sharing Plan for the for the Murrumbidgee Regulated River Water Source 2016*.[71] This review will help identify opportunities to improve water sharing provisions and associated outcomes.

The **Protecting Our Places Grants Program**[72] encourages and empowers Aboriginal communities to protect, conserve and restore landscapes and waterways that are important to them to achieve long-term beneficial outcomes for the environment.

Implementing recommendations from the first 10-Year Snowy Water Licence Review has involved development of an integrated water model of the Snowy, Murray and Murrumbidgee systems and exploring improvements to the delivery of environmental flows through the Snowy River Increased Flows program. The next Snowy Water Licence Review, due to commence in 2027, will focus on a range of administrative and technical issues including exploring better ways to deliver environmental flows.

Recently, the *Water Amendment (Restoring Our Rivers) Act 2023*, was passed. This provides increased funding and an extension of two and a half years to complete delivery of several SDLAM projects.

70. More information on long-term water plans is available at: www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/all-long-term-water-plans
71. More information on water sharing plan reviews is available at: www.nrc.nsw.gov.au/water/wsp-reviews/schedule
72. More information on the Protecting Our Places Grants Program is available at: www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/grants-available/protecting-our-places

What is already happening

The **River Works Program**[73] includes local projects addressing erosion control and stream channel revegetation and activities by organisations such as local Landcare groups to remove riparian weeds removal, stream bank stabilisation and promoted 'waterway friendly' farming practices.[74] The program focuses on bank stability and maintenance of channel capacity in the reaches of the Tumut River.

The Australian Government committed $15.2 million to investigate and identify a safe, effective and integrated range of measures to control carp populations in Australia. $10.4 million was allocated to the Fisheries Research and Development Corporation to undertake a feasibility assessment, referred to as the **National Carp Control Plan**.

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

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

The NSW Government and other local organisations are delivering programs that support the adoption of best practice land management by local landholders to improve productivity and reduce land and water degradation. These programs include:

- restoration of riparian habitat for targeted species
- irrigation audits
- guidelines for fertiliser application
- improved management of farm runoff and water quality
- adaptive farms for sustainable landscapes
- improved capacity to prepare and recover from droughts and bushfires
- community engagement and extension to consolidate and increase awareness of natural values
- control of weeds and pest animals.

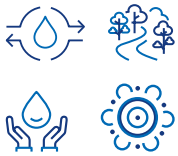
Landcare groups and the Local Land Services are focusing on projects involving riparian areas or land degradation, including the **Refreshing Rivers Program**, which is a 10-year project aiming to improve waterway health across the Murray–Riverina region by encouraging the adoption of river-friendly land management practices. This includes the development of waterway management plans that are tied to social/cultural, environmental, and economic outcomes.

Extension services are also provided by the Natural Resource Access Regulator (NRAR) to help landholders, agricultural producers, irrigators and others understand water laws and their environmental responsibilities.

73. water.dpie.nsw.gov.au/our-work/water-infrastructure-nsw/regional-projects/river-murray-joint-programs
74. For example, see: www.holbrooklandcare.org.au/projects/refreshing-the-upper-billabong/ and www.uppersnowylandcare.org.au/

Legend			
 Balancing competing interests for water	 Improving the health and resilience of ecosystems	 Addressing barriers to Aboriginal people's water rights	 Supporting existing and emerging industries and livelihoods

Table 7. Overview of proposed actions for Priority 2 – Improve river and catchment health

Proposed action	Summary	Challenges addressed
Action 2.1 Rehabilitate ecologically and culturally important sites within the mid and lower catchment	This action aims to improve habitat for native plants and animals and improve water quality, river health and ecosystem resilience in the regulated areas of the Murrumbidgee region.	
Action 2.2 Encourage partnerships with the irrigation sector for environmental water delivery to public and private lands	Governments, irrigation infrastructure operators, Aboriginal people and landholders working together through voluntary partnerships to deliver water for the environment to reach ecosystems on public and private lands.	
Action 2.3 Mitigate the impact of infrastructure on native fish	Progress work to seek the installation of fish passages at priority sites and build on existing government commitments to encourage and provide incentives for the installation of diversion screens at priority pumps sites. This action would also restore and restock degraded native fish habitats and explore solutions to address cold water pollution.	
Action 2.4 Support the development and implementation of Murrumbidgee and Billabong Creek Floodplain Management Plans and address floodplain structures	Support the development of valley-wide, connected floodplain management plans and address floodplain works and structures that adversely impact the environment and Aboriginal cultural assets and values.	
Action 2.5 Continue to invest in modelling to improve groundwater knowledge in the Murrumbidgee region	Continue to improve groundwater system models that underpin water management planning in the Murrumbidgee region. This would include developing multi-disciplinary models that incorporate socio-economic, physical and groundwater data.	

Proposed action	Summary	Challenges addressed
Action 2.6 Encourage best practice land management	Support private landholders to adopt best practice land management in priority waterways by offering resources, tools and advisory services in grazing, farming, erosion control, biodiversity and habitat restoration. This action would align with other catchment improvement initiatives focusing on catchments where river reaches have a high recovery potential or improvements are critical to achieving catchment health objectives.	
Action 2.7 Support place-based initiatives to deliver cultural outcomes for Aboriginal people	Support Aboriginal organisations and communities to develop tailored projects for their communities. This action would aim to move away from centralised decision-making and develop a flexible program that can be adapted and is driven by the principle of self-determination. It would include a demonstration river reach, programs to engage Aboriginal youth in water and landscape management, and improved access to sites of cultural significance.	
Action 2.8 Implement the Reconnecting River Country Program in the Murrumbidgee region	Removal of constraints to enable the flexible use of water for the environment to increase the frequency and extent rivers connect to their wetlands and floodplains.	

Image courtesy of Destination NSW. Murrumbidgee River Narrandera.

Proposed action 2.1: Rehabilitate ecological and culturally important sites within the mid and lower catchment

The mid and lower Murrumbidgee catchments of the Murrumbidgee region contain ecologically and culturally important sites.

The mid Murrumbidgee wetland is a network of riverine lagoons and billabong formations that occur along the river between Narrandera and Carrathool. These wetlands rarely dry out completely and provide drought refuge for a wide range of species including many listed as endangered or threatened. Fivebough Swamp and Tuckerbil Swamp are internationally Ramsar listed wetlands.

The Lower Murrumbidgee Floodplain (known as the Lowbidgee) provides a mosaic of aquatic habitats including in-channel habitat, swamps, lakes, lagoons and floodplains. It is located between Maude and Balranald, the floodplain covering an area of over 200km^2. The area has significant areas of national parks and irrigated and dryland agricultural industries. It includes the second largest red gum forest in Australia (along the river downstream of Redbank Weir) and significant black box, lignum and reed-bed communities. Griffith and Leeton are also located in the lower areas of the Murrumbidgee.

This action aims to rehabilitate regionally significant riparian, wetland and floodplain to improve habitat for native plants and animals and improve water quality throughout the river system.

It would complement previous environmental restoration initiatives by:

- exploring further opportunities for new or upgraded environmental watering works
- improving monitoring of ecological outcomes
- making changes to the funding model of NSW-held environmental water portfolios.

Potential examples include, but are not limited to:

- upgrading existing or installing new water delivery infrastructure (such as channels, levees, regulators, escapes and pumps) to provide water to wetlands
- upgrading existing infrastructure that restrict or no longer support flows to key sites (for example, road crossings, box culverts and bridges)[75]
- addressing the high nutrient loads from Muttama, Hillas, Adjungbilly, Yanco and Billabong Creek catchments and the Murrumbidgee River near Yanco
- reducing the high turbidity in Tarcutta, Yanco, Colombo and Billabong creeks and the Murrumbidgee River at Yanco, Carrathool and Balranald Weir
- mitigating high salinity, soil erosion and rising water tables in the mid-catchment tributaries of the Muttama, Kyeamba, Tarcutta and Jugiong Creeks[76]
- collaborating with Aboriginal people and communities to maintain and preserve water-related cultural sites and landscapes
- developing a system to prioritise areas to protect or rehabilitate – for example, based on detailed habitat mapping data, native fish conditions, threatened species distribution, the River Styles Framework, severity of land degradation and environmental management outcomes
- funding the management of the NSW-held environmental water portfolio from consolidated revenue, rather than having to rely on the sale of allocation to generate the required revenue
- review opportunities to reduce the reliance placed upon held environmental water portfolios to address water quality incidents, noting that this is not the role of held environmental water portfolios
- reviewing the effectiveness of previous measures to manage native species and mitigate invasive species, such as carp, to inform more effective long-term actions.

Note that these proposed projects are not able to be completed within the time available to be considered under the SDLAM (by 31 December 2026) and therefore will not be put forth for SDLAM consideration.

75. Some of this work would complement work proposed under the SDLAM program.
76. Salt mobilised from these streams during high flows contributes to increased salinity down the Murrumbidgee River. In addition, salinity from upper Billabong Creek has been managed by a salt interception scheme and ongoing operation of this scheme is under review – its potential decommissioning poses a risk to salt load export into the Edward River and the Murray River.

Proposed action 2.2: Encourage partnerships with the irrigation sector for environmental water delivery to public and private lands

Water for the environment is typically delivered to watercourses and wetlands situated on public lands such as nature reserves and national parks. However, partnerships between the irrigation industry and environmental water managers have also enabled the delivery of water for the environment to private lands.

For example, Murrumbidgee Irrigation has delivered over 11 GL of environmental water since 2015 including to Ramsar-listed sites within their delivery network. Coleambally Irrigation has undertaken 33 environmental watering deliveries over 13 sites since 2015. This includes areas of the Coleambally Irrigation Biodiversity Reserve to protect Superb Parrots, Southern Bell Frogs and Bunyip Birds.[77]

There is significant potential to expand on this by governments, irrigation infrastructure operators and land holders working together through voluntary partnerships. Outcomes achieved could be enhanced by complementary on-ground measures such as drawing upon First Nations and landholder knowledge and scientific research.

Modernised supply networks allow precise control and measurement of water. In turn, this will support the precise delivery of environmental water, which means that specific environmental outcomes and at-risk ecosystems can be targeted with accuracy and control. It will also help to demonstrate the full accountability and benefits of publicly held environmental water. Landholders and people within the community will be able to be actively involved in environmental management, creating a sense of ownership, collaboration and participation – key to rebuilding confidence in water management.

This action proposes to explore additional opportunities to deliver water to wetlands using irrigation networks through voluntary partnerships between land holders, irrigation infrastructure operators and governments, including integrating First Nations knowledge and scientific research.

Image courtesy of Destination NSW. Cattle, Murrumbidgee Shire.

77. www.nswic.org.au/media_release/nswic-game-changing-environmental-watering-now-on-un-watering-action-agenda/

Proposed action 2.3: Mitigate the impact of infrastructure on native fish

Many species of native fish need to move freely within and between rivers and waterways to source food, avoid predators and find shelter, escape the impacts of drought, and seasonally spawn, migrate and recruit. Improving conditions for native fish will increase their resilience and the resilience of all aquatic communities. Water infrastructure such as dams, weirs and pumps are impacting this movement by creating physical barriers, removing and killing juvenile fish, and creating conditions – for example, cold water – too far removed from a natural state.

Implementing the NSW Fish Passage Strategy

Priority 3 of the NSW Water Strategy includes an action to address threats to native fish through 3 state-wide, catchment scale initiatives: implementing the NSW Fish Passage Strategy; addressing cold water pollution through interventions such as temperature monitoring and mitigation technology; and investing in fish-friendly water extraction technology at priority sites in each region.

Improve fish passage at priority sites as guided by the NSW Fish Passage Strategy

Currently, native fish can only move freely through the Murrumbidgee system during high flows when water flows over weirs and other instream barriers. Removing barriers to fish movement and allowing fish to breed and find food and essential habitat is critical to supporting resilient native fish populations in the Murrumbidgee region.

The NSW Fish Passage Strategy outlined several priority sites for improving fish passage in the Murrumbidgee region. These include:

- Balranald Weir
- Redbank Weir
- Maude Weir
- Hay Weir
- Golgeldrie Weir
- Yanco Weir
- Berembed Weir
- Yanga Wetlands.

Implement diversion screens at priority pumps

Since European settlement, the Basin has undergone significant ecological decline. Native fish populations have declined dramatically, at least 26 of the 46 native fish species found here are now listed as rare or threatened, and many ecological processes have been interrupted. A key impact of irrigation in the Basin is the entrainment, injury and/or death of tens of millions of native fish annually – estimated at 3.5 native fish per ML of water extracted.[78]

In NSW alone, over 4,500 water pumps are operated for irrigation. In the Murrumbidgee River, the total take by irrigated agriculture in 2020–2021[79] was 2,207.44 GL, potentially impacting over 7.76 million native fish in this time. Almost all of this take is either unscreened or infrastructure use outdated 'trash racks', which provide limited or no protection for native fish and burden farmers with unnecessary maintenance expenses caused by incoming debris (over $500,000 annually in some cases).

Modern fish-protection screens are automated, self-cleaning technologies that keep fish and debris in natural waterways and out of irrigation infrastructure. The screens work by reducing the velocity of water entering a pump intake, without reducing the volume of water that can be extracted. The technology is proven to work and is available for any type of water diversion, of any size. In NSW, 25 modern screens have been installed to date with 42 more with manufacture underway and scheduled to be installed by 2025.

Modern fish-protection screens can maximise the benefits of the Murray–Darling Basin Plan (the Basin Plan), by reallocating water from agriculture to the environment. The technology protects 90% of native fish that would otherwise be entrained, and effectively eliminates the impacts of debris on water infrastructure. The installation of screens reduces point-source mortality of native fish and helps stimulate widespread adoption of this best practice by irrigators, delivering significant and enduring ecological, economic, social and cultural benefits.

This action would build on existing government commitments that continue to encourage and provide incentives for installing of diversion screens at priority pump sites in the Murrumbidgee region.

78. Boys et al 2021, Native Fish losses due to water extraction in Australian rivers: Evidence, impacts and a solution in modern fish and farm friendly screens, Ecological Management and Restoration, Vol 22, Issue 2.
79. Murray–Darling Basin Authority (2022). *Annual Water Take Report 2020–2021*. MDBA, Canberra. Available at: www.mdba.gov.au/sites/default/files/publications/annual-water-take-report-2020-21.pdf

Restore priority habitats of threatened fish species

Reduced and degraded habitat for native fish in the Murrumbidgee region has led to many species becoming threatened or locally extinct. Restoring habitats can improve the resilience of native fish, which would lead to overall improvements in river function such as the restoration of complex food webs and enhanced water quality.

In some areas, native fish species are locally extinct. Once habitats have been restored, a conservation restocking program would be required for some species in some areas.

In collaboration with existing initiatives, this action would seek to restore habitats in the following areas:

- Adjungbilly Creek and Tantangara Creek
- unregulated Tantangara Creek
- mid-Murrumbidgee between Gundagai and Narrandera
- mid-Murrumbidgee wetlands, Coppabella Creek, Billabong Creek.

Progress cold water pollution mitigation

Cold water pollution has damaging impacts on riverine ecological function, particularly in summer when biological cues such as fish spawning are disrupted. Water releases from Blowering and Burrinjuck dams have high potential for causing severe cold water pollution because they draw water from relatively deep levels in the storages and release large volumes of water during summer. The combined cold water pollution effects of both dams persist for up to 200 to 300 km downstream of the Tumut-Murrumbidgee River confluence. WaterNSW is undertaking a study for Blowering Dam[80] to investigate and assess options to mitigate or reduce the potential environmental and ecological impacts of cold water releases downstream of these dams.

While variable-level offtakes can be operated to reduce cold water pollution risks, in warmer months, the presence of potentially toxic surface algae often means that it is not possible to use the variable-level offtake to take warmer surface water. As it is not currently possible to remove the risk of algal blooms in these dams, additional actions to manage cold water pollution need to be taken.

Through this action, WaterNSW and the Department of Regional NSW would continue to:

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

80. The Cold Water Pollution Mitigation Options Study (CWPMOS) for Blowering, Copeton and Keepit Dams is under development.

Proposed action 2.4: Support the development and implementation of Murrumbidgee and Billabong Creek Floodplain Management Plans and address floodplain structures

During the first public exhibition of the draft Murrumbidgee Regional Water Strategy, stakeholders raised concerns about existing structures on floodplains in the Murrumbidgee region and their impact on the environment and Aboriginal cultural assets and values. We also heard concerns about the increased risk to life and property from existing and new structures on floodplains following the recent flooding in the region.

In 2021, the department's Water group completed a review under section 43 of the *Water Management Act 2000* and is currently progressing the replacement of the 3 localised floodplain management plans (FMPs) – 2 local government-based FMPs and 1 declared FMP – for the Murrumbidgee region with 2 valley-wide FMPs and associated declared floodplains.[81]

A whole-of-valley approach to floodplain management will benefit some of the Murrumbidgee region's most critical wetlands that are located at the end of the regulated system and ensure healthy floodplains that support healthy catchments.

As part of developing the Murrumbidgee and Billabong creek FMPs the department would:

- develop new hydraulic models
- identify existing flood works (approved and unapproved)
- identify flood dependent ecological assets and Aboriginal cultural assets and values.

In addition to supporting the development and implementation of the Murrumbidgee and Billabong Creek FMPs, this action would address existing structures on floodplains that adversely impact the environment and Aboriginal cultural assets and values and increase the risk to life and property. Progressing this action would require:

- working with NRAR and WaterNSW to bring unapproved or non-compliant structures on floodplains into compliance
- considering options to accelerate this process in the Murrumbidgee region. This could include rolling out a program like the Improving Floodplain Connections Program[82] for the region.

81. More information is available on the replacement floodplain management plans at: water.dpie.nsw.gov.au/our-work/floodplain-management/plans/southern-floodplain-management-plans
82. The Improving Floodplain Connections Program is currently being delivered in the Northern Basin. More information can be found at this website: www.industry.nsw.gov.au/water/plans-programs/healthy-floodplains-project/improving-floodplain-connections

Proposed action 2.5: Continue to invest in modelling to improve groundwater knowledge in the Murrumbidgee region

The NSW Government uses computer-based water system models to inform many decisions in regional water management. Groundwater system models simulate the behaviour of aquifers over time, including groundwater recharge and the take of water from bores. They help analyse seasonal patterns and longer-term trends in groundwater levels. Models also help to understand the potential risks to groundwater dependent ecosystems and to groundwater quality.

Groundwater models can also:

- provide regional information to support local water utilities in planning for future water supply
- provide a better understanding of the impacts of groundwater extraction on other users of a groundwater source to improve the assessment of licence applications
- help to understand the potential risks to groundwater-dependent ecosystems and to water quality
- incorporate new understanding on interconnectivity between surface water and groundwater
- integrate socio-economic and physical data
- consider the potential impacts of climate change and how that will influence the behaviour of groundwater resources into the future.

Continuing to improve these models as new data becomes available will be particularly important for managing and sharing limited water resources and predicting and mitigating the impacts of increasingly variable and extreme conditions in the Murrumbidgee region.

To progress this action, the department would:

- update, calibrate and peer review numerical groundwater models for the Murrumbidgee region
- upgrade and expand the monitoring bore network to fill in data gaps that are essential for improving our models. Additional and replacement monitoring bores are critical to ensure there is sufficient data to build and calibrate models
- incorporate shifts in demand and changes in rainfall patterns that are likely driven by climate variability
- incorporate new understanding on interconnectivity between surface water and groundwater
- develop multi-disciplinary models incorporating socio-economic and physical data, as well as groundwater volume, level and quality data
- develop approaches to help use the models to inform future water level and quality management practices.

Image courtesy of James Maguire, NSW Department of Climate Change, Energy, the Environment and Water.
Yarradda Lagoon, Murrumbidgee valley.

Proposed action 2.6: Encourage best practice land management

Best practice land management improves on-farm water balance and quality of water. This action would build on existing programs to support private landholders to adopt best practice land management in priority waterways across the region.

Landholders play a key role in improving ecosystems and habitats through best practice land management. Many landholders have adopted best practice land and water management in the Murrumbidgee region; however, we heard that some landholders need support in recognising potential improvements they could adopt in managing their land and water requirements. Furthermore, feedback received through recent water engagements with local landholders indicated some are frustrated with the lack of extension services available to help them understand the rules, obligations and opportunities for accessing and managing farm water needs.

Support for this action would be provided largely through natural resource management and sustainable agriculture advisory services and on-ground projects, with a focus on:

- stock grazing management
- carbon and regenerative farming
- soil disturbance and erosion management
- soil condition and ground cover management
- native vegetation and biodiversity management
- streambank and riparian vegetation protection and restoration
- structural instream habitat restoration works
- drainage and fertiliser use management.

A suite of fit-for-purpose tools would be used to build landholder capacity in knowledge, skills, access to networks and resources. These tools could include:

- one-on-one consultation sessions
- providing advice and referrals for information
- online resources including information webinars, podcasts and social media updates
- field days and demonstration sites
- identifying funding models including landholder incentives.

The delivery of this program would align with and complement the framework developed in proposed action 2.1 Rehabilitate ecological and culturally important sites within the mid and lower catchment and proposed action 4.2 Support (on-going) river restoration in the upper Murrumbidgee catchment. This would ensure that support for improvements in private landholder land and water management practice is directed to catchments where river reaches have a high recovery potential or improvements are critical to achieving key catchment health objectives. Implementation of this action could support existing programs and be delivered in partnership with other government agencies, as well as local Aboriginal and community groups.

Proposed action 2.7: Support place-based initiatives to deliver cultural outcomes for Aboriginal people

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

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

To progress this proposed action in the Murrumbidgee region:

- the Cultural Watering Plans project would be continued to include further communities in the region[83]
- access to Country would be improved, including to sites that have local significance. This could include opening up local parcels of public land that have access to waterways but are otherwise gated or locked – such as Travelling Stock Reserves or Crown roads
- a demonstration reach would be established, using cultural knowledge and science to rehabilitate riparian land, through planting of native species and caring for Country
- programs that engage Aboriginal youth in water and landscape management would be established, with the aim of building cultural awareness and giving a sense of ownership and cultural connectivity
- local programs that identify and record significant water-dependent sites in the Murrumbidgee valley would be established, with information stored in a culturally appropriate way.

Incorporating Aboriginal knowledge and culture into catchment management

As custodians of Australia's land and water for tens of thousands of years, Aboriginal people have developed a rich spiritual connection to Country and have a large body of culture and knowledge.

A more holistic approach to improving catchment health involves working collaboratively with Aboriginal people, drawing on their knowledge and experience, and integrating their perspectives, approaches and values into water and catchment management frameworks.

We need to develop whole-of-system governance structures that are supported and understood by Aboriginal people and to give Aboriginal people direct input to water management decision making. We also need to provide Aboriginal people with opportunities to manage water using their culture and knowledge and to create improved economic opportunities and environmental outcomes. Restoring degraded spiritual and cultural sites is also an important act of reconciliation.

NSW's obligation under the Basin Plan

The NSW Government has obligations for the development of water resource plans under Chapter 10, Part 14 of the Basin Plan. These plans must identify Aboriginal people's objectives and desired outcomes for managing water resources in each region. A requirement under the Basin Plan is ensuring there is adequate consultation with First Nations in developing water resource plans.

The objectives and outcomes as stated by the Aboriginal Nations in the Murrumbidgee water resource plans will be the basis for further initiatives focussed on considering and supporting Aboriginal people's objectives and outcomes in water resource management.

83. More information is available on Cultural Watering Plans at: water.dpie.nsw.gov.au/our-work/projects-and-programs/aboriginal-water-program/cultural-watering-plans

Proposed action 2.8: Implement the Reconnecting River Country Program in the Murrumbidgee region

The Reconnecting River Country Program is a key Murray–Darling Basin initiative essential to creating healthier functioning river systems in the Murray and Murrumbidgee valleys.

Currently, rivers connect to wetlands and floodplains less often than is needed to maintain healthy ecosystems, due to river regulation and extraction. Water for the environment aims to restore the balance, however constraints restrict the effective use of this water contributing to the continual decline of the health of Country, including the species depending on these environments to survive.

A constraint is any physical, policy or operational barrier limiting the flow of water in river systems. There are a range of flow constraints in the Basin, some examples include:

- physical restrictions such as low-lying watercourse crossings, weirs and levees
- operational restrictions such as river operation rules and practices
- policy barriers such as existing legislation.

The program is proposing to remove constraints to enable the flexible use of water for the environment to increase the frequency and extent rivers connect to their wetlands and floodplains. Removing constraints is critical to achieving the Murray–Darling Basin Plan's improved environmental outcomes and making best use of existing water recovered from communities.

The program is currently in the development phase, and is working with landholders, First Nations people, public land managers and local communities on key aspects of its development.

If the program proceeds to delivery, greater flexibility to manage water for the environment would create healthier river systems providing a range of benefits for native vegetation, native fish, waterbirds, turtles, frogs and other wildlife.

Healthier river systems would provide generational benefits for local communities and the broader Basin community.

Image courtesy of Destination NSW. Snowy Mountains, NSW.

Priority 3

Support sustainable economies and communities

Regional cities and towns in the Murrumbidgee region could face increasing risks to the security of their water supplies over the coming decades. Agriculture, energy generation and tourism will continue to be important to the region's economy into the future. It is vital to understand the risks and challenges to our industries and communities to better manage water supply. It is also important that operational, planning and development decisions take into account the likely reliability and security of future water supplies.

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

What is already happening

The NSW Government has developed the **NSW Alternatives to Buybacks Plan** to detail how we will deliver on existing and new projects to protect NSW Basin communities and industries from large scale water buybacks. Further details are provided above (refer to Alignment with the Basin Plan section above). It is expected that the Commonwealth will progress with water purchases but will also make funding available for community adjustment to manage and mitigate negative social and economic impacts arising from water purchases towards the 450 GL water recovery target.

Funding of $3.9 million has been provided under **Future Ready Communities** to promote resilience and develop drought resilience plans that assess drought impacts and responses. Individual plans can focus on intra- or inter-industry diversification, leadership and social capital building, and planning council works. The Future Ready Regions Strategy and Future Ready Communities Pilot Program includes a commitment to upgrade the Enhanced Drought Information System to provide farms with world-leading weather and climate data so they can make better business decisions, and to support councils to develop drought resilience plans.

Funding of $48 million has been provided for the **Farms of the Future Program**[84] to support on-farm connectivity and encourage farmers to adopt agtech to boost their productivity, water efficiency and drought preparedness.

Aboriginal water rights are being advanced, including setting a target of 3% of water entitlements to be owned by Aboriginal people and organisations under the National Agreement on Closing the Gap. The state-wide **NSW Aboriginal Water Strategy** will identify measures to deliver on Aboriginal people's water rights and interests in water management.

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

The NSW Government has supported local councils to develop **regional economic development strategies** (REDS) based on the concept of a Functional Economic Region. The REDS set a clear economic development strategy for the region. An update was completed for the Murrumbidgee region in 2023.[85]

Regional Plans across NSW were updated in 2023. These plans set a 20-year framework, vision and direction for strategic planning and land use to ensure regions continue to be vibrant places for people to live, work and visit.

84. More information available at: www.dpi.nsw.gov.au/dpi/climate/farms-of-the-future
85. More information available at: www.nsw.gov.au/regional-nsw/regional-economic-development-strategies

What is already happening

The NSW Government has developed region-specific information about drought management. The **NSW Drought Hub** provides resources to assist stakeholders to prepare and manage for drought. Region-specific actions in the Murrumbidgee Regional Water Strategy will also improve management of future droughts.

The NSW Government has launched a new $5.95 million **Aboriginal Ranger Program** to enhance Aboriginal people's connection to Country and provide meaningful career pathways. This structured employment and development program is designed to attract and retain talented Aboriginal people to build public sector capabilities. A key goal is to give participants accelerated exposure to Local Land Services and its operations. Trainees will be equipped with transferable skills and a sound understanding of the workings of the public sector. The program will create broadscale employment and training opportunities for Aboriginal people and communities across NSW.

The **NSW Extreme Events Policy framework** includes a staged approach and provides a range of measures for water managers to extend remaining supplies for critical needs as conditions deteriorate. As an extreme drought is prolonged, water managers will progressively introduce more stringent restrictions on access to water by different water users. The NSW Department of Climate Change, Energy, the Environment and Water's website has a summary of the types of actions that the department may take as the drought becomes more critical.[86]

The open data framework recently published by the department outlines how open data will be managed and driven to improve transparency and data sharing. This is part of a policy to provide more open and easily accessible data.

Image courtesy of Destination NSW. Wagga Wagga, NSW.

86. More information available at: water.dpie.nsw.gov.au/about-us/how-we-work/legislation-and-policies/extreme-events-policy

Legend			
 Balancing competing interests for water	 Improving the health and resilience of ecosystems	 Addressing barriers to Aboriginal people's water rights	 Supporting existing and emerging industries and livelihoods

Table 8. Overview of proposed actions for priority 3 – Support sustainable economies and communities

Proposed action	Summary	Challenges addressed
Action 3.1 Support the development of new water related Aboriginal business opportunities in the Murrumbidgee region	Support Aboriginal business development opportunities in the Murrumbidgee region, some of which may require access to water resources. This action would also investigate ways to expand water-related employment opportunities for Aboriginal people in the Murrumbidgee region.	
Action 3.2 Reduce uncertainty in groundwater security for regional towns and industry	This action focuses on enhancing groundwater security in the Murrumbidgee region that is crucial for towns and industries. It addresses varying quality and availability issues especially during droughts. Strategies include monitoring contaminants, developing innovative salinity solutions filtration tech and collaborating with councils to promote for sustainable groundwater use and develop a policy for managed aquifer recharge.	
Action 3.3 Investigate innovative ways to improve runoff in water supply catchments	This action explores expansion of cloud seeding activities for increased snowfall and investigates strengthening bushfire management to preserve crucial runoff processes and water quality.	
Action 3.4 Support towns and local water utilities to understand and manage their future water security risks	Supports towns and local water utilities to manage future water security risks. This action involves risk analysis, upgrading water models, exploring alternative supply options and promoting urban efficiency measures, including stormwater harvesting and smart metering. Various programs and collaborations would aim to enhance water system efficiency and conservation.	
Action 3.5 Consider an enduring level of supply to support regional towns and centres	Establish enduring water supply levels for regional towns by moving away from the concept of acceptable risk. This action involves determining minimum water needs during extreme droughts and guiding local utilities in adopting this approach considering community needs and willingness to pay.	
Action 3.6 Improve public access to climate information and water availability forecasts	Improve existing platforms and products to provide information about water availability and climate change in a format tailored for water users and their business planning needs in the Murrumbidgee region.	

Proposed action	Summary	Challenges addressed
Action 3.7 Progress the implementation of the Murrumbidgee Cultural Access Licence review	Support the Murrumbidgee Cultural Access Licence review to address restrictions for Aboriginal people. Recommendations include facilitating planning processes, identifying grant and new investment opportunities, assessing cultural sites and examining the rules for carryover, trade and commercial gain under the licence.	
Action 3.8 Manage delivery risks in the regulated Murrumbidgee River	Improve the efficiency of the regulated Murrumbidgee River system through technological improvements, infrastructure solutions, operational changes and flood management reviews, while considering environmental and cultural factors.	

Image courtesy of Destination NSW. Shear Outback cafe and gift shop, NSW.

Proposed action 3.1: Support the development of new water-related Aboriginal business opportunities in the Murrumbidgee region

During our consultation on the draft Murrumbidgee Regional Water Strategy, we heard about the need for economic development and business opportunities in the region that are led by Aboriginal communities. Stakeholders showed strong support for initiatives that result in employment opportunities for Aboriginal people and particularly Aboriginal youth. However, it was stressed these roles needed to be based in the community. Training opportunities, particularly for Aboriginal youth, were also identified as a key priority.

Investing in regional Aboriginal businesses can help diversify incomes in the region, create employment for local Aboriginal youth and improve social and economic outcomes for Aboriginal people. Realising some of these opportunities may require access to surface water or groundwater resources.

The NSW Government is supporting Aboriginal business development opportunities in the Murrumbidgee region through a range of programs, including the Aboriginal Partnership Program[87] led by the Department of Regional NSW. The program will support government agencies and communities in progressing economic development opportunities. A dedicated Aboriginal Partnership Manager will work with Aboriginal organisations, businesses, and individuals to identify and develop new business opportunities or better manage existing ones and access support or grant funding.

Other support is also available through the NSW Department of Aboriginal Affairs, the NSW Aboriginal Land Council and the National Indigenous Australians Agency.

Through this proposed action, existing programs and support would be leveraged to identify and progress new water-related Aboriginal business, employment and training opportunities, including by establishing cultural water officers and/or river rangers.

Proposed action 3.2: Reduce uncertainty in groundwater security for regional towns and industry

Groundwater is an important water source for towns, communities and industries across the Murrumbidgee region. Groundwater availability and quality varies across the region according to the geology and location.

During drought, groundwater use tends to increase as surface water becomes less available. Groundwater in the Murrumbidgee region is used for agricultural, industry, stock and domestic purposes and town water supply.

Groundwater is used as the primary source of water for 16 mid and Lower Murrumbidgee towns to meet their critical daily needs. Most of the groundwater sources in the region are fully allocated, with usage in Wagga Wagga Alluvial Groundwater Source close to the extraction limit during recent drought years.

Groundwater in the Lower Murrumbidgee Shallow Groundwater Source and Lower Murrumbidgee Deep Groundwater Source is known to have elevated levels of salinity that limit or prevent its use. Opportunities for information sharing and developing affordable desalination and filtration technology will support the region to use groundwater more effectively and sustainably.

In the Murrumbidgee region, monitoring contamination is vital to ensure safe drinking water. Contaminants such as pre- and polyfluoroalkyl substances (otherwise known as PFAS), fuel tank sites and agriculture waste leachate can contaminate groundwater sources. Preventing contaminants from entering the groundwater through correct storage and management practices is the most efficient practice, as extracting contaminated groundwater and treated it prior to use can be expensive.

87. More information available at: www.nsw.gov.au/regional-nsw/regional-aboriginal-partnerships-program

Consistent with the NSW Groundwater Strategy, this action would:

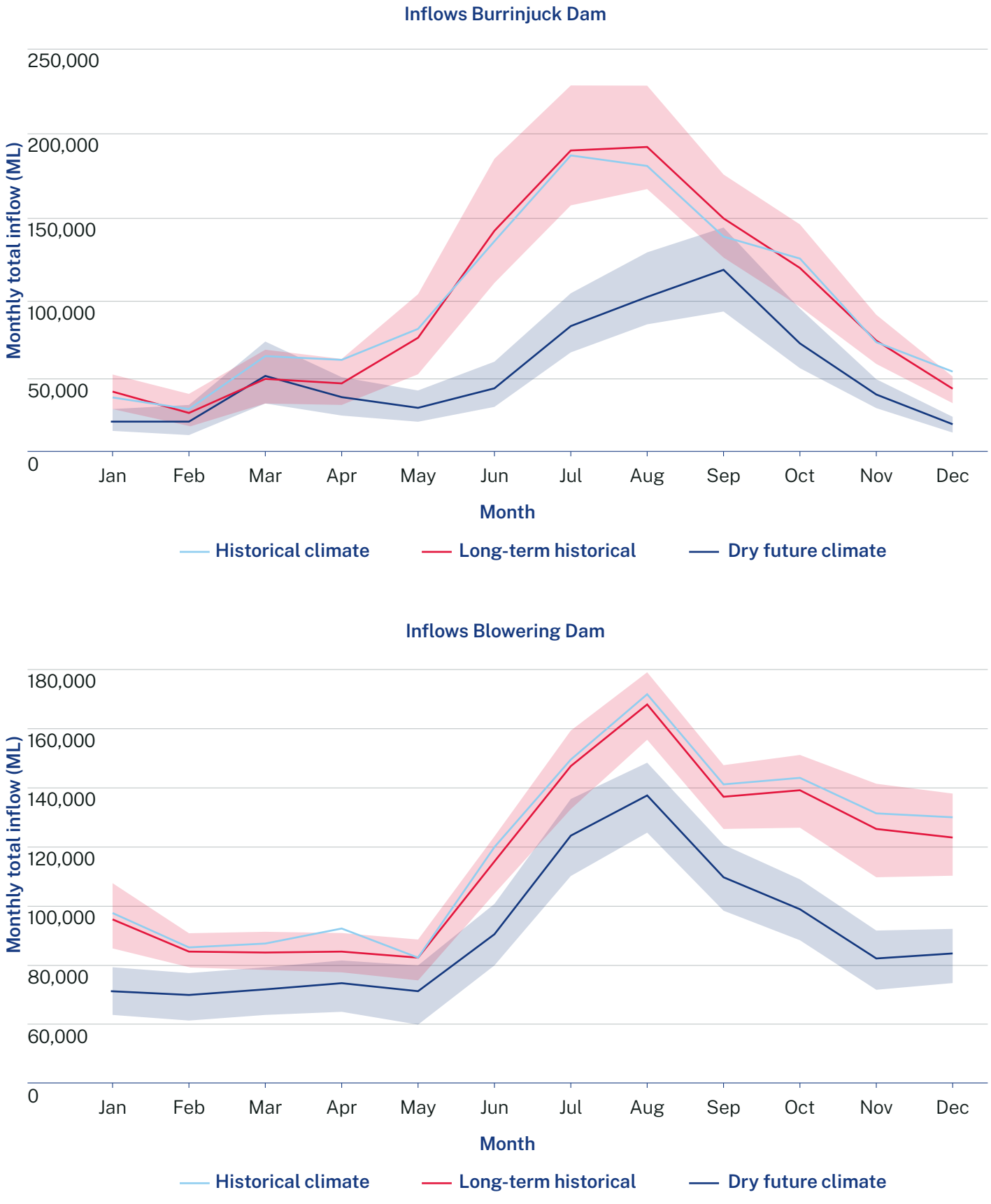
- collaborate with councils to understand groundwater resource availability and quality at a local scale
- continue to develop a policy framework for managed aquifer recharge
- consider sustainable groundwater use in regional planning and development initiatives
- develop a groundwater level management framework with actions to manage any local water level decline. This would include establishing groundwater condition limits to ensure fair and ongoing access to groundwater for towns, industries and the environment
- review the regulation of basic landholder rights, including stock and domestic basic landholder rights in and around urban centres
- support development of innovative salinity solutions for groundwater communities and industry
- support efforts by the Department of Defence and Riverina Water to manage the plume of PFAS in the East Wagga bore field by:
  - providing a coordinated state government response. This includes supporting Riverina Water in their strategic planning to explore long-term options to secure safe drinking water supply for the region. We will ensure Goldenfields is included in these considerations
  - supporting the investigation of alternate sources of water such as moving the bore and/or constructing a pipeline from one of the major dams in the region as well as other options.

Image courtesy of Gavin Hansford, NSW Department of Climate Change, Energy, the Environment and Water. Kosciuszko, Middle Beach Murrumbidgee Valley National Park, NSW.

Proposed action 3.3: Investigate innovative ways to improve runoff in water supply catchments

New climate and modelling data (Figure 18) highlights that under the dry future climate scenario there would be a decrease in inflow volume into the storages of the Murrumbidgee River system, particularly during the traditional dam filling period of winter/spring.

Figure 18. Impact of dry future climate scenario on seasonal inflows into Burrinjuck (top) and Blowering (bottom) dams



In the upper Murrumbidgee catchment, climate data indicates that median flows are lower and cease-to-flow events more prevalent under the dry future climate scenario compared to the historical climate scenario. This has implications for the unregulated systems in the upper Murrumbidgee and inflows into the major dams.

Cloud seeding (Glaciogenic seeding) is a weather modification technique that introduces a seeding agent (silver iodide) into suitable clouds to encourage the formation and growth of ice crystals. This enhances the amount of snow or rain falling from the cloud.

Snowy Hydro Limited has been trialling snowfall cloud seeding since 2004 over an area of approximately 2,110 km^2 from just south of Thredbo through to Kiandra. An independent scientific evaluation of this trial found cloud seeding increased precipitation by an average of 14% during targeted events with no adverse effects on precipitation downwind of the target area and no adverse environmental effects.[88]

The additional snowfall improves snow conditions for winter sports, as well as providing more meltwater for energy production and subsequent release to the Murray and Murrumbidgee rivers for irrigation, town water supply and the environment.

A drying, more variable climate will also increase the severity of already-problematic bushfires in the region, leading to significant changes to hydrological runoff processes. When intense fires occur in catchments such as the Snowy Mountains and upper Murrumbidgee, they can have profound impacts on water quality in the short term and also diminish the volume of rainfall that is converted into runoff for streams and dam inflows over the long term.

The region's key watersheds need to be better managed to avoid adverse fire regimes and associated water-quantity and water-quality impacts and to improve runoff. Progressing this proposed action would involve investigations by the NSW government to better understand:

- the feasibility of expanding cloud seeding operations (beyond Snowy Hydro's operational program) in key water supply catchments to improve snowfall in the Murrumbidgee
- how bushfire management could be strengthened, with investment from the water sector, to preserve and rehabilitate vitally important runoff processes. This would include investigating the feasibility of including rainfall runoff processes as a strategic bushfire management priority and identifying the associated fire management activities.

Using Snowy Hydro infrastructure to store consumptive water

A feasibility study into commercial arrangements for storing or banking water in Snowy Hydro Ltd infrastructure was completed in November 2022. The study included stakeholder engagement with irrigation organisations, the Australian Government and state agencies from Victoria and South Australia. A risk assessment and examination of the key criteria required for commercial arrangements identified the following high risks and issues:

- administration needs
- potential impacts on South Australia storage rights
- MDB agreement for Victoria's share
- equitability of user access
- water for environment calculations (RMIF)
- the need to change multiple legislative instruments and relatively low level of interest of stakeholders.

88. NSW Natural Resources Commission, 2012. Cloud seeding trial: www.nrc.nsw.gov.au/completed/cloud-seeding

Proposed action 3.4: Support towns and local water utilities to understand and manage their future water security risks

There is increasing competition for limited water resources and there are key knowledge gaps regarding water use and losses in the Murrumbidgee region. Increased climate variability and climate change is likely to reduce water security and reliability for towns and industry.

Additionally, significant population growth of regional centres and towns is expected over the next 20 years which will increase demand on town water supply. The major areas for growth are in Wagga Wagga, Queanbeyan-Palerang and Yass Valley areas.

Climate modelling has shown that, with current demand levels, the risk of surface water shortfalls for Murrumbidgee towns is generally low, but likely to increase significantly under our dry future climate scenarios and with population growth, with potential shortfalls for the towns of Queanbeyan and Yass. Whereas Bungendore is experiencing rapid population growth and the current groundwater supplies are unlikely to meet the requirements of the growing population.

More needs to be done with less water under a more variable future climate. Community, business and government expectations are that water needs to be used more efficiently to reduce domestic and industry demand. With potential shortfalls and expected growth in the Murrumbidgee region, water efficiency and demand measures could be used to help reduce demand on water sources and make existing water supplies go further.

To progress this action, NSW Government would:

- support councils and local water utilities with guidance to confirm the level of risk through town water security analysis using the new climate data
- upgrade the existing groundwater and surface water models for the Murrumbidgee catchment to enable future water availability (supply shortfalls assessments) to Wagga Wagga, Leeton and Griffith to be assessed
- support councils and local water utilities to investigate options for town water security
- investigate capability to purchase or trade additional water entitlements
- investigate potential alternative supply options from groundwater
- investigate innovative water management options for towns and industry such as stormwater harvesting and use of recycled water by industry, within or near towns
- investigate urban water efficiency measures including:
  - water restrictions to limit town water use during dry periods and prolong water supplies
  - installation of rainwater tanks and greywater systems on houses and commercial buildings, encouraging water-efficient appliances
  - reducing leakage from pipes
  - smart metering and pricing.

Safe and Secure Water Program

The $1 billion Safe and Secure Water Program, established in 2017, is managed by the department and co-funds vital water and sewerage projects across regional NSW. This co-funding assists non-metropolitan councils, local water utilities, county councils, water supply authorities and joint organisations to deliver projects that provide safe, secure and sustainable water and wastewater services to regional NSW.

Projects funded in the Murrumbidgee region include:

- Bungendore
- Queanbeyan-Palerang Regional Council
- Snowy-Michelago
- Yass Valley Council
- Cootamundra-Gundagai
- Junee
- Coolamon

- Narrandera
- Leeton
- Griffith
- Hay
- Jerilderie
- Balranald.

Town Water Risk Reduction Program

The NSW Government is collaborating with local water utilities and the wider water sector on the Town Risk Reduction Program. This program is delivering a new approach to working together that enables local water utilities to access the capacity and capabilities of State Government entities, including agencies and State-owned corporations, to manage risk and priorities in town water systems more strategically and effectively.

Several pilots have been initiated through this program to trial new approaches to local water utility strategic planning. Recognising the important connection between each local water utility's strategic planning and regional water strategies, Canberra Region Joint Organisation, which includes councils in the Murrumbidgee region has been successful in being a participant in the program.

NSW Water Efficiency Program

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

Regional Leakage Reduction Program

A key aspect of the Water Efficiency Program is addressing network leakage and water loss. The need to focus on local water utilities' network leakage and water losses became apparent during the drought and has been reinforced during consultation with councils and the wider sector as part of the Town Water Risk Reduction Program. Several councils in the Murrumbidgee region have participated in the active leak detection component of the program, with Griffith and Hay receiving grants for co-funded projects under this program.

Aboriginal Communities Water and Sewerage Program

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

Smart Approved WaterMark – Smart Water Advice Program

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

Local water utility performance data

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

Proposed action 3.5: Consider an enduring level of supply to support regional towns and centres

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

Metropolitan water utilities such as Sydney Water and Hunter Water have shifted their focus away from an 'acceptable level of risk', recognising that running out of water is a risk that neither communities they supply nor government will tolerate, regardless of the probability of it happening. Instead, they are exploring the concept of 'enduring supply' to inform long-term water supply planning.

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

Determining the enduring level of supply is informed by:

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

This action would develop guidance for local water utilities to use the enduring supply approach. This could include, but not limited to, guidance about:

- highlighting the benefits and opportunities of adopting 'enduring supply', and how it differs from other local water utility strategic planning processes
- key steps involved and what assumptions and data are required
- the kinds of rainfall-independent solutions that could be involved
- levels of stakeholder consultation required.

Proposed action 3.6: Improve public access to climate information and water availability forecasts

All parts of the community and government need access to reliable and timely information to make informed decisions and effectively engage in water planning and decision making. Having transparent and accessible data to contribute to discussions around drought and flood management was a key point raised by stakeholders.

An incomplete understanding of the risks relating to future water availability can lead to poor investments, poor business decisions, poor drought security planning and loss of opportunities to invest in alternative water supplies. For example, towns and communities may be unaware of the higher risk not just to their essential water supplies but also to their local economies when a significant proportion of the economy is based around irrigated and rainfed agriculture – both of which suffer heavy impacts during extended severe droughts.

Having an incomplete picture of how, when and where water is used also has implications for water quality and water-dependent habitats. Longer and more severe droughts increase the risk of debilitating ecosystem damage, fish deaths and severe blue-green algae outbreaks. Better understanding of potential future climate scenarios will improve our ability to plan for, and mitigate, ecosystem risks.

The NSW Government will consult with stakeholders on their information needs and the best ways to communicate with them. We will design and deliver suitable training and information products and platforms that communicate information such as:

- 12-month climate outlooks and how these could influence water allocation decisions and other operational water-sharing decisions, which could help water users make informed decisions on managing their allocations using carryover or trading water on the market
- indications of potential water allocations, provided ahead of the 1 July start of the water year where possible, to support business planning
- potential implications of long-term climate data for:
  - surface water availability and water quality
  - the likelihood of consecutive years of low or no water availability
  - periods when access to water allocations may be restricted by delivery problems in the regulated river system
  - groundwater availability.

- improvements over time in flow forecasting capabilities and investment in science and analytics to better understand rates of return of flows from floodplains into rivers
- how future use may affect the condition of groundwater resources
- a decision framework for how available water determinations are made based on use, compliance triggers, and carryover
- information about groundwater resources and how they are managed to assist councils and other water users to make more informed decisions about their water supply security.

We will also:

- increase the frequency of surface water data collected – specifically during high-flow and flood periods, including updating the reliability and accuracy of gauging stations
- take a proactive approach to understanding the water quality and quantity requirements of emerging industries in order to inform policy development and planning decisions
- deliver upfront education and clarity to new industries and government on potential water sources, given that the surface water sources and some groundwater sources are already fully allocated and there is potential for reduced water availability in the future
- encourage new industries to have comprehensive drought management plans as they set up in the region
- modernise communication around commence-pump and cease-to-pump targets being met in real time.

The work will build on or complement existing state and national information platforms and products, including WaterNSW's WaterInsights and Water Information dashboards.

Increasing the amount of publicly available climate-related information, including short-term and long-term water availability forecasts, will help the Murrumbidgee region's businesses plan with greater certainty. It will also support farm-level climate adaptation decisions.

Collecting more data and better data

The NSW Government is undertaking a range of programs aimed at improving its understanding of water flows and water use in the Murrumbidgee region.

Climate risk data

The NSW Government has recently published the long-term climate variability risk data that supports the regional water strategies. This is the first step in providing water users with better access to information on the future risks to water availability. The stochastic datasets for rainfall and potential evapotranspiration for the Murrumbidgee region and a number of other NSW regions are available on the SEED portal.[89]

Non-urban water metering framework[90]

It has been almost 5 years since new metering rules were put in place for non-urban water users. More than 70% of large commercial water users with irrigation pumps bigger than 500mm have installed accurate, tamper-proof meters. The installation of meters by thousands of smaller water users will also provide opportunities for improving water sharing management and arrangements.

The non-urban metering rules are being reviewed to assess progress since the rules have been in place, and to determine how the rules can be improved and compliance with them made easier. Recent consultation was held and a what we heard report will be published soon.

89. More information available at: www.seed.nsw.gov.au
90. More information available at: water.dpie.nsw.gov.au/nsw-non-urban-water-metering

Hydrometric Network Review[91]

NSW is currently undertaking a review of its hydrometric (river gauge) network. The review is looking at the coverage and data quality obtained from the existing hydrometric network and identifying ways to improve information collected.

The gauging stations will deliver transparent, accurate and accessible data in real time to water users, communities and stakeholders alike, building on more than 1,300 monitoring sites already available in real time to the public. Information available from the new stations will include stream levels, flow volumes, and water quality.

These sites will enhance the network so we can better manage stream connectivity, compliance, environmental water release, and extreme events. The new stations will add even more localised data, helping to better understand local conditions so we can better balance the needs of water users and the environment, and better prepare for floods and droughts.

Water users can access the data through tools including WaterNSW's Water Insights portal[92] and WaterLive App and the Bureau of Meteorology's Water Information Portal[93] and Water Data Online.[94]

Proposed action 3.7: Progress the implementation of the Murrumbidgee Cultural Access Licence review

Special purpose cultural access licences, under the *Water Management Act 2000*, are issued annually for specific projects that address cultural watering. These licences cannot be used for commercial use and cannot be traded. Once the project is completed the licence is abolished. This makes ongoing cultural watering difficult and is an onerous process for renewal.

This action would help support and progress the implementation of the Murrumbidgee Cultural Access Licence (CAL).

During development of the Murrumbidgee Regional Water Strategy, we heard that the Murrumbidgee CAL was restrictive for Aboriginal people and could only be accessed at a few locations. Since then, the department has done a review of this licence which includes several recommendations such as:

- resource a facilitated and collaborative annual planning process, including input from water management experts regarding water volume and timing requirements
- identify and communicate grant opportunities that will support the procurement of mobile pumps
- explore options for new investment in mobile pumps
- ensure the community are aware of the Water Sharing Plan review process and the opportunity to provide submissions.

This action would progress the implementation of recommendations from this review.

In addition, 35 sites between Tumut and Maude were identified as being culturally significant and having value in fishing, camping, ancestral remains, wetland value and/or cultural heritage. These sites will be assessed for accessibility and inclusion in a cultural watering program using the Murrumbidgee CAL.

The department will examine the rationale for the rules relating to carryover, trade, and commercial gain regarding the CAL and perform a risk benefit analysis for changing these rules. The assessment will consider the risk and benefits in the Murrumbidgee and in a state-wide context such as the NSW Aboriginal Water Strategy.

91. More information available at: water.dpie.nsw.gov.au/science-data-and-modelling/data/hydrometric-network-review
92. More information available at: www.waterinsights.waternsw.com.au/
93. More information available at: www.bom.gov.au/water/
94. More information available at: www.bom.gov.au/waterdata/

Proposed action 3.8: Manage delivery risks in the regulated Murrumbidgee River

Challenge 1: Balancing competing interests for water, highlights the issues currently facing the delivery of water in the regulated Murrumbidgee River system. This includes exploring ways to improve the deliverability of water through the system, while balancing the needs of water users, the environment and Aboriginal cultural values.

This action would seek to improve the efficiency of the Murrumbidgee regulated river system, through coordinated investigations with stakeholders into:

- technological advances that could improve operational controls and dynamic management of the regulated river system
- shortlisted infrastructure solutions to provide additional buffer storage capacity across the catchment including at locations downstream of the flow constraints of the Murrumbidgee and Tumut rivers to improve delivery during periods of peak demand – for example, augmentation of Bundidgerry and Tombullen storages, as well as a small weir on the lower reaches of the Tumut River
- operational changes to the release of discretionary environmental water by releasing more water from Blowering Dam and less from Burrinjuck Dam during winter where required to assist with balancing both storages
- reviewing flood management and airspace operation of both dams to manage releases prior to potential wet weather. This would inform parts of the Snowy Water Licence rules and include an investigation of potential operational or rule changes to improve flood mitigation functions
- developing an environmental protocol for river operators to ensure minimum flows required for basic water quality needs, appropriate weir-pool management to avoid stratification, reducing erosion impacts in the Tumut River, etc.

It should be noted that any changes to water resource plans, resulting from this action, would require assessment by the MDBA to ensure compliance with the requirements of the Basin Plan.

Long-listed water security options for the Murrumbidgee region

Alternative infrastructure options to improve catchment storage and minimise water delivery risks were explored in the development of the Murrumbidgee Regional Water Strategy.

The options were considered in several hydrological, economic and eco-hydrological strategic assessments, as well incorporation of stakeholder feedback. They included:

- large scale increases to water storage including raising Blowering Dam (option 36) and enlarging Burrinjuck Storage Reservoir (option 37) and a new large dam on the Murrumbidgee River near Gundagai (option 33c). These options were found to be too financially costly and had significant environmental impacts, and with only minimal benefits. As such, they were not shortlisted
- smaller scale buffer storages to enable a greater level of supply at key points downstream of river constraints (options 33a, 33b, 38 and 39). Some of these options were considered to be worthwhile of further consideration as part of this action.
- a gravity pipeline along the Tumut River from Blowering Dam, to address channel capacity constraints (option 35). This option was found to be too financially costly, with only minimal benefits. As such, it was not shortlisted.

At this stage and with the information available, options 33a, 33c, 34, 35, 36, and 37 have failed to progress to the shortlist of actions. The primary assessment of hydrological, economic and environmental analyses showed these options to be unviable. Refer to Attachment C: Assessment of options that impact supply, demand, or allocation of water, for details.

Further details on the results of the assessments are provided in Attachment C: Assessment of options that impact supply, demand, or allocation of water.

Priority 4

Sustainable water management in the upper Murrumbidgee catchment

The upper Murrumbidgee River catchment covers an area over 14,000 km^2 and consists of urban, peri-urban, rural and natural upland/alpine landscapes. Headwaters rise in the Kosciuszko National Park in the southwest and the river flows through the Australian Capital Territory (ACT) in the middle reaches, before entering Burrinjuck Reservoir near Yass (Figure 9). There are many unregulated tributaries reliant on rainfall and snowmelt and the river is a vital water source for communities, industries, and the environment.

The combination of Snowy Scheme flow diversions, development pressures and land use practices continue to produce several challenges in the area, such as a poor and declining river health, compromised cultural values and endangered species.

These challenges are outlined above.

What is already happening

NSW Government and stakeholders are already working to maintain and improve the health of the upper Murrumbidgee River. The following programs are key initiatives currently active:

Delivery of environmental flows through the **Snowy Montane River Increased Flows (SMRIF) program**, which is managed by the NSW Department of Climate Change, Energy, the Environment and Water – Biodiversity, Conservation and Science (BCS), in consultation with the Snowy Advisory Committee. Further information is available on the department's website.[95]

Implementation of the recommendations from the first 10-Year Snowy Water Licence Review. Key work has involved development of an integrated water model of the Snowy, Murray and Murrumbidgee systems and exploring improvements to the delivery of environmental flows to the Snowy River. Some options may also be implemented in the upper Murrumbidgee. The next Snowy Water Licence Review, due to commence in 2027, will focus on a range of administrative and technical issues including continuing to explore better ways to deliver environmental flows.

As implemented in the 2022–23 and 2023–24 water year, temporary water restriction rules will continue to be implemented to prevent extraction of environmental flows. This will apply to unregulated licence holders in the Murrumbidgee I and II water sources. More information is available on the temporary water restrictions webpage.

The ACT government has its own ACT Water Strategy that aims to deliver security of water supply, improved water quality and catchment health, and a 'water smart' community. It covers the full breadth of water management activities in the ACT, including catchment management, stormwater and flood management, water supply and services, water for the environment, recreational water use and public health. Periodic implementation plans are also released by the ACT Government. One key initiative is the ACT Healthy Waterways that seeks to improve the quality of water entering waterways of the upper Murrumbidgee River system. The project includes the construction of water sensitive 'green' infrastructure – like wetlands, ponds and rain gardens – as well as research trials, community education campaigns and improvements to water monitoring practices.

Under the *2020 ACT–NSW Memorandum of Understanding for Regional Collaboration* (the MoU), the ACT and NSW Governments and Queanbeyan-Palerang and Yass councils agreed to establish the **ACT–NSW Urban Water Issues Steering Committee** to support strategic discussion of issues relating to urban water supply in the ACT/NSW cross-border region.

95. More information about Snowy Montane River Increased Flows at: water.dpie.nsw.gov.au/our-work/projects-and-programs/snowy-scheme/snowy-water-initiative/snowy-montane-river-increased-flows

What is already happening

The ACT and Region Catchment Management Coordination Group was established by the ACT Government to facilitate improved governance and coordination of water catchment activities within the ACT and the surrounding region.

Aboriginal communities are working on actions to improve the ecological health and cultural values of the area. Particularly the **Ngunnawal Aboriginal Water Assessment Project** Plan which is completing 6 onsite assessments per year within a period of 3 years, addressing 2 sites per assessment, producing an Aboriginal Water Assessment report each time.

The Upper Murrumbidgee Demonstration Reach (UMDR) is working on numerous projects to protect and improve the health of the upper Murrumbidgee River. These include works focused on woody weed control, managing stock access and restoring native vegetation along the banks and in-stream, engaging communities and encouraging adoption of best management practices, improving fish passage and recreating geomorphic complexity.

Australian River Restoration Centre is another institution working on different initiatives to restore the health of the upper Murrumbidgee. As an example, **Rivers of Carbon – Upper Murrumbidgee River Rehabilitation program** involves targeted actions to improve the health of the river.

Waterwatch engages with the community to monitor and raise awareness of local waterways. Running for over 20 years, the program covers the upper Murrumbidgee River and source catchments. They educate and raise awareness in schools and the community on issues concerning catchment health and use data collected by volunteers to inform policy and on ground catchment management.

The Australian Government has recently committed $15 million to catchment management for 3 years and $5 million for 5 years for science and monitoring for the catchment health of the upper Murrumbidgee. This new support for the river's health and following new data will provide critical inputs to a potential review of the SWIOID. Additionally, it was announced funding of $500,000 to support First Nations participation in the SWIOID review and a contingency of up to $30 million over a maximum of 3 years to support additional water in the upper Murrumbidgee if drought-like conditions occur.

Many of the proposed actions or components thereof, highlighted in the priorities above, also apply to the upper Murrumbidgee area. These include: 1.1, 1.3, 1.4, 1.5, 2.5, 2.6, 2.7 and 3.1–3.8.

The following proposed actions 4.1 to 4.5 are proposed as being specific to the upper Murrumbidgee area.

Image courtesy of Destination NSW. Wagga Wagga, NSW.

Legend			
 Balancing competing interests for water	 Improving the health and resilience of ecosystems	 Addressing barriers to Aboriginal people's water rights	 Supporting existing and emerging industries and livelihoods

Table 9. Overview of proposed actions for Priority 4 – Sustainable water management in the upper Murrumbidgee catchment

Proposed action	Summary	Challenges addressed
Action 4.1 Establishment of governance and coordination arrangements	Establish formal governance and coordination mechanisms to ensure the effective delivery of priority actions in the upper Murrumbidgee catchment. This action involves communication and engagement among various government levels, traditional owners, and community organisations to agree on a shared vision and establish objectives, targets and monitoring requirements. It also involves oversight of actions and considering whether further changes might be needed.	
Action 4.2 Support (on-going) river restoration in the upper Murrumbidgee catchment	Develop a coordinated catchment recovery program with a range of river restoration actions to address ecological impacts in the upper Murrumbidgee catchment. The action includes collaborative programs for improved environmental water management, pest species control, threatened species reintroduction and protecting the quality of source water to reduce treatment costs.	
Action 4.3 Investigate improvements to the flow regime of the upper Murrumbidgee River	Investigates opportunities to restore a sustainable flow regime in the upper Murrumbidgee River by addressing hydrological challenges. This action includes scientific studies, infrastructure investments, water plan revisions and temporary water restrictions to protect environmental flows.	
Action 4.4 Addressing sustainable population growth pressures in the upper Murrumbidgee catchment	Inter-governmental collaboration to explore water supply solutions, develop frameworks for growth, enhance climate risk assessment and streamline water resource planning across NSW and the ACT.	

Proposed action 4.1: Establishment of governance and coordination arrangements

In order for the various actions in this priority to be effectively implemented and well-coordinated there needs to be appropriate communication and engagement at all levels from the various governments – the NSW, Commonwealth, ACT, Victoria and multiple agencies therein, NSW local governments, as well as traditional owners and community/industry organisations.

This action would involve recognising and mapping existing groups and the establishment of formal governance and coordination arrangements between these groups to effectively coordinate and advise upon the delivery of the actions. Arrangements would need to address, but not limited to:

- shared high level vision and outcomes for the upper Murrumbidgee catchment
- shared performance objectives, targets and monitoring, evaluation and reporting requirements
- consideration if changes to legislation, intergovernmental agreements or committees are required
- oversight and coordination across implementation of actions and monitoring in the upper Murrumbidgee catchment
- stakeholder engagement
- ongoing funding for governance and coordination.

Proposed action 4.2: Support (on-going) river restoration in the upper Murrumbidgee catchment

Historical and current land and water management has impacted the ecology of the upper Murrumbidgee catchment resulting in altered stream flows, increased rates of sedimentation, weed infestations, loss of fish numbers and species, and loss of aquatic habitats.

This action would develop and fund a coordinated upper Murrumbidgee River catchment recovery program that integrates a range of river recovery actions. This would be undertaken collaboratively with stakeholder organisations, First Nations, and other state/territory and federal government agencies. Progressing this action would include:

- coordinated environmental water management and legislated protection for environmental flow releases
- enhancing and building on existing catchment management programs
- pest species management, as well as discontinuing stocking of trout in the upper Murrumbidgee River
- threatened species re-introductions
- monitoring and evaluation
- improve understanding and potentially addressing runoff impacts created by farm dams.

Investing in catchment management and prioritising source water protection helps reduce water treatment costs

By implementing effective catchment management practices, the quality of the source water can be improved. This means that the water entering treatment plants is already of higher quality, requiring less intensive treatment. When source water is cleaner, it reduces the need for expensive and complex treatment processes, such as advanced filtration or chemical dosing, which can be energy-intensive and costly.

Catchment management focuses on preventing pollution at the source rather than relying solely on water treatment plants to remove contaminants. By addressing pollution sources, such as industrial discharges or agricultural runoff, early on, the need for costly remediation measures at water treatment plants is minimised. Prevention is generally more cost-effective than dealing with pollution after it has entered the water supply.

Water treatment plants are expensive to build and maintain. Effective catchment management can help preserve the lifespan and efficiency of treatment infrastructure by reducing the load on the systems. With a cleaner source water the equipment and facilities at treatment plants are subject to less wear and tear resulting in reduced maintenance costs and increased longevity. By investing in catchment management and prioritising source water protection water treatment costs can be significantly reduced in the long term.

Proposed action 4.3: Investigate improvements to the flow regime of the upper Murrumbidgee River

The combination of Snowy Scheme flow diversions and land use practices continue to produce several challenges in the upper Murrumbidgee River, such as a poor and declining river health, compromised cultural values and endangered species:

- undertaking scientific studies to address key knowledge gaps concerning river health
- designing a program to identify and record significant water dependant cultural sites in line with proposed action 2.7 Support place-based initiatives to deliver cultural outcomes for Aboriginal people
- a review of the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) 2002
- continuing to explore improvements in environmental water management with partner agencies and stakeholders via a review of the SWOID or Snowy Water Licence. This could include:
  - introduction of carry-over allocations for Snowy Montane Rivers Increased Flows
  - improving flexibility to allow changes to be made to scheduled daily flow releases to respond to natural flow events or environmental requirements
  - allowing flow releases to have more natural variation within a 24-hour period rather than being held constant for that time
  - investigating investment in infrastructure improvements to improve the ability to release environmental flows, such as increased outlet capacity of Tantangara Dam that would be of sufficient capacity to give effect to any increased flows arising from a review into the SWIOID. Plus, infrastructure improvements to montane river systems to allow more flexible management of releases between the montane streams and upper Murrumbidgee
  - increasing annual volumes of water releases from Tantangara Dam.
- revision of the Murrumbidgee Long Term Water Plan[96]
- investigation of energy generation trade-offs associated with any proposed changes to flow releases
- water sharing plan amendments to legislate protection of water for the environment through the upper Murrumbidgee River
- long-term resourcing of monitoring to understand the response of riverine ecosystems to improved management and ecological condition.

Temporary water restrictions[97]

Throughout the 2024–25 water year, the NSW Department of Climate Change, Energy, the Environment and Water – Biodiversity, Conservation and Science (BCS) will be delivering environmental water from Tantangara Dam into the upper Murrumbidgee River that flows through the Murrumbidgee I and II Water Sources. The water sources are described in the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016*.

A temporary water restriction, under section 324 of the *Water Management Act 2000*, will be imposed to protect the environmental flows from extraction by unregulated licence holders, since no protection for environmental flow exists in the relevant water sharing plan. The order effectively increases the access threshold of the unregulated river access licences by the modelled volume of environmental flow passing the 2 reference gauges for the Murrumbidgee I and II water sources. Any water in the river above the increased thresholds will still be available to unregulated licence holders. The section 324 order will not impact access for domestic and stock licence holders so they can continue to extract water during the restrictions.

96. www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/murrumbidgee
97. water.dpie.nsw.gov.au/our-work/allocations-availability/temporary-water-restrictions

Proposed action 4.4: Addressing sustainable population growth pressures in the upper Murrumbidgee catchment

The NSW towns and cities of Bungendore, Yass and Parkwood, can expect to see significant growth over the next decade given their proximity to and economic and employment ties with the ACT.

Given the significant limitations in water supplies in NSW parts of the upper Murrumbidgee catchment, there is currently inter-governmental dialogue and work occurring to understand the feasibility of the supply of water from the ACT to these places in NSW. Both NSW and the ACT are collaborating and remain committed to this work. However, there are numerous policy challenges to overcome.

The Draft South East & Tablelands 2041 Regional Plan identifies the need to improve water security and quality throughout the region, noting the projected future growth and development of the region and the uncertainties of climate variability and change. Actions proposed include:

- working with Queanbeyan-Palerang and Yass Valley Councils to identify and implement agreed priorities that address water security, infrastructure provision and allocation
- outline innovative water planning solutions for the Capital subregion addressing matters such as:
  - forecast population growth and strategic planning
  - ecological and aquatic ecosystem management, infrastructure capacity
  - sustainable water management practices in line with the NSW Water Strategy.

Under the *2020 ACT–NSW Memorandum of Understanding for Regional Collaboration* (the MoU), the ACT and NSW Governments and Queanbeyan-Palerang and Yass councils agreed to establish the ACT–NSW Urban Water Issues Steering Committee to support strategic discussion of issues relating to urban water supply in the ACT/NSW cross-border region.

Through the MoU and the NSW Government's actions on this committee, this action would explore improvements to inter-jurisdictional management arrangements in the upper Murrumbidgee region in partnership with the ACT Government and local councils to:

- investigate solutions for the provision of cross-border water supplies in areas where water supply is a major limitation to housing growth
- develop a cross-border regional framework for sustainable growth in the upper Murrumbidgee to facilitate mutual benefits and provide greater certainty for developers, communities and governments alike
- promote a consistent approach to the assessment of climate risk and climate adaptation to strengthen water security in the upper Murrumbidgee region
- improve the integration of cross-border water resource planning and management
- consider how any changes to the operation of Tantangara Dam under proposed action 4.3: Investigate improvements to the flow regime of the upper Murrumbidgee River, could integrate efficiently with any needs or proposals under this action
- consider opportunities for streamlining costs and constraints for local councils to meet different environmental regulations implemented in the NSW and the ACT jurisdictions.

How to have your say

5

Image courtesy of Destination NSW. Goobarragandra River, Tumut.

When will the actions be implemented?

A critical feature of the final Murrumbidgee Regional Water Strategy will be making sure what actions and investments that are needed now and those that will or may be needed further into the future are clearly identified. The strategy considers a 20-year timeframe aiming to chart a progressive journey that enables us to meet existing challenges, identify and prepare for foreseeable coming challenges and lay the groundwork for adapting to future uncertainties and changed circumstances.

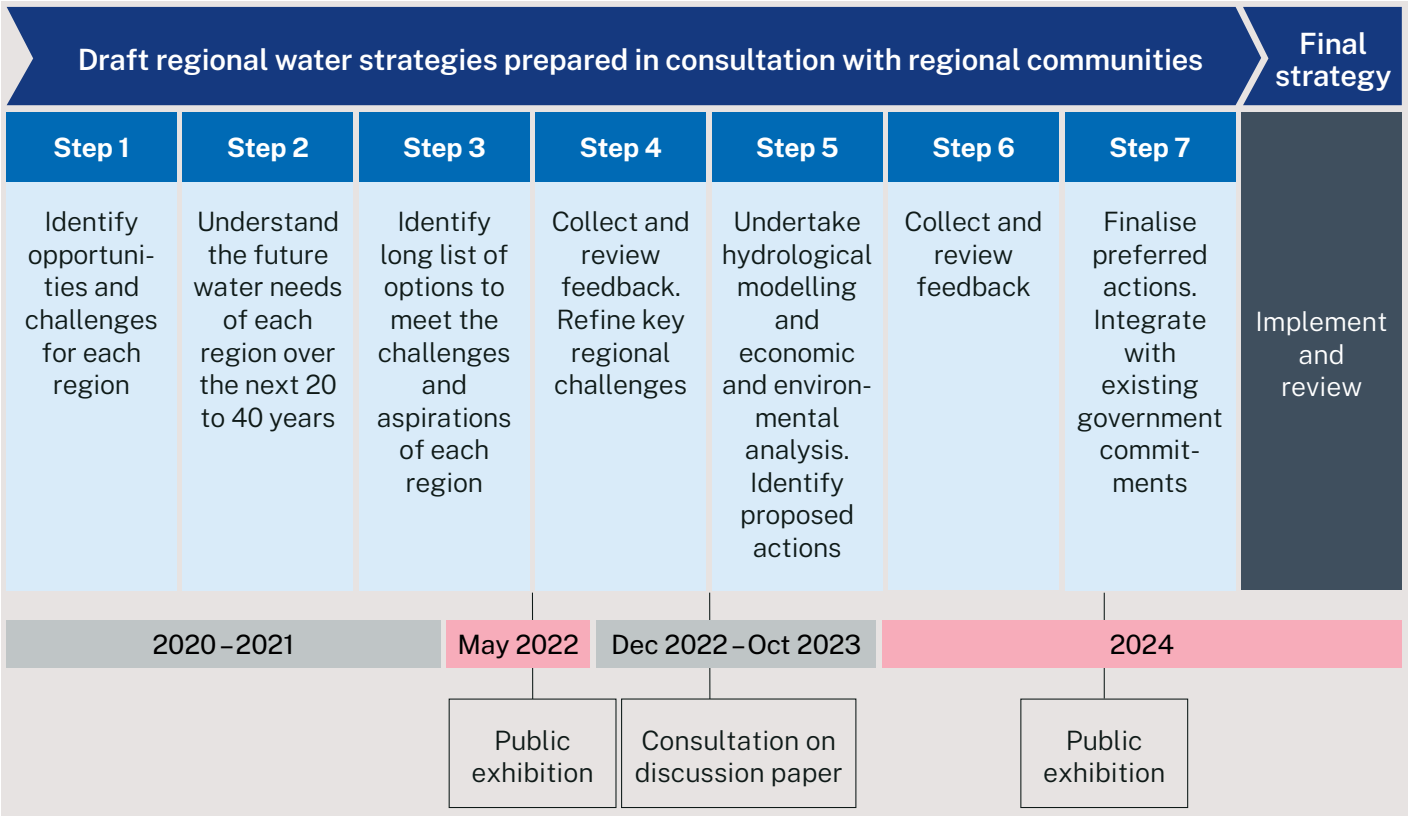
After public consultation, an implementation plan will be developed that will set out when each action will commence, and what will be achieved by when. The implementation plan will also identify key partners for delivering these actions, including local councils, government agencies, local community and industry groups and local Aboriginal communities.

Not all actions will be commenced at once. The availability of funding and the progress of existing government commitments will be a key consideration in planning when and how the actions will be implemented. The regional water strategies will be a key tool in securing funding as future opportunities arise.

This consultation paper seeks your feedback on which actions should be prioritised for implementation over the next 3 to 5 years, and which ones should be implemented in the medium and longer term. Figure 19 shows the Murrumbidgee Regional Water Strategy delivery timeline for your reference.

Image courtesy of Boris Hlavica, NSW Department of Climate Change, Energy, the Environment and Water.
Murrumbidgee Valley National Park, NSW.

Figure 19. Murrumbidgee Regional Water Strategy delivery timeline



Your voice is important. This consultation paper is on public exhibition from 22 May to 14 July 2024. Supporting information is available at dpie.nsw.gov.au/murrumbidgee-regional-water-strategy

You can also have your say by providing written feedback to the NSW Department of Climate Change, Energy, the Environment and Water via:

Web: dpie.nsw.gov.au/murrumbidgee-regional-water-strategy

Email: regionalwater.strategies@dpie.nsw.gov.au

Specific feedback is requested on:

- whether any of the actions in this consultation paper should not be shortlisted and why
- how actions should be staged and which actions should be implemented first

Please note that all submissions will be published on the NSW Department of Climate Change, Energy, the Environment and Water's website, unless you let us know in your submission that you do not wish the content to be released.

To support community engagement on this consultation paper, consultation sessions will be held to give participants additional context and a more thorough understanding of proposed priorities and actions. Details of these sessions can be found at the website listed above.

Attachments

6

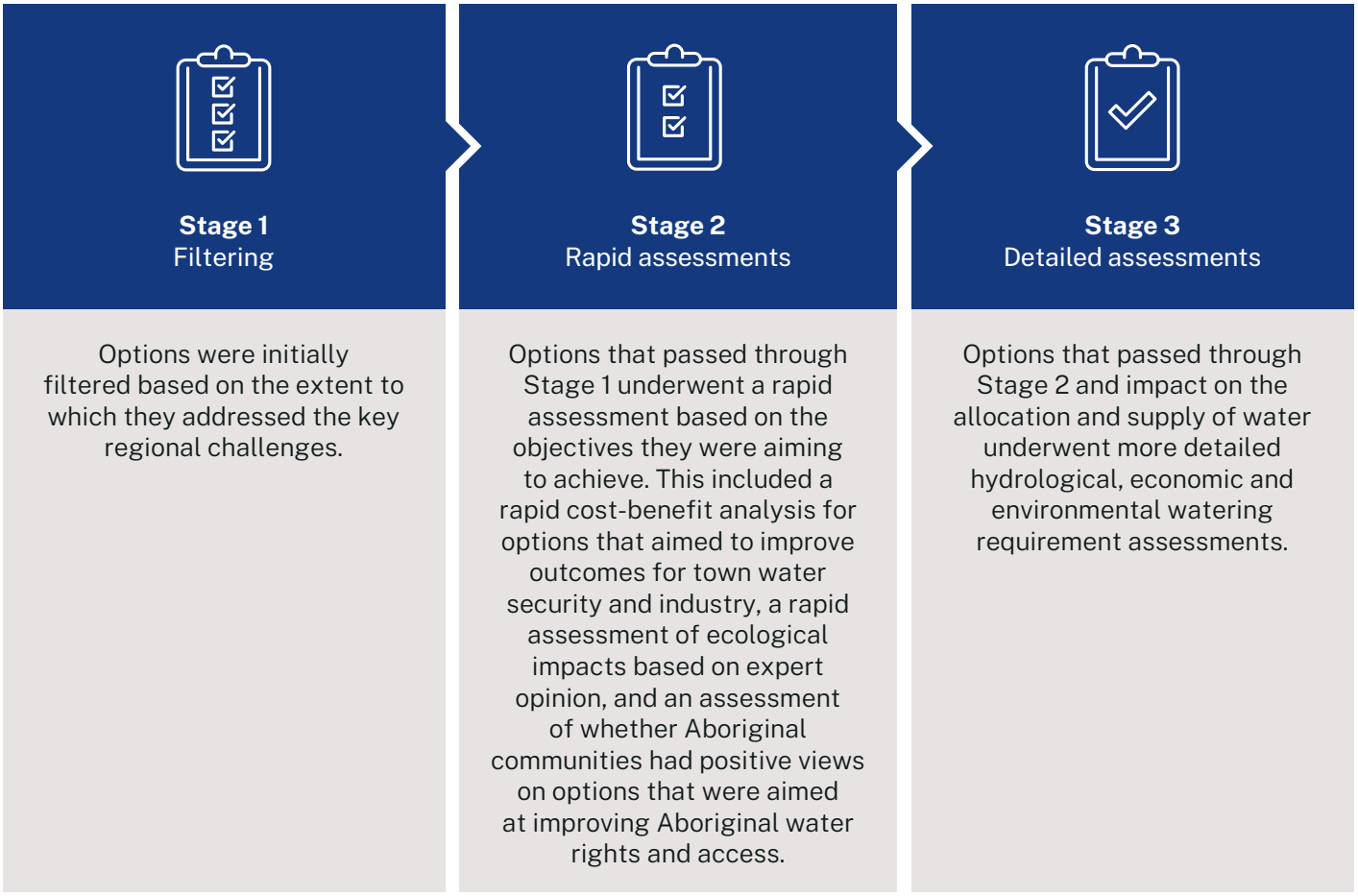
Image courtesy of James Maguire, NSW Department of Climate Change, Energy, the Environment and Water.
Birds take flight over Tuckerbil Swamp, Murrumbidgee Valley.

Attachment A: Summary of the options assessment process

The original draft Murrumbidgee Regional Water Strategy presented 53 options to address regional challenges. In response to the public exhibition, these original options were updated and expanded. Additional options were also added to the list.

The process to move from the long list to the short list is summarised in Figure 20.

Figure 20. Going from a long list of options to a short list



At each step of the assessment, the long list of options from the draft Murrumbidgee Regional Water Strategy were filtered and narrowed based on evidence, analysis and community feedback. Several options were consolidated, refined or not progressed and converted into proposed actions.

Attachment B summarises the overall outcomes of the options assessment (Table 10). Results from the economic and ecohydrological analyses are presented in Attachment C.

The analysis is a high-level assessment, appropriate for a strategic purposes, and it is not designed to consider all possible impacts on the environment, water users or Aboriginal people. However, it does provide enough detail to determine if an option is likely to make a net positive contribution to the regional water strategy's objectives. More detailed environmental, economic and cultural assessments are required and will be undertaken in any subsequent business case development or planning process for actions that proceed to the implementation stage.

After community consultation, the recommended actions for the regional water strategy will be sequenced, meaning, they will not all be implemented at the same time.

Attachment B: Assessment results – Long list of options to proposed shortlist of actions

This section summarises the assessment outcomes for each of the options in the draft Murrumbidgee Regional Water Strategy.

Table 10. Assessment of the long list of options

✓ Options progressed to next step

› To be considered in other NSW processes

× Option not progressed

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
1. Improve access to culturally significant areas and waterways for Aboriginal people	✓	not assessed	insufficient information to assess	› ✓	The NSW Water Strategy action 2.5: *Work with First Nations/Aboriginal People to maintain and preserve water-related cultural sites and landscapes* provides the overarching framework. This will be considered as part of the NSW Aboriginal Water Strategy. Incorporated into Murrumbidgee Regional Water Strategy proposed action 2.7.
2. Review Aboriginal Cultural Water Licence framework	✓	not assessed	insufficient information to assess	›	A review of the Aboriginal Cultural Water Licence framework is currently being undertaken as part of the NSW Aboriginal Water Strategy.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
3. Assess access arrangements for the Murrumbidgee Aboriginal Cultural Water Access Licence	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.7.
4. Fund water entitlements for Aboriginal communities	✓	not assessed	insufficient information to assess	→	The NSW Water Strategy action 2.3: *Provide Aboriginal ownership of and access to water for cultural and economic purposes* provides the overarching framework. This will also be considered as part of the NSW Aboriginal Water Strategy.
5. Secure flows for water-dependent cultural sites	✓	not assessed	insufficient information to assess	→ ✓	The NSW Water Strategy action 2.1: *Strengthen the role of First Nations/ Aboriginal People in water planning and management* provides the overarching framework. This will be considered as part of the NSW Aboriginal Water Strategy. Incorporated into Murrumbidgee Regional Water Strategy proposed actions 2.1 and 4.2.
6. Shared benefit project (environment and cultural outcomes)	✓	not assessed	minor/ moderate improvement (regarding environmental effects only)	→	The NSW Water Strategy action 2.1: *Strengthen the role of First Nations/ Aboriginal People in water planning and management* provides the overarching framework. This will be considered as part of the NSW Aboriginal Water Strategy.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
7. Support long-term participation of local Aboriginal people in water-related matters	✓	not assessed	insufficient information to assess	› ✓	The NSW Water Strategy action 2.1: *Strengthen the role of First Nations/ Aboriginal People in water planning and management* provides the overarching framework. This will be considered as part of the NSW Aboriginal Water Strategy. Incorporated into Murrumbidgee Regional Water Strategy proposed action 1.4.
8. Incorporate Aboriginal history of water and culture in the southern Basin into water data	✓	not assessed	minor/ moderate improvement (regarding environmental effects only)	› ✓	The NSW Water Strategy action 2.5: *Work with First Nations/ Aboriginal People to improve shared water knowledge* provides the overarching framework. This will also be considered as part of the NSW Aboriginal Water Strategy. Incorporated into Murrumbidgee Regional Water Strategy proposed action 1.4.
9. Review drought rules for the Murrumbidgee region	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 1.2.
10. Review the allocation and accounting framework in the Murrumbidgee (surface water)	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 1.2.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
11. Review groundwater extraction limits	✓	not assessed	no/little change	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 1.1.
12. Provide increased clarity about sustainable groundwater management	✓	not assessed	minor/ moderate improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.1, 2.5 and 3.2.
13. Investigate Water Access Licence conversion	✓	Assessment of this option was split into 2 – See results for option 13a and 13b in Attachment C	minor/ moderate impact	13a ✓ 13b ✗	Option 13a incorporated into Murrumbidgee Regional Water Strategy proposed action 1.2.
14. Investigate land use change and population growth impacts on water resources	✓	not assessed	minor/ moderate improvement	✓ ›	This action will be progressed through the NSW Water Strategy action 4.4: *better integrate land use planning and water management*. Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.5, 3.5 and 4.4.
15. Strengthen inter-jurisdictional water management	✓	not assessed	minor/ moderate improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 4.1 and 4.4.
16. Develop climate risk evidence base to inform the next Snowy Water Licence Review	✓	not assessed	minor/ moderate improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 1.3.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
17. Enhance southern inland floodplain management plans	✓	not assessed	minor/ moderate improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 2.4.
18. Review impediments to water recycling projects	✓	not assessed	no/little change	✓ ›	This would be investigated as part of town Integrated Water Cycle Management Plans through Safe and Secure Water Program. Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.4.
19. Assess potable re-use for towns	✓	not assessed	no/little change	› ✓	This would be investigated as part of town Integrated Water Cycle Management Plans through Safe and Secure Water Program. Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.4.
20. Managed aquifer recharge investigations and policy	✓	not assessed	no/little change	› ✓	The action is being addressed at a state level in the NSW Groundwater Strategy. Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.2.
21. Secure and reliable access to groundwater for towns	✓	not assessed	no/little change	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.1, 3.2 and 3.4.
22. Maintain water-related amenity in the Murrumbidgee region during droughts	✓	not assessed	no/little change	›	This would be investigated as part of town Integrated Water Cycle Management Plans through Safe and Secure Water Program.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
23. Improve protection of groundwater dependent ecosystems	✓	not assessed	minor/ moderate improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.1 and 2.5.
24. Address cold water pollution	✓	not assessed	major/extreme improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 2.3.
25. Improve flows to important ecological sites	✓	not assessed	major/extreme improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 2.1 and 2.10.
26. Develop a river and catchment recovery program for the Murrumbidgee region	✓	not assessed	major/extreme improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.4, 2.6, 2.7 and 4.2.
27. Investigate water quality improvement measures	✓	not assessed	major/extreme improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.1, 1.5, 2.1, 2.2, 2.3, 2.6, 4.2 and 4.3.
28. Manage groundwater salinity	✓	not assessed	minor/ moderate improvement	› ✓	The action is being addressed at a state level in the NSW Groundwater Strategy. Supported through Murrumbidgee Regional Water Strategy proposed action 1.1.
29. Assess pollution from disused mines and mineral occurrences	✗	not assessed	insufficient information to assess	›	This is being addressed through the Legacy Mines Program.
30. Review environmental water arrangements	✓	not assessed	minor/ moderate improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.2, 2.1, 2.2, 3.8 and 4.3.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
31. Re-establish threatened fish species through habitat restoration and conservation restocking	✓	not assessed	major/extreme improvement	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 2.3 and 4.2.
32. Monitor sediment compaction over the long term	✗	not assessed	minor/ moderate improvement	›	The action is being addressed at a state level in the NSW Groundwater Strategy.
33. Investigate alternatives for increased storage capacity	✓	assessed	major/extreme impact	Most elements not progressed. Only sub-option 33b has progressed ✓ ✗	Sub options 33a and 33c were not viable due to adverse results in the hydrological modelling, cost-benefit analysis, and environmental assessment. See Attachment C for full results. This option will be considered further through Murrumbidgee Regional Water Strategy proposed action 3.8.
34. Investigate new storage at Lake Mejum–Coolah	✓	not assessed due to a lack of information to be able to model appropriately	major/extreme impact	✗	Major/extreme environmental impacts expected. Previous investigations and customer feedback revealed the proposal was not an optimal site for off-river storage, and more viable alternatives exist.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
35. Install gravity pipeline along Tumut River	✓	assessed	minor/ moderate impact	✗	Deemed not viable due to adverse results in the hydrological modelling, cost-benefit analysis, and environmental assessment. Was also considered in combination with Option 36 – also not viable. See Attachment C for full results.
36. Raise Blowering Dam	✓	assessed	major/extreme impact	✗	Deemed not viable due to adverse results in the hydrological modelling, cost-benefit analysis, and environmental assessment. See Attachment C for full results.
37. Enlarge Burrinjuck Storage Reservoir	✓	assessed	major/extreme impact	✗	Deemed not viable due to adverse results in the hydrological modelling, cost-benefit analysis, and environmental assessment. See Attachment C for full results.
38. Expand Bundidgerry off-river storage and a new transfer canal	✓	assessed	major/extreme impact	✓	Considered viable for further consideration as part of Murrumbidgee Regional Water Strategy proposed action 3.8. See Attachment C for full results.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
39. Augment Tombullen Storage and modify operational changes	✓	only the operational changes assessed	major/extreme impact	✓	Only operational rule changes were assessed in this assessment. The results for option 38 provide an indication as to the potential benefits/ impacts of enlarging Tombullen storage. Viable for further consideration as part of Murrumbidgee Regional Water Strategy proposed action 3.8.
40. Investigate inter-regional connections	✗	not assessed	no/little change	✗	Does not meet a regional challenge.
41. Change environmental releases from Murrumbidgee storages	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 3.8 and 4.3.
42. Review flood management and airspace operation	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.2 and 3.8.
43. Investigate groundwater desalination for industry and towns	✓	not assessed	no/little change	✓ ›	The action is being addressed at a state level in the NSW Groundwater Strategy. Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.4.
44. Better understand water use with data collection and analytics	✓	not assessed	no/little change	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.6.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
45. Improve the understanding of groundwater sources and processes, risks and impacts	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 1.1, 2.5 and 3.2.
46. Undertake a water dependent industry resilience study	✓	not assessed	no/little change	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 1.5.
47. Develop targeted education and capacity building programs	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.6.
48. Investigate water availability in the Murrumbidgee region	✓	not assessed	insufficient information to assess	›	A working group of industry stakeholders, and NSW and Australian government agencies has been established to explore the issue of potential underuse.
49. Investigate non-residential water efficiency (towns and industries)	✓	not assessed	no/little change	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 3.4 and 3.5.
50. Investigate the expansion of cloud seeding in key water supply catchments	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.3.
51. Undertake joint exploration for groundwater with the NSW Geological Survey	✓	not assessed	no/little change	›	The action is being addressed at a state level in the NSW Groundwater Strategy.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
52. Review water markets and trade	✓	not assessed	no/little change	→	This option is being addressed through the current water market reforms in the Murray–Darling Basin.
53. Consider hydrological processes in bushfire management	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 2.6 and 3.3.
New Option: Sharing of new Regional Water Strategy climate and modelling data with local water utilities to inform local strategic planning	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.4.
New Option: Improve channel sharing arrangements for environmental water releases	✗	not assessed	insufficient information to assess	✗	Did not meet a regional challenge.
New Option: Training and information products	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed action 3.6.
New Option: Undertake a town water vulnerability study	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy proposed actions 3.4 and 3.5.
New Option:Upper Murrumbidgee River Improvements	✓	not assessed	insufficient information to assess	✓	Incorporated into Murrumbidgee Regional Water Strategy Priority 4.

Attachment C: Assessment of options that impact supply, demand, or allocation of water

This attachment summarises the results of the hydrologic, economic, and environmental assessment of the 11 options in the draft Murrumbidgee Regional Water Strategy that were able to be hydrologically assessed as they potentially impact the supply, demand, or allocation of water in the regulated river system.

Assessment was done by first adding the option into the Department's river system models and observing the changes that occurred to extraction of water and flows compared to the base case of current situation.

Importantly, the modelling assumed that the diversion limit set by the Basin Plan is not exceeded. This was done by reducing the amount of water for lower priority licences if an option would have resulted in the diversion limits being exceeded.

In the past, water infrastructure and policy changes have been assessed against approximately 130 years of data – the historical set of instrumental data. Using the long-term paleoclimatic analysis developed for the regional water strategies, together with projections of future climate change gives us a much better understanding of the water risks that the region could face and how well different options could perform under different climate scenarios that we haven't seen in our observed past. The rapid cost-benefit analysis (CBA) was carried out using the historical data, while the detailed CBA and environmental assessments were carried out using the new long-term climate datasets.

The long-term climate data sets comprise:

- the long-term historical climate scenario, which is a 10,000-year synthetic data set based on paleoclimatic analysis
- the dry future climate change scenario, which is essentially the long-term historical climate scenario, adjusted by a set of scaling factors derived from the NARCliM project (SRES A2 climate scenario).

For the purposes of the economic and environmental assessments, these datasets were broken down into 1,000 periods (termed realisations for the purposes of this assessment) of 40-year duration. This allows us to understand the economic and environmental impacts over the 40-year outlook of the regional water strategies. It also allows us to better plan for uncertainty by considering 1,000 different possibilities of what the climate may look like over the next 40 years, given the assumed climate scenario.

Ecological assessment methods

The ecological effects of the options were modelled and assessed at 37 selected flow gauge sites across the regulated watercourses across the Murrumbidgee River catchment. The sites were selected based on their proximity to the impacts of the option and relationship to the likely or potential ecological requirements of aquatic flora and fauna.

Following on from the rapid ecological assessment which involved a high-level assessment based on expert opinion, flow metrics used for this assessment involved commonly[98] and readily used flow metrics that describe typical components of the flow regimes upon which flow-dependent species and communities rely. These include the frequency and duration of no flow events and base flows, the frequency of freshes, large and infrequent bank-full and overbank flows, low flows (90th and 95th percentile flows) and the annual volume of flows (standard metrics in Table 13).

Key high flow Environmental Water Requirement (EWR) metrics (Table 12) were gained from environmental water managers as being key metrics with regard to management of ecological assets. These metrics were closely aligned to metrics and objectives in the Murrumbidgee Long Term Watering Plan (LTWP).[99]

98. For example, in DoI Water (2019). *Risk Assessment for the Murrumbidgee Water Resource Plan Area (SW9): Part 1. Schedule D.*
99. Department of Planning, Industry and Environment (2020). *Murrumbidgee Long Term Water Plan. Part B: Murrumbidgee planning units.*

These flow metrics were assessed for the long-term historical past climate and dry future climate scenarios. The results were then categorised as having an impact from extreme improvement to extreme detrimental impact to rate the potential impacts or benefits to the environment. The rapid environmental assessment uses a 5-category ranking and this detailed assessment uses the expanded 11-category ranking. The effect on these metrics was calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios using the categories in Table 11.

The absolute values (Abs) for these EWR thresholds are shown to indicate whether these metrics are being met under Long-Term Water Plan recommendations.

The optimal range for the frequency of these Balranald and Darlington Point high flows range from 3 to 10 years in 10 years. The flows need a duration of 5 days or more for connectivity (such as for fish dispersal), but also need occasional events that allow 3–10 months of persistent water. This persistence will depend on the volume and duration of flows, but also the capacity of the local floodplain to retain flood water. The time between these high flow events at Balranald should be no more than 2 years for non-woody vegetation and frog (floodwater-initiated) recruitment but could be up to 5 years for fish dispersal and connection. At Darlington Point, these should be no more than 1.5 years to enable a large fresh with wetland connection but can be up to about every 5 years for fish dispersal and connection.

Table 11. Explanation of categories used in ecological assessment

Stage 1 category	Stage 2 category	Estimated percentage change in hydrology/ecology
Major/Extreme impact	**Extreme impact**	More than 30% change in a negative direction (i.e. < -30%)
	Major impact	More than 20% change in a negative direction (i.e. < -20%)
Minor/Moderate impact	**Moderate impact**	More than 10% change in a negative direction (i.e. < -10%)
	Minor impact	More than 3% change in negative direction (i.e. < -3%)
No/Little change	**Little impact**	Less than 3% change in a negative direction (i.e.< 0%)
	No change	0%, rounded to the nearest whole percentage point
	Little improvement	Less than 3% change in a positive direction (>0% and <3%)
Minor/Moderate improvement	**Minor improvement**	More than 3% change in a positive direction (i.e. >3%)
	Moderate improvement	More than 10% change in a positive direction (i.e. >10%)
Major/Extreme improvement	**Major improvement**	More than 20% change in a positive direction (i.e. >20%)
	Extreme improvement	More than 30% change in a positive direction (i.e. >30%)

Table 12. Environmental Water Requirement metrics used in quantitative assessments

Metric (unit of measurement)	Option description	Beneficial % change
Environmental Water Requirements (EWRs)	**Large fresh, wetland inundation and small overbank[100] flows identified as important by environmental water managers**	
Frequency of Balranald high flows (events/130 years)	5,000–12,000 ML/day at Murrumbidgee River at D/S Balranald Weir (site 410130) flows, for a minimum of 5 days at any time of the year. 410130 is the reference gauge for the 'Balranald to Murray' Planning Unit in the Long-Term Watering Plan, and so represents the end of this river system and is just downstream of Yanga Lake.	Increase
Time between Balranald high flows (years)	Events as defined above.	Decrease
Duration of Balranald high flows (days)	Events as defined above.	Increase
Frequency of Darlington Point high flows (events/130 years)	15,000–40,000 ML/day at Murrumbidgee River at Darlington Point (410021), for a minimum of 5 days at any time of the year. 410021 is the reference gauge for the 'Gogeldrie Weir to Maude Weir' Planning Unit in the Long-Term Watering Plan. It is at the approximate downstream end of the mid-Murrumbidgee wetlands.	Increase
Time between Darlington Point high flows (years)	Events as defined above.	Decrease
Duration of Darlington Point high flows (days)	Events as defined above.	Increase
Standard metrics	**Commonly used ecological metrics**	
Median annual flow (ML (megalitres))	The median of the annual flow rates (ML/year) calculated from the time series model.	Increase
Mean annual flow (ML)	The average of the annual flow rates (ML/year) calculated from the time series model.	Increase
Mean duration of no flow events (days)	The average duration (consecutive days) of no flow events per water year. Longer no flow events adversely impact species that rely on in-stream refuges.	Decrease
Number of no flow events (events/130 years)	The average number of no flow events per water year in the time series model. More frequent no flow events adversely impact species that rely on in-stream refuges.	Decrease
Number of years with a no flow event (years/130 years)	The count of water years in the time series model with at least one identified no flow event.	Decrease

100. Types of Environmental Water Requirements (EWRs). See P. 41 Murrumbidgee Long Term Water Plan Part A: Murrumbidgee catchment.

Metric (unit of measurement)	Option description	Beneficial % change
Very low flow threshold (ML/day)	Flow rate (ML/day) for 95th percentile discharge of daily flows (for that option or the base case).	Increase
Days below the very low flow threshold (days/130 years)	Days below the 95th percentile threshold.	Decrease
Low flow standard deviation	Variation across days in the frequency of low flows.	Decrease
Low flow threshold (ML/day)	Flow rate (ML/day) for 90th percentile discharge of daily flows (for that option or the base case).	Increase
Days below the low flow threshold (days/130 years)	Days below the 90th percentile threshold.	Decrease
Base flow threshold (ML/day)	Base flows, defined as the 80th percentile flow (for that option or the base case), are typically confined to the low flow part of the channel. These enable longitudinal connectivity, and habitat types (riffles and pools) that support specialist aquatic species.	Increase
Fresh (20th percentile) flow threshold (ML/day)	Freshes, defined as the 20th percentile flow (for that option or the base case), typically inundate the sides of the banks and, if present, any in-channel bars and benches.	Increase
Number of freshes (events/year)	The average number of fresh events.	Increase
Mean duration of fresh events (days)	The average duration (consecutive days) of freshes.	Increase
Time between freshes (days)	The average time (consecutive days) between freshes.	Decrease
10-year ARI flow rate (ML/day)	The flow rate in ML/day that occurs in the model time series on a 10-year average recurrence interval (ARI). 1, 1.5-, 2-, 5- and 10-year ARIs reflect increasingly large and less frequent flows.	Increase

The changes effected by the proposed options would, in the scenarios shown, be changes in addition to the other changes due to climate. Some metrics will be under considerable stress already because of climate change effects. In particular, Table 13 indicates that under a the long-term historical and the dry future climate scenarios many measures of environmental requirement will be impacted by climate influences alone. These results[101] generally indicate a moderately more stressed flow regime under long-term historical conditions but, not surprisingly, much more stressed ecological conditions under a future dry climate.

101. It should also be noted that these are compounding effects. That is, the results for the long-term historical climate scenario compares to the changes from the historical scenario. Whilst the dry future climate is compared to the long-term historical climate scenario.

Table 13. Predicted environment effects under a long-term historical past climate and dry future climate using standard environmental metrics

	Long-term historical climate	Dry future climate
Metric	**Average effect**	
Mean annual flow (ML)	no effect	extreme impact
Median annual flow (ML)	no effect	extreme impact
Duration of no flow spells (days)	extreme improv	moderate impact
Number of no flow events per 130 years	moderate improv	extreme impact
Number of years with a no flow event	moderate improv	extreme impact
Very low flow discharge (95th percentile, ML/day)	minor impact	major impact
Days below the very low flow rate	moderate impact	extreme impact
Low flow discharge (90th percentile, ML/day)	minor impact	major impact
Days below the low flow rate	no effect	minor impact
Low flow standard deviation	minor improv	minor impact
Base flow threshold (ML/day)	no effect	major impact
Fresh (20th percentile) flows (ML/day)	minor improv	extreme impact
Number of freshes (events/year)	no effect	minor impact
Duration of freshes (days)	minor improv	moderate impact
Time between freshes (days)	minor impact	moderate improv
High flows with a 1-year recurrence (ML/day)	minor impact	extreme impact
High flows with a 1.5-year recurrence (ML/day)	minor impact	extreme impact
High flows with a 2-year recurrence (ML/day)	minor improv	extreme impact
High flows with a 5-year recurrence (ML/day)	minor improv	extreme impact
High flows with a 10-year recurrence (ML/day)	moderate improv	extreme impact

Options assessment results

Results of the hydrological, cost-benefit and environmental assessments of these options are presented below.

Option 13a: Investigate water access licence conversion of 10% of general security entitlements to high security

Purpose	To give regulated river water users the ability to improve the security of their entitlements.
Description	This option involves the voluntary conversion of 10% of consumptive general security (GS) entitlements to high security (HS) entitlements. To ensure SDL compliance, we derived a conversion factor for the converted entitlements and increased the storage reserve by the additional HS entitlements. The conversion factor for this option was found to be 0.42.
Results	Option 13a is viable for shortlisting. The hydrological modelling results and in particular, the economic assessment results, showed that the benefits outweighed potential impacts. In addition, impacts on environmental metrics were negligible. In particular, the modelling results indicate nil changes on HS allocations in general for all climate scenarios, except the potential for a slight decrease under the dry future climate scenario (but this is within the error bounds of the model). There were minor increases in GS effective allocations for 30 September and minimal to nil increases in GS effective allocations for 30 June, which are likely within the model error bounds. Supplementary (Supp.) and local water utilities (LWU) water diversions were not materially affected. There is also very little impact on average end-of-system flows. As expected, the model indicates a substantial increase to HS (~19%) diversions and a decrease in GS (~8–10%) diversions for all climate scenarios due to the changed portion of entitlement shares. Note that this option is expected to help transfer the use of inflows from wet years (when typically demands are lower) to more moderate or dry years. In terms of cost benefits results, there are negligible changes for towns in all modelled climate scenarios. While annual crops results show a decrease in economic outcome (~7–8%) for all modelled climate scenarios. However, permanent crops indicate a positive impact for all modelled climate scenarios with increases in the range of 17–18%. The ecohydrological analysis indicated that the environmental effects of Option 13a are few. Minor to moderate impacts were observed at a minority of sites, such as minor impacts on the days below the low flow threshold. It is noted that this option also drew concerns from water user stakeholders, highlighting the potential for 3rd party impacts on the reliability of the remaining GS water entitlements. As such, implementation of this action would need to be done with close engagement of stakeholders to understand and where possible, address concerns.
Limitations	The assumptions used in the modelling assessment were conservative in that they were specifically designed to not overstate benefits or underestimate impacts. The identification of a conversion factor, locations for conversions and proportion of sleeper licences, etc were all heavily considered in multiple modelling iterations and reflect this conservative approach. Further details on the modelled approach for this option can be found in the supporting document – *Hydrologic analysis of options for the Murrumbidgee Regional Water Strategy.*

Hydrological and cost-benefit analyses results

Summary of hydrological and rapid cost benefit assessment results are shown below. These changes in average results are compared to the base case (i.e. without the option).

Table 14. Hydrological results for Option 13a: Investigate water access licence conversion of 10% general security entitlements to high security

Prop	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.	LWU	Gauge 410130
Historical climate	0%	2%	0%	1%	20%	-8%	0%	0%	0%
Long-term historical climate	0%	3%	0%	1%	19%	-8%	0%	0%	-1%
Dry future climate	-1%	4%	0%	0%	19%	-10%	0%	0%	-1%

Notes: All results are changes in relation to the baseline modelling results.

High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover

Table 15. Cost benefit analysis for Option 13a: Investigate water access licence conversion of 10% of general security entitlements to high security

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	-261.4 (-6.9%)	1,254.6 (18%)	0.0	993.3	NA
Long-term historical climate	Negl	-241.4 (-6.8%)	1,249.9 (17.9%)	0.0	1,008.5	NA
Dry future climate	Negl	-191.6 (-8.1%)	1,084.5 (16.9%)	0.0	892.8	NA

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading~0). NA – Not available, represents BCR could not be calculated as this option has no cost; values in parenthesis are the % change values to the baseline values.

Environmental assessment

The effects on Option 13a shown by the standard statistics (Table 17) show on average no impact, although minor to moderate impacts are observed across some sites, such as moderate impacts on the days below the low flow threshold. There was a very minor (4%) improvement with a reduction in flows below the low flow rate under the long-term historical climate. This is broadly consistent with a prediction of minor to moderate impact in the rapid assessment.

The effects on Option 13a on the high flow environmental metrics (Table 16) are below the 3% change significance level and as such none of the cells are shaded. The largest proportional effects are reductions in fill frequency at 1% under both long-term historical and dry future climates.

High flow requirements (Table 16) are mostly met, as shown with the absolute vales. The required frequency of high-flow inundation (3 to 10 years in 10) is being met under both climate scenarios. The required duration (5 days or more) is being met in almost all scenarios, except in rare situations at around the 95th percentile when flows could be at or below a duration of 5 days under the dry future climate scenario. The required time between events (2–5 years) at Darlington Point is also below the requirements for large freshes or at the margin of requirements for fish dispersal in the most extreme percentile shown under a dry future climate. This is almost entirely a future dry climate effect, not an option effect. In these worst-case scenarios this could be significant for flood dependent species such as river red gum that often need flooding every 1–2 years,[102] or could affect vulnerable species like silver perch that require large flows for dispersing long distances[103] and for the survival of age 1+ juvenile fish.[104]

These effects are averaged over time at each gauge, so there could be low flow sequences in these records where ecological impacts occur that are shown in these results. For this reason, the 5th and 95th percentile results are also shown.

Table 16. Predicted environmental effects on high flow environmental metrics for Option 13a: conversion of 10% of general security entitlements to high security

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	-1 (Abs = 21)	-1 (Abs = 11)
Balranald high flow duration (days)	0 (0, 0) (Abs = 18 (3, 65))	0 (0, 0) (Abs = 17 (3, 61))
Time between high flow events (years) at Balranald	0 (0, 1) (Abs = 0.1 (0, 2))	0 (0, 1) (Abs = 0.3 (0, 4))
Darlington Point high flow frequency (/10 years)	0 (Abs = 13)	0 (Abs = 5)
Darlington Point high flow duration (days)	0 (0, 0) (Abs = 14 (8, 38))	0 (0, 0) (Abs = 13 (8, 31))
Time between high flow events (years) at Darlington Point	0 (0, 0) (Abs = 0.2 (0, 3))	0 (0, 1) (Abs = 0.7 (0, 8))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

102. Doody, T. M., Colloff, M. J., Davies, M., Koul, V., Benyon, R. G., & Nagler, P. L., 2015. *Quantifying water requirements of riparian river red gum (Eucalyptus camaldulensis) in the Murray–Darling Basin, Australia–implications for the management of environmental flows*. Ecohydrology, 8(8), 1471–1487.
103. Koster, W. M., Stuart, I., Tonkin, Z., Dawson, D., & Fanson, B., 2021. *Environmental influences on migration patterns and pathways of a threatened potamodromous fish in a regulated lowland river network*. Ecohydrology, 14(2), e2260.
104. Tonkin, Z., Stuart, I., Kitchingman, A., Thiem, J. D., Zampatti, B., Hackett, G., Koster, W., Koehn, J., Morrongiello, J., Mallen-Cooper, M. & Lyon, J., 2019. Hydrology and water temperature influence recruitment dynamics of the threatened silver perch Bidyanus bidyanus in a regulated lowland river. Marine and Freshwater Research, 70(9), 1333–1344.

Table 17. Predicted environmental effects on standard ecological metrics for Option 13a: conversion of 10% of general security entitlements to high security

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	no effect
Number of no flow events per 130 years	no effect	no effect
Number of years with a no flow event	no effect	no effect
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	minor improv	no effect
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	no effect	no effect
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Option 13b: Investigate water access licence conversion of 50% of general security entitlements to high security

Purpose	To give regulated river water users the ability to improve the security of their entitlements.
Description	This option involves the voluntary conversion of 50% of consumptive general security (GS) entitlements to high security (HS) entitlements. To ensure SDL compliance, we derived a conversion factor for the converted entitlements and increased the storage reserve by the additional HS entitlements. The conversion factor for this option was found to be 0.48.
Results	Option 13b is not viable for shortlisting. This assessment highlights that whilst there are economic benefits associated with this option, there is also the potential for unacceptable impacts on the environment. The modelling results show in the historical and long-term historical climate scenarios that HS allocation remains unchanged, while GS effective allocation increases by approximately 10% and 17%, respectively. However, in the dry future climate scenario, HS allocation decreases by 5%, and GS effective allocation increases by 4%. Additionally, there's a notable decrease in average annual flow at Balranald. The modelling also shows substantial changes in average water diversions. There is a significant increase in water diversions for HS entitlements across all scenarios, ranging from 106% to 111%, and a decrease in diversions for GS entitlements, ranging from 47% to 57% (as expected). The cost-benefit analysis shows that, annual crop economic outcomes experience substantial declines across all climate scenarios, ranging from approximately 39.4% to 44.1%. Inversely, permanent crops show positive impacts, with increases ranging from 88.4% to 102.2%. The environmental assessment highlights some adverse impacts on various environmental metrics. While there are improvements in minor high flow duration at Balranald and time between high flow events at Darlington Point, the option results in minor impacts on high flow frequency and time between high flow events at Balranald. There were minor impacts on the frequency of freshes, major impacts on the size of 2-year recurrence large flows, and minor-major impacts on days below the low and very flow thresholds (the 90th and 95th percentiles) across all river gauges. Additionally, the reduction in summer and autumn flows increased the risk of unsuitable river refuges. This option also drew significant concern from water user stakeholders, highlighting the potential for 3rd party impacts on the reliability of the remaining GS water entitlements.
Limitations	The assumptions used in the modelling assessment were conservative in that they were specifically designed to not overstate benefits or underestimate impacts. The identification of a conversion factor, locations for conversions and proportion of sleeper licences, etc were all heavily considered in multiple modelling iterations and reflect this conservative approach. Further details on the modelled approach for this option can be found in the supporting document – *Hydrologic analysis of options for the Murrumbidgee Regional Water Strategy*.

Hydrological and cost-benefit analyses results

Summary of hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 18. Hydrological results for Option 13b (average): Investigate water access licence conversion of 50% general security to high security

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.	LWU	
Historical climate	0%	10%	0%	1%	111%	-47%	1%	0%	-2%
Long-term historical climate	0%	17%	0%	2%	110%	-47%	2%	0%	-3%
Dry future climate	-5%	4%	-1%	-9%	106%	-57%	1%	0%	-7%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).
*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

Table 19. Cost benefit analysis for Option 13b: Investigate water access licence conversion of 50% of general security to high security entitlement

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	-1,486.5 (-39.4%)	7,111.6 (102.2%)	0.0	5,625.1	NA
Long-term historical climate	Negl	-1,391.2 (-39.3%)	7,104.1 (101.6%)	0.0	5,712.9	NA
Dry future climate	Negl	-1,044.5 (-44.1%)	5,678.6 (88.4%)	0.0	4,633.8	NA

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading). NA – Not available, represents BCR could not be calculated as this option has no cost; values in parenthesis are the % change values to the baseline values.

Environmental assessment

Option 13b shows minor effects on the high flow metrics specified by environmental managers, moderate impacts on the size of floods with a 2-year recurrence, and minor-major impacts on freshes, no flow days and days below the low and very low flow rates.

The effects on Option 13b on the high flow environmental metrics (Table 20) show minor impacts on flow frequency under both climate scenarios, and the time between events at Balranald under a dry future climate. At Darlington Point there is, however, a minor improvement in the time between events under a future climate.

Regarding the absolute values for the high flow metrics, the required frequency of high-flow inundation (3 to 10 years in 10) is met.

The required duration (5 days or more) is almost always met. The required time between events (2–5 years) is almost always met across all scenarios, except, because of climate change (not the option), in the driest of the dry future sequences.

The effects on Option 13b shown by the standard statistics (Table 21) show minor impacts on the frequency of freshes under a dry future climate, and minor-major impacts on days below the low and very flow thresholds (the 90th and 95th percentiles). In particular, the days below a very low flow increased within 22–24% within the 2 climates. The time between freshes was 11% and 17% less under a long-term historical climate and dry future climate respectively. Additionally, the reduction in summer and autumn flows increases the risk of unsuitable river refuges.

Table 20. Predicted environmental effects on flow metrics for Option 13b: Investigate water access licence conversion of 50% of general security entitlements to high security

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	-4 (Abs = 20)	-5 (Abs = 10)
Balranald high flow duration (days)	6 (0, 0) (Abs = 19 (3, 65))	0 (0, 2) (Abs = 17 (3, 61))
Time between high flow events (years) at Balranald	2 (0, 1) (Abs = 0.1 (0, 1.7))	9 (0, 4) (Abs = 0.3 (0, 3.9))
Darlington Point high flow frequency (/10 years)	2 (Abs = 14)	-3 (Abs = 5)
Darlington Point high flow duration (days)	0 (0, 0) (Abs = 14 (8, 38))	0 (0, 7) (Abs = 13 (8, 33))
Time between high flow events (years) at Darlington Point	0 (0, -1) (Abs = 0.2 (0, 2.9))	-4 (0, 8) (Abs = 0.7 (0, 8.5))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 21. Predicted environmental effect on standard ecological metrics for Option 13b: Investigate water access licence conversion of 50% of general security entitlements to high security

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	no effect
Number of no flow events per 130 years	no effect	no effect
Number of years with a no flow event	minor impact	minor impact
Very low flow discharge (95th percentile, ML/day)	minor impact	minor impact
Days below the very low flow rate	no effect	no effect
Low flow discharge (90th percentile, ML/day)	major impact	major impact
Days below the low flow rate	no effect	no effect
Low flow standard deviation	moderate impact	minor impact
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	minor impact
Time between freshes (days)	minor improv	minor improv
High flows with a 2-year recurrence (ML/day)	moderate impact	moderate impact
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	minor impact

Option 33a: Investigate new 47 GL weir near Gundagai on the lower Tumut River

Purpose	Provide re-regulation storage downstream of flow constraints on the Tumut River to improve efficiency and enable delivery of higher flows during peak demand periods in regulated river system operations.
Description	This option involves adding a 47 GL on-river storage on the Tumut River, just upstream of its confluence with the Murrumbidgee River. Such buffer storage would be utilised to assist in the delivery of water from Blowering Dam to downstream water users, during periods of high demand.
Results	Option 33a is deemed not viable it is expected that option 33b would fulfil the desired purpose, for a smaller investment, and negative environmental assessment. The hydrological modelling results for the historical climate scenario and long-term historical show there are no significant changes in effective allocations. However, in the dry future climate scenario, GS effective allocation increases somewhat by 4%. There's a minor decrease in average annual flow at Balranald across all scenarios. Additionally, there is a substantial decrease in average water diversions for supplementary access, ranging from -9.0% to -11%, due to the restrictions imposed to maintain overall water use consistent with the base case (as a surrogate for SDL compliance). The cost-benefit analysis shows negligible changes in economic outcomes for towns in all climate scenarios. However, there are minimal declines in economic outcomes for annual crops, ranging from approximately -0.5% to -0.6%. In contrast, there are modest positive impacts on permanent crops, with increases ranging from 0.5% to 6.0%. Despite these economic fluctuations, the net present value reflects significant variations in different scenarios, indicating potential uncertainty on implementation costs. The environmental assessment reveals some minor improvements in high flow Environmental Water Requirements (EWR) compared to the base case. There is a pattern of increased 'no flow' or below 'very low flow' periods, particularly under a dry future climate which would impact the survival and condition of aquatic and riparian flora and fauna. This increase in low- and no flow events could offset the benefits of high flows, leading to high mortality rates among aquatic organisms and heightened stress levels in riparian trees. Seasonal analysis indicates that these no- and very low flow impacts occur more often in Autumn. These findings indicate some environmental concerns associated with the implementation of this option.

Limitations	The assessment did not integrate assessment of this option with other rule-based or infrastructure improvements to the regulated system as they are not known now. Therefore, it is not possible to make a judgement as to how this option would perform as a buffer storage under a more broadly modified regulated system, and mitigate the risk of water delivery shortfalls during periods of peak demand. Impacts on Aboriginal cultural values and uses were also not assessed, nor impacts to adjoining properties to the proposed pondage. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (ie without option) model run. The cost estimate for this option was based upon: • Capital Expenditure (CAPEX) plus Discounted Cash Flow of Operational Expenditure minus Discounted Residual Value. CAPEX was based on a 'Class 5' level estimate in accordance with the Association for the Advancement of Cost Engineering (AACE) cost estimate classification system, which targets a level of project definition up to 2%. The CAPEX prepared is a summary of direct and indirect construction costs, however there are several exclusions such as land acquisition cost and environmental offsets.

Hydrological and cost-benefit analyses results

Summary of hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 22. Hydrological results for Option 33a: Investigate new 47 GL weir near Gundagai on the lower Tumut River

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	0%	0%	0%	1%	0%	1%	-9%	-2%	0%
Long-term historical climate	0%	2%	0%	1%	0%	1%	-9%	-2%	-1%
Dry future climate	1%	4%	1%	5%	1%	3%	-11%	-2%	-2%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

**Supplementary access was restricted in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000.*

Table 23. Cost benefit analysis result for Option 33a: Investigate new 47 GL weir near Gundagai on the lower Tumut River

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	-20.7 (-0.5%)	42.7 (0.6%)	291.2	-269.2	0.1
Long-term historical climate	Negl	-16.6 (-0.5%)	36.0 (0.5%)	291.2	-271.8	0.1
Dry future climate	0.3 (99.1%)	15.3 (0.6%)	386.4 (6.0%)	291.2	110.8	1.4

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading); values in parenthesis are the % change values to the base case values.

Environmental assessment

The main pattern is more dry periods, where the lower reach of the regulated river has either ceased flowing or is flowing below the 90th or 95th percentile, especially under a dry future climate. These results that are averaged across time are likely to reflect infrequent flow sequences where flows are much lower during low flow periods, which would greatly impact the survival and condition of aquatic and riparian flora and fauna. Infrequent extreme events such as extended drought often have major ecological consequences for river ecosystems.[105]

This was consistent with the rapid expert-based assessment that, against the broad banner of 'Investigate alternatives for increased storage capacity', predicted a major to extreme impact.

This option shows improvements in high flows, due to the restrictions placed on supplementary access to maintain overall diversions consistent with the base case. It had slight percentage improvements in the high flow EWRs at Balranald with duration and time between events. Regarding the absolute values for the high flow EWR thresholds, the required frequency of high-flow EWR inundation (3 to 10 years in 10) is met on average across all scenarios.

The required duration (5 days or more) of high flow EWRs is also always met. The required time between high flow EWR events(2–5 years) is also met and is often quite shorter. Similarly, the freshes in the standard statistics indicate some improvements in fresh frequency under the historical climate, and strong improvements in fresh duration overall.

There were, on average across sites, minor to major impacts on no and very low flows, with more days under low and very low flows under a dry future climate. Under a dry future scenario, there was a major effect on the days below the very low flow threshold. These effects would be likely to offset the minor benefits with the high flows as mortality of aquatic organisms such as fish and aquatic invertebrates is likely to be high during the no- or low flow events. Stress levels in riparian trees, especially river red gum, would also be higher between events and as such any recovery towards full condition after flood events will be less likely.[106] The minor increase in variation at low flows, especially under a dry future climate could reduce the recovery capacity of aquatic species. This option also shows reduced autumn flows compared to the base case under long-term historical scenarios.

105. Tonkin, J. D., 2022. *Climate change and extreme events in shaping river ecosystems*. Encyclopedia of Inland Waters, 2, 653–664.
106. Doody, T. M., Benger, S. N., Pritchard, J. L., & Overton, I. C., 2014. Ecological response of *Eucalyptus camaldulensis* (river red gum) to extended drought and flooding along the River Murray, South Australia (1997–2011) and implications for environmental flow management. *Marine and Freshwater Research*, 65(12), 1082–1093.

Table 24. Predicted environmental effects on high flow metrics for Option 33a: Investigate new 47 GL weir near Gundagai on the lower Tumut River

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	0 (Abs = 21)	1 (Abs = 11)
Balranald high flow duration (days)	6 (0, -2) (Abs = 19 (3, 64))	0 (0, 0) (Abs = 17 (3, 62))
Time between high flow events (years) at Balranald	-4 (0, 0) (Abs = 0.1 (0, 1.7))	0 (0, -3) (Abs = 0.3 (0, 3.7))
Darlington Point high flow frequency (/10 years)	2 (Abs = 14)	3 (Abs = 6)
Darlington Point high flow duration (days)	0 (0, 0) (Abs = 14 (8, 38))	0 (0, 3) (Abs = 13 (8, 32))
Time between high flow events (years) at Darlington Point	-2 (0, -1) (Abs = 0.2 (0, 2.9))	0 (0, -3) (Abs = 0.7 (0, 7.6))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 25. Predicted environmental effects on standard ecological metrics for Option 33a: Investigate new 47 GL weir near Gundagai on the lower Tumut River

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	no effect
Number of no flow events per 130 years	minor impact	minor impact
Number of years with a no flow event	minor impact	minor impact
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	moderate impact	major impact
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	minor impact	minor impact
Low flow standard deviation	no effect	minor impact
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	minor improv	no effect
Time between freshes (days)	minor impact	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Option 33b: Investigate new 20 GL weir near Gundagai on the Murrumbidgee River

Purpose	Provide re-regulation storage downstream of flow constraints on the Tumut River to improve efficiency and enable delivery of higher flows during peak demand periods in regulated river system operations.
Description	This option involves investigating a new 20 GL weir near Gundagai on the Murrumbidgee River to create buffer storage downstream of flow constraints in the Tumut River. Such buffer storage would be utilised to assist in the delivery of water from Blowering Dam to downstream water users, during periods of high demand.
Results	Viable for further consideration the shortlist as part of proposed action 3.8 Manage delivery risks in the regulated Murrumbidgee River. Despite the negative benefit cost ratio, the option would help to mitigate the risk of delivery shortfalls, which are situations whereby water demands exceed the capacity of supply available that exists downstream of river capacity constraints in the Tumut River. Such events could lead to a loss in crop production. Compared with Option 33a, which was not considered viable, the scale of the investment and expected environmental impacts would be smaller. Hydrological analyses indicate modest but tangible benefits for HS and GS. Notably, end-of-year allocations for GS could see improvements ranging from 4–9%, alongside increases in diversions of about 3–6%. However, it is important to note that supplementary access faces substantial reductions of, approximately 23% due to imposed restrictions aimed at maintaining overall water use consistent with baseline levels, a necessary step for SDL compliance. Furthermore, there are concerns regarding the reduction in average annual flow at Balranald, with decreases ranging from 0% to 2% across different climate scenarios. This reduction may have implications for ecological health and water availability in the region. The cost-benefit analysis indicates that while there are some economic benefits associated with the proposed option, these benefits are tempered by certain drawbacks. The analysis reveals that under historical, long-term historical, and dry future climate scenarios, there are small to negative changes in economic outcomes, including net present costs and net present values. Specifically, the economic outcomes for annual crops range from a decrease of 0.9% to 1% and for permanent crops, from an increase of 0.1% to 0.3%. The average benefit-cost ratio remains around -0.1 to 0 across all scenarios, suggesting that the economic viability of the proposed option may be negative. Such negative economic benefits are expected to be more of an artefact of the limitations placed on supplementary water use to meet SDL requirements in the assessment, than the option itself. Whilst there are some positive impacts on ecological outcomes, particularly regarding high flow event durations and breeding opportunities (for example, for waterbirds) near Darlington Point and Balranald, there are also ecological concerns, including because these events occur less often at Balranald. The option shows some ecological impacts including minor increases in the days below the very low flow threshold, minor increases in the duration of no flow spells and minor increases in the between freshes. Additionally, reductions in summer flows compared to the base case heighten low flow risks, including the potential for hypoxic conditions. These impacts would need to be addressed to minimise such risks and to also meet requirements of the Basin Plan (for example, against s10.28 – no net reduction in planned environmental water).

Limitations	The assessment did not integrate assessment of this option with other rule-based or infrastructure improvements to the regulated system as they are not known now. The analysis did not seek to optimise rules so as to minimise adverse environmental impacts caused by additional regulation. Therefore, it is not possible to make a judgement as to how this option would perform as a buffer storage, under a more broadly modified regulated system, and mitigate the risk of water delivery shortfalls during periods of peak demand. This assessment would be undertaken in the implementation of proposed action 3.8. Impacts on Aboriginal cultural values and uses were not assessed. Impacts to adjoining properties to the proposed pondage were also not assessed. These, and other matters, would need to be investigated as part of feasibility and environmental impact assessments. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (ie without the option) model run. A full assessment using the accredited SDL model would also be required in future investigations. The cost estimate for this option was based upon: • Capital Expenditure (CAPEX) plus Discounted Cash Flow of Operational Expenditure minus Discounted Residual Value. CAPEX was based on a pro-rata (according to storage volume) of the 'Class 5' level estimate for Option 33a above.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 26. Hydrological results for Option 33b: Investigate new 20 GL weir near Gundagai on the Murrumbidgee River

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	0%	5%	0%	4%	0%	3%	-23%	-1%	-1%
Long-term historical climate	0%	7%	0%	5%	1%	5%	-24%	-1%	-2%
Dry future climate	0%	7%	0%	9%	1%	6%	-23%	0%	-2%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover

**Supplementary access was restricted in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000*.

Table 27. Cost benefit analysis result for Option 33b: Investigate new 20 GL weir near Gundagai on the Murrumbidgee River

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	-34.7 (-0.9%)	20.1 (0.3%)	124.1	-138.7	-0.1
Long-term historical climate	Negl	-14.7 (-0.4%)	3.8 (0.1%)	124.1	-135	-0.1
Dry future climate	Negl	-22.9 (-1%)	22.3 (0.3%)	124.1	-124.6	0

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading). Values in parenthesis are the % change values to the baseline values.

Environmental assessment

The effects of the 20 GL weir option on the high flow environmental metrics (Table 28) are mixed, with a probable overall negative effect on ecological outcomes. There were minor to moderate improvements in high flow event duration at Balranald, and moderate improvements in the time between events at Darlington Point. These changes might improve the magnitude of ecological outcomes, such as the viability of waterbird recruitment by allowing more opportunities to breed at wetlands near Darlington Point, and for a longer time during a recruitment event at Balranald.

However, there were minor to moderate impacts on the time between events, and minor impacts on event frequency at Balranald. Moreover, the effects shown by the standard statistics (Table 29) show minor increases in the days below the very low flow threshold, minor increases in the duration of no flow spells and a minor reduction in the time between freshes. This option also shows reduced summer flows compared to the base case under both climate scenarios meaning that these impacts on low flow would be occurring when the river is low and more prone to low flow risks such as the development of hypoxic conditions.

Table 28. Predicted environmental effects on high flow metrics for Option 33b: Investigate new 20 GL weir near Gundagai on the Murrumbidgee River

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	-4 (Abs = 20)	0 (Abs = 11)
Balranald high flow duration (days)	11 (0, 5) (Abs = 20 (3, 68))	6 (0, 7) (Abs = 17 (3, 61))
Time between high flow events (years) at Balranald	4 (0, 1) (Abs = 0.1 (0, 1.7))	11 (0, -1) (Abs = 0.3 (0, 3.8))
Darlington Point high flow frequency (/10 years)	0 (Abs = 13)	-3 (Abs = 5)
Darlington Point high flow duration (days)	0 (0, 3) (Abs = 14 (8, 39))	0 (0, 10) (Abs = 13 (8, 34))
Time between high flow events (years) at Darlington Point	-16 (-25, 2) (Abs = 0.1 (0, 2.9))	-11 (0, 2) (Abs = 0.6 (0, 8))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 29. Predicted environmental effects on standard ecological metrics for Option 33b: Investigate new 20 GL weir near Gundagai on the Murrumbidgee River

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	minor impact	minor impact
Number of no flow events per 130 years	no effect	no effect
Number of years with a no flow event	no effect	no effect
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	minor impact	minor impact
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	no effect	no effect
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	minor improv	no effect
Time between freshes (days)	minor impact	minor impact
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Option 33c: Investigate new 1000 GL dam near Gundagai on the Murrumbidgee River

Purpose	To improve water security in the regulated Murrumbidgee region.
Description	This option involves investigating a new 1000 GL dam near Gundagai on the Murrumbidgee River.
Results	Option 33c is deemed not viable due to adverse results in the hydrological modelling, cost-benefit analysis and environmental assessment. In particular, the option was not considered viable due to extremely poor benefit-cost ratios, indicating its lack of economic viability. In the historical climate scenario, Option 33c shows significant increases in water allocations for GS entitlements, for example from 53% to 83% at 30 September. However, these increases are accompanied by a decrease in average annual flow at Balranald of up to 13% under a dry future climate scenario, signifying a detrimental impact on the flow regime. There is a complete restriction in diversions for consumptive supplementary access due to the restrictions imposed to maintain overall water use consistent with the base case (as a surrogate for SDL compliance). The cost-benefit analysis presents negligible to slightly negative changes in economic outcomes for towns and economic outcomes for crops. Essentially, the large investment is not able to realise the benefits because of maintaining compliance with the SDL. The environmental assessment underscores the impacts on the natural flow regime predicted by agency experts. There are extreme impacts on no flows and very low flows which indicate low flow risks such as hypoxia-related fish mortality events would be exacerbated. There are minor impacts on fresh frequency, moderate to major improvement in fresh duration, but moderate to major effects on the time between freshes. There are extreme impacts on the time between high flow events at Balranald but less impact on high flows at Darlington Point. In summary, Option 33c presents significant environmental concerns and economic challenges, rendering it not viable for implementation.
Limitations	Given the poor economic results on the historical scenario, the option was not economically assessed on either the long-term historical scenario or the dry future climate scenario, as the results are not expected to be significantly different enough to warrant their assessment. Impacts on the Murray system were not assessed, and, given the reduction in end of system flows in the results, there would likely be reduced water availability for the NSW Murray water users as well. Impacts on Aboriginal cultural values and uses were not assessed. Impacts to adjoining properties to the proposed pondage were also not assessed. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (i.e. without the option) model run. The cost estimate for this option was based upon: • Capital Expenditure (CAPEX) plus Discounted Cash Flow of Operational Expenditure minus Discounted Residual Value. CAPEX was based on a ‘cost-curve’ approach, which identifies a cost estimate based on the associated costs of comparable asset construction projects.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 30. Hydrological results for Option 33c: Investigate new 1000 GL dam near Gundagai on the Murrumbidgee River

Climate Dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	2%	44%	1%	23%	3%	18%	-100%	0%	-3%
Long-term historical climate	3%	55%	2%	18%	3%	17%	-100%	1%	-4%
Dry future climate	2%	81%	2%	61%	4%	35%	-100%	0%	-13%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

**Supplementary access was restricted in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000*.

***Under this scenario the lower Murrumbidgee could receive significantly lower flows.

Table 31. Cost benefit analysis result for Option 33c: Investigate new 1000 GL dam near Gundagai on the Murrumbidgee River

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	-19.1 (-0.5%)	10.2 (0.1%)	2,703.2	-2,712.1	0
Long-term historical climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*
Dry future climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading). Values in parenthesis are the % change values to the baseline values.

*These options were not modelled under the long-term historical and dry future climate scenarios as they resulted in such a poor BCR result under the historical scenario.

Environmental assessment

This option has numerous extreme impacts on the flow regime. There are extreme impacts on the time between high flow events at Balranald (Table 32). There are extreme impacts on the number of years with a no flow event under the long-term historical climate (Table 33). This would have more impact in summer and during autumn when low flow risks such as hypoxia-related fish mortality are higher.[107] Some sites are much more affected. Murrumbidgee River at Gundagai (410004) shifts from zero to 79% of years with a no flow event. Old Man Creek at Kywong (Top reeds, 410093) shifts from 3 to 46% of years with a no flow event. The number of days below the low and very low flow threshold are subject to extreme impacts across both climate scenarios. While there are moderate-major improvements in fresh duration the time between freshes are subject to a moderate to major reduction. This is consistent with the expert-based rapid assessment where under the more general banner of 'Investigate alternatives for increased storage capacity' the estimated impact was major to extreme.

This option is very detrimental to high flows at Balranald (Table 32). It has a major impact on flood frequency, where the effect of the climate often doesn't meet the requirement of 3–10 events per 10 years. It also has an extreme impact on the time between high flow events at Balranald, especially during very dry years within the long-term and future climate models (the 1 in 20 drier flow sequences). However, the absolute time between events (years) usually meets most requirements. The exception is under the more extreme scenarios within dry future climate conditions, where the frequency of large flows that enable wetland connections does not meet the required 1.5-year return frequency.

Compared to Balranald, this option causes less impact on high flows at Darlington Point. The option shows a negligible or minor effect on the frequency of events at Darlington Point under the long-term historical climate and dry future climate respectively. The option could add to the stress under a future climate as climate change would more than halve flow frequency overall so that the requirements of many organisms would not be met.

The time between high flow events at Darlington Point is moderately improved or not improved under the long-term historical and dry future climate scenarios respectively. However, the river and floodplain environment would be stressed during the driest (1 in 20) of very dry flow sequences (because of climate change, not the option). Under these extremely dry future events, the required high flow events are occurring approximately every 3 to 9 years within the long-term historical climate and dry-future climate respectively. These flows occur far less often than the required:

- 18 months between events to prevent drying out of refuge pools for floodplain specialist native fish
- two years between events for floodplain specialist fish, for waterbird foraging and breeding sites, and to increase cover and extent of non-woody vegetation communities.[108]

When these high flow events do occur at Darlington Point, they have a minor or moderate improvement in duration, often meeting the target of 5 days or more. These occur more often at the same time of year as under the base case, and so could often be environmentally beneficial in this limited regard.

107. Baldwin, D.S., 2019. *Weir stratification and hypoxic water management – Murrumbidgee River 2019*. A report prepared for the Commonwealth Environmental Water Office and the Murray–Darling Basin Authority. 45 pp.
108. Department of Planning, Industry and Environment (2020). *Murrumbidgee Long-Term Water Plan. Part B: Murrumbidgee planning units*.

Table 32. Predicted environmental effects on high flow environmental metrics for Option 33c: Investigate new 1000 GL dam near Gundagai on the Murrumbidgee River

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	-14 (Abs = 18)	-11 (Abs = 10)
Balranald high flow duration (days)	22 (0, 8) (Abs = 22 (3, 70))	6 (33, 2) (Abs = 18 (3, 65))
Time between high flow events (years) at Balranald	31 (0, 6) (Abs = 0.2 (0, 1.8))	89 (0, -1) (Abs = 0.6 (0, 3.8))
Darlington Point high flow frequency (/10 years)	1 (Abs = 14)	-7 (Abs = 5)
Darlington Point high flow duration (days)	7 (0, 16) (Abs = 15 (8, 44))	15 (0, 16) (Abs = 15 (8, 36))
Time between high flow events (years) at Darlington Point	-13 (0, 1) (Abs = 0.1 (0, 3))	0 (0, 13) (Abs = 0.7 (0, 9))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 33. Predicted environmental effect on standard ecological metrics for Option 33c: Investigate new 1000 GL dam near Gundagai on the Murrumbidgee River

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	minor impact	no effect
Duration of no flow spells (days)	extreme impact	moderate impact
Number of no flow events per 130 years	major impact	moderate impact
Number of years with a no flow event	extreme impact	moderate impact
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	extreme impact	extreme impact
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	extreme impact	extreme impact
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	minor impact	no effect
Duration of freshes (days)	moderate improv	major improv
Time between freshes (days)	major impact	moderate impact
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Option 35: Install gravity pipeline along Tumut River

Purpose	To improve the delivery of water out of Blowering Dam and improve harmonisation of Blowering and Burrinjuck dam levels to increase system-wide water availability.
Description	This option involves investigating a 2000 ML/day additional outlet on Blowering Dam and gravity pipeline that returns water to the lower Tumut River, just upstream of the Murrumbidgee River confluence.
Results	Option 35 is deemed not viable due to adverse results in the hydrological modelling, cost-benefit analysis, and environmental assessment. In particular, the option was not considered viable due to extremely poor benefit-cost ratios, indicating its lack of economic viability. In the historical climate scenario, Option 35 shows a minimal decrease in water allocation for HS and GS entitlements, with a 2% reduction. While there are minimal to nil changes in average water diversions and annual flow at Balranald. However, in the long-term historical climate and dry future climate scenarios, the option demonstrates no substantial changes with a 4% increase in GS for the dry future climate scenario, suggesting limited impact on water allocation and flow dynamics. The cost-benefit analysis reveals negligible to negative changes in economic outcomes for all extractive users, towns, annual irrigators and permanent crops. The environmental assessment indicates minor effects on high flow metrics and minor-extreme impacts on no and very low flows. While there are no significant effects on high flow event frequency, there is a reduction in the duration of ecologically important high flows at Balranald under a dry future climate, which highlights potential ecological implications.
Limitations	Given the poor economic results on the historical scenario, the option was not economically assessed on either the long-term historical scenario or the dry future climate scenario, as the results are not expected to be significantly different enough to warrant their assessment. The modelling sought to optimise harmonisation between Blowering and Burrinjuck dams by minimising the combined spills from the dams, resulting more sensitive than the results from the installation of the pipeline. Impacts on Aboriginal cultural values and uses not assessed. Impacts to the properties where the pipeline would be sited were also not assessed. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (ie without the option) model run. The cost estimate for this option was based upon: • Capital Expenditure (CAPEX) plus Discounted Cash Flow of Operational Expenditure minus Discounted Residual Value. CAPEX was based on a ‘cost-curve’ approach, which identifies a cost estimate based on the associated costs of comparable asset construction projects.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 34. Hydrological results Option 35: Install gravity pipeline along Tumut River

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	0%	-2%	-1%	0%	0%	-1%	0%	0%	1%
Long-term historical climate	0%	0%	0%	0%	0%	-0%	0%	0%	0%
Dry future climate	0%	4%	0%	0%	0%	1%	0%	0%	0%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

Table 35. Cost benefit analysis result Option 35: Install gravity pipeline along Tumut River

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	-35 (-0.9%)	-5 (-0.1%)	13,571.7	-13,611.7	0
Long-term historical climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*
Dry future climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading). Values in parenthesis are the % change values to the baseline values.

*These options were not modelled under the long-term historical and dry future climate scenarios as they resulted in such a poor BCR result under the historical scenario.

Environmental assessment

Overall, this option had minor effects on high flow metrics (Table 36) and minor impacts on the frequency of no and a major to extreme impact on the days below the very low flow threshold, with the average extreme impact under a dry future climate (Table 37). The rapid agency expert assessment also had mixed results, where there was an overall impact estimate of minor to moderate impact, this reflected modelled impacts ranging from no to little change to major to extreme impact.

Effects on the high flow metrics were few (Table 36). There were no significant effects on event frequency, with the frequency under both climate scenarios regularly meeting requirements, but less so for Darlington Point under the future dry scenario where events tended to occur every second year on average. Some species require an event in 80% of years and so this frequency will adversely affect fish that require floodplain refugia, non-woody vegetation and waterbirds. However, this frequency will be sufficient for red gum replenishment and fish dispersal events.[109] There was a minor reduction in the duration of high flows at Balranald under a dry future climate, but the absolute values would generally meet requirements in each location. There were some very minor improvements in the time between events at Balranald but, again, the absolute values were generally meeting requirements. There were no significant effects for Darlington Point.

Table 36. Predicted environmental effects on high flow metrics for Option 35: Install gravity pipeline along Tumut River

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	2 (Abs = 21)	1 (Abs = 11)
Balranald high flow duration (days)	0 (0, -2) (Abs = 18 (3, 64))	-6 (0, 0) (Abs = 18 (4, 62))
Time between high flow events (years) at Balranald	-4 (0, -1) (Abs = 0.1 (0, 1.7))	-3 (0, -1) (Abs = 0.3 (0, 3.8))
Darlington Point high flow frequency (/10 years)	-1 (Abs = 13)	-3 (Abs = 5)
Darlington Point high flow duration (days)	0 (0, 0) (Abs = 14 (8, 38))	0 (0, 3) (Abs = 13 (8, 32))
Time between high flow events (years) at Darlington Point	0 (0, 1) (Abs = 0.2 (0, 2.9))	-1 (0, 2) (Abs = 0.7 (0, 8))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

109. Department of Planning, Industry and Environment (2020). *Murrumbidgee Long-Term Water Plan Part B: Murrumbidgee catchment*. Page 74

Table 37. Predicted environmental effects on standard metrics for Option 35: Install gravity pipeline along Tumut River

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	minor impact
Number of no flow events per 130 years	minor impact	minor impact
Number of years with a no flow event	minor impact	minor impact
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	major impact	extreme impact
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	minor impact	moderate impact
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Option 36: Raise Blowering Dam

Purpose	To improve water security in the regulated Murrumbidgee region.
Description	This option involves investigating the raising of the Blowering Dam spillway by 4.5 m to create an extra 200 GL of capacity (not a raising of the broader dam wall). It considers 2 variations in the pre-release compensation reserve airspace for Snowy Hydro electricity generation: • 100 GL of airspace • 200 GL of airspace.
Results	Option 36 is deemed not viable due to adverse results in the hydrological modelling and cost-benefit analysis. Both Option 36 variants, with 100 GL or 200 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation, show minimal changes in effective allocations across different climate scenarios. However, there are significant decreases in average water diversions for supplementary access, ranging from approximately -45% to -47%. Additionally, a no perceptible changes on average annual flow at Balranald is observed across all scenarios. These findings indicate that while there may be some adjustments in water allocations, the overall impact on water availability and flow patterns is relatively modest for both options. Comparable results for water allocations are achieved with the smaller investment proposed in option 33b. This is because of the effects of maintaining overall diversions to be consistent with that of the base case (a proxy for SDL compliance in this assessment) in both options. In terms of economic outcomes, both options yield negligible changes for towns across all climate scenarios. However, there are minor declines in economic outcomes for annual and permanent crops. Despite these fluctuations, there are significant variations in net present value across different scenarios, suggesting potential uncertainty regarding implementation costs. This underscores the need for careful consideration of the economic implications of either option. Regarding environmental impacts, both Option 36 variants show minor effects on high flow metrics and minor reductions in the frequency of no-flow events and days below the very low flow threshold. Hence, there are concerns about ecological impacts on larger flows, and the range of results indicate greater impacts at a local level.
Limitations	Impacts on Aboriginal cultural values and uses were not assessed. Impacts to bank stability of the Tumut River and impacts to adjoining properties to the proposed pondage were also not assessed. These, and other matters, would need to be investigated as part of feasibility and environmental impact assessments. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (ie without the option) model run. A full assessment using the accredited SDL model would also be required in future investigations. The cost estimate for this option was based upon Capital Expenditure (CAPEX) plus Discounted Cash Flow of Operational Expenditure minus Discounted Residual Value. CAPEX was based on a 'Class 5' level estimate in accordance with the Association for the Advancement of Cost Engineering (AACE) cost estimate classification system, which targets a level of project definition up to 2%. The CAPEX prepared is a summary of direct and indirect construction costs however, there are exclusions such as land acquisition cost and environmental offsets. Another issue that is not considered in this assessment, is the likely detrimental impacts on channel erosion and bank stability for the Tumut River, due to the added volume of supply that will need to pass through.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 38. Hydrological results Option 36: Raise Blowering Dam with 100 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	0%	7%	0%	4%	1%	5%	-46%	0%	0%
Long-term historical climate	0%	9%	0%	2%	1%	5%	-47%	0%	0%
Dry future climate	0%	7%	0%	7%	0%	5%	-45%	0%	0%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

**Supplementary access was restricted (50% reduction) in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000.*

Table 39. Hydrological results Option 36: Raise Blowering Dam with 200 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation

Climate dataset	Change in average (30 Sept.) effective allocation (%)		Change in average (30 June) effective allocation* (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security	High security	General security	High security	General security	Supp.**	LWU	
Historical climate	0%	5%	0%	4%	0%	5%	-46%	0%	0%
Long-term historical climate	0%	9%	0%	2%	1%	5%	-47%	0%	0%
Dry future climate	0%	7%	0%	5%	0%	5%	-45%	0%	1%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*Effective allocation totals the announced Available Water Determination + carryover.

**Supplementary access was restricted (50% reduction) in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000.*

Table 40. Cost benefit analysis results Option 36: Raise Blowering Dam with 100 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	0 (94.2%)	-116.9 (-3.1%)	-0.2 (0%)	116.3	-233.3	-1
Long-term historical climate	0 (1.5%)	-89.4 (-2.5%)	2.1 (0%)	116.3	-203.6	-0.8
Dry future climate	0 (4.6%)	-95 (-4%)	17.2 (0.3%)	116.3	-194.1	-0.7

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading). Values in parenthesis are the % change values to the baseline values.

Table 41. Cost benefit analysis results Option 36: Raise Blowering Dam with 200 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	0 (100%)	-134.2 (-3.6%)	-3.7 (-0.1%)	116.3	-254.3	-1.2
Long-term historical climate	0 (0.9%)	-87 (-2.5%)	-3.6 (-0.1%)	116.3	-206.8	-0.8
Dry future climate	0 (2.6%)	-88.1 (-3.7%)	-18.2 (-0.3%)	116.3	-222.5	-0.9

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading. Values in parenthesis are the % change values to the baseline values.

Environmental assessment of raising Blowering Dam with a 100 GL airspace for pre-release compensation reserve for Snowy Hydro electricity generation

Overall, this option had minor effects on the high flow metrics (Table 42) and showed a minor reduction in the frequency of years with no flow events under a long-term historical climate and the number of days below the very low flow threshold under a dry future climate (Table 43). These are smaller changes than were expected in the rapid expert-based assessment, which provided impact estimates of major to extreme.

Option-related effects on the high flow metrics were all minor, with the only benefit just above the 3% significance threshold for the dry future climate, and the underlying absolute flow frequencies meeting Long Term Watering Plan requirement of typically between 3 to 10 years in 10 in any case (Table 42). Similarly, the reductions in duration, and extended time between events at Balranald are unlikely to impact environmental features as the underlying absolute numbers also meet LTWP requirements of typically 5 days or more of duration, and time between events of 2–5 years or less.

Table 42. Predicted environmental effects on high flow metrics for Option 36: Raise Blowering Dam with a 100 GL airspace

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	1 (Abs = 21)	4 (Abs = 11)
Balranald high flow duration (days)	0 (0, -2) (Abs = 18 (3, 64))	-6 (0, -3) (Abs = 16 (3, 59))
Time between high flow events (years) at Balranald	0 (0, -2) (Abs = 0.1 (0, 1.7))	4 (0, -5) (Abs = 0.3 (0, 4))
Darlington Point high flow frequency (/10 years)	1 (Abs = 14)	1 (Abs = 5)
Darlington Point high flow duration (days)	0 (0, -3) (Abs = 14 (8, 37))	0 (0, 0) (Abs = 13 (8, 31))
Time between high flow events (years) at Darlington Point	4 (0, -1) (Abs = 0.2 (0, 3))	2 (0, 0) (Abs = 0.7 (0, 8))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 43. Predicted environmental effects on standard ecological metrics for Option 36: Raise Blowering Dam, with a 100 GL airspace

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	no effect
Number of no flow events per 130 years	no effect	no effect
Number of years with a no flow event	minor improv	no effect
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	no effect	minor improv
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	no effect	no effect
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Environmental assessment of raising Blowering Dam with 200 GL airspace for pre-release compensation reserve for Snowy Hydro electricity generation

Increasing the airspace reserve from 100 to 200 GL produced very similar effects for this option. The differences in the effects on high flow metrics were all around 1% or less, and so could be considered equivalent (Table 44). The standard metrics results are almost the same (Table 45). These showed a minor reduction in the frequency of years with no flow events under a long-term historical climate and (because of very slightly larger percentage compared to the 100 GL option) also under a dry future climate. The sites with the larger percentage changes are very small differences in absolute terms, with, for example, under the long-term historical climate, the number of low flow days per 130 years increasing from 3.8 to 3.9 for Tumut River at Oddys Bridge for both the 100 and 200 GL options. Again, the number of days below the very low flow threshold were less frequent under a dry future climate (Table 43). Again, these are smaller changes than were expected with the rapid assessment, which provided impact estimates of major to extreme.

Table 44. Predicted environmental effects on high flow metrics for Option 36: Raise Blowering Dam with a 200 GL airspace

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	2 (Abs = 21)	5 (Abs = 11)
Balranald high flow duration (days)	0 (0, -3) (Abs = 18 (3, 63))	-6 (0, -3) (Abs = 16 (3, 59))
Time between high flow events (years) at Balranald	0 (0, -2) (Abs = 0.1 (0, 1.7))	3 (0, -5) (Abs = 0.3 (0, 3.6))
Darlington Point high flow frequency (/10 years)	1 (Abs = 14)	3 (Abs = 6)
Darlington Point high flow duration (days)	0 (0, -3) (Abs = 14 (8, 37))	0 (0, 0) (Abs = 13 (8, 31))
Time between high flow events (years) at Darlington Point	4 (0, -1) (Abs = 0.2 (0, 2.9))	3 (0, -2) (Abs = 0.7 (0, 7.7))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 45. Predicted environmental effects on standard metrics for Option 36: Raising Blowering Dam with a 200 GL airspace

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	no effect
Number of no flow events per 130 years	no effect	no effect
Number of years with a no flow event	minor improv	minor improv
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	no effect	minor improv
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	no effect	no effect
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Option 36a. Combined gravity pipeline along Tumut River and raised Blowering Dam

Purpose	To improve the delivery of water out of Blowering Dam and improve harmonisation of Blowering and Burrinjuck dam levels to increase system-wide water availability to improve water security in the regulated Murrumbidgee region.
Description	This is a combination of options 35 and 36 (Tumut gravity pipeline and the enlarged Blowering Dam). This also explores the 2 Blowering airspace options of 100 and 200 GL.
Results	Option 36a is deemed not viable due to adverse results in the hydrological modelling, cost-benefit analysis, and environmental assessment. In particular, the option was not considered viable due to extremely poor benefit-cost ratios, indicating its lack of economic viability. In all climate scenarios, Option 36a shows minimal to no change in water allocation for both HS and GS entitlements, with slight variations in average water diversions and annual flow at Balranald. While the changes are marginal, they signify a potential disruption in the natural flow regime, albeit not significant. The cost-benefit analysis reveals negligible to no changes in economic outcomes for towns and annual crops under the historical climate scenario. However, there are slight negative changes in permanent crops. Despite these minor fluctuations, the net present value indicates no significant deviation from the baseline, suggesting limited economic impact. In other climate scenarios, the option wasn't even considered viable due to extremely poor benefit-cost ratios, indicating its lack of economic viability. The environmental assessment indicates some extreme impacts. There are minor impacts on the high (large fresh to overbank) flows identified by environmental water managers and major to extreme increases in the frequency of flows below the very low flow threshold. Some individual sites experience extreme impacts with no, low, and very low flows. This indicates environmental challenges associated with Option 36a.
Limitations	Given the poor economic results on the historical scenario, the option was not economically assessed on either the long-term historical scenario or the dry future climate scenario, as the results of those are not expected to be significantly different enough to warrant their assessment. Impacts on Aboriginal cultural values and uses were not assessed. Impacts to adjoining properties to the proposed pondage and impacts to the properties where the pipeline would be sited were also not assessed. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (i.e. without the option) model run. The cost estimate for this option was based on the combined cost estimates for options 35 and 36.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 46. Hydrological results Option 36a: Combined gravity pipeline along Tumut River and raised Blowering Dam with 100 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	0%	2%	0%	1%	0%	1%	-10%	0%	1%
Long-term historical climate	0%	7%	0%	1%	0%	3%	-10%	0%	-1%
Dry future climate	0%	7%	0%	5%	0%	4%	-10%	0%	-1%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

**Supplementary access was restricted (84% of baseline) in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000*.

Table 47. Hydrological results Option 36a: Combined gravity pipeline along Tumut River and raised Blowering Dam with 200 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation

Climate dataset	Change in average (30 Sept.) effective allocation (%)		Change in average (30 June) effective allocation* (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security	High security	General security	High security	General security	Supp.**	LWU	
Historical climate	0%	2%	0%	1%	0%	1%	-10%	0%	0%
Long-term historical climate	0%	7%	0%	1%	0%	3%	-9%	0%	-1%
Dry future climate	0%	7%	0%	5%	0%	4%	-9%	0%	-1%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*Effective allocation totals the announced Available Water Determination + carryover.

**Supplementary access was restricted (50% reduction) in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000*.

Table 48. Cost benefit analysis results Option 36a: Combined gravity pipeline along Tumut River and raised Blowering Dam with 100 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	0 (98.8%)	-8.9 (-0.2%)	-0.7 (0%)	13,688	-13,697.6	0
Long-term historical climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*
Dry future climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading Values in parenthesis are the % change values to the baseline values.

*These options were not modelled under the long-term historical and dry future climate scenarios as they resulted in such a poor BCR result under the historical scenario.

Table 49. Cost benefit analysis results Option 36a: Combined gravity pipeline along Tumut River and raised Blowering Dam with 200 GL of pre-release compensation reserve airspace for Snowy Hydro electricity generation

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	0 (100%)	-9 (-0.2%)	-9.2 (-0.1%)	13,688	-13,706.2	0
Long-term historical climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*
Dry future climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*

*These options were not modelled under the long-term historical and dry future climate scenarios as they resulted in such a poor BCR result under the historical scenario.

Environmental assessment

This combines 2 options assessed separately in the rapid expert assessment:

- install gravity pipeline along Tumut River, which was rated by agency experts as a minor to moderate impact on average
- raise Blowering Dam, which was rated with a likely major to extreme impact.

It seems likely that if these options were brought together for the rapid assessment, the combined effects would have led to a consistent major to extreme impact.

The detailed assessment results for 100 and 200 GL show such small differences that they can be treated as near identical. The only difference regarding the impact categories is that a major rather than extreme impact is observed for the frequency of days below the very low flow threshold under the 200 GL option.

The high (fresh to overbank) flow environmental metrics (Table 50 and Table 52) show no improvements. There is a minor reduction in duration for Balranald under future climate change, but the median duration of 16 days suggests this would have little ecological effect in most cases. Similarly, even though the time between events shows a minor impact at Darlington Point under the long-term historical climate, the time between events is typically well within LTWP requirements.

The standard statistics (Table 51 and Table 53) results support the presumed rapid assessment with predictions of minor impacts on no flow frequency and major or extreme impacts on the number of days below the very low flow threshold across both climate scenarios. Some individual sites show extreme percentage increases for no, low and very low flows. For example, the number of days below the very low flow threshold at Tumut River at Tumut (410006) increased from 8 to 34 days per 100 years under the long-term historical climate and 100 GL airspace varient option.

Table 50. Predicted environmental effects on high flow metrics for proposed Option 36a: Combined gravity pipeline along Tumut River and raised Blowering Dam with a 100 GL airspace

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	1 (Abs = 21)	1 (Abs = 11)
Balranald high flow duration (days)	0 (0, -2) (Abs = 18 (3, 64))	-6 (0, -3) (Abs = 16 (3, 61))
Time between high flow events (years) at Balranald	0 (0, 0) (Abs = 0.1 (0, 1.7))	3 (0, -1) (Abs = 0.3 (0, 3.7))
Darlington Point high flow frequency (/10 years)	0 (0, -3) (Abs = 14 (8, 37))	-3 (Abs = 5)
Darlington Point high flow duration (days)	0 (0, -3) (Abs = 14 (8, 37))	0 (0, 0) (Abs = 13 (8, 31))
Time between high flow events (years) at Darlington Point	4 (0, 1) (Abs = 0.2 (0, 2.9))	1 (0, 2) (Abs = 0.7 (0, 8))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 51. Predicted environmental effects on standard statistics for proposed Option 36a: Combined gravity pipeline along Tumut River and raised Blowering Dam with a 100 GL airspace

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	minor impact
Number of no flow events per 130 years	minor impact	minor impact
Number of years with a no flow event	no effect	minor impact
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	major impact	extreme impact
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	minor impact	moderate impact
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	minor impact	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Table 52. Predicted environmental effects on high flow metrics for proposed Option 36a: Combined gravity pipeline along Tumut River and raised Blowering Dam with a 200 GL airspace

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	1 (Abs = 21)	1 (Abs = 11)
Balranald high flow duration (days)	0 (0, -3) (Abs = 18 (3, 63))	-6 (0, -3) (Abs = 16 (3, 59))
Time between high flow events (years) at Balranald	0 (0, -1) (Abs = 0.1 (0, 1.7))	2 (0, -1) (Abs = 0.3 (0, 3.7))
Darlington Point high flow frequency (/10 years)	-2 (Abs = 13)	-3 (Abs = 5)
Darlington Point high flow duration (days)	0 (0, -5) (Abs = 14 (8, 36))	0 (0, 0) (Abs = 13 (8, 31))
Time between high flow events (years) at Darlington Point	4 (0, 1) (Abs = 0.2 (0, 2.9))	1 (0, 2) (Abs = 0.7 (0, 8))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 53. Predicted environmental effects on standard statistics for proposed Option 36a: Combined gravity pipeline along Tumut River and raised Blowering Dam with a 200 GL airspace

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	minor impact
Number of no flow events per 130 years	minor impact	minor impact
Number of years with a no flow event	no effect	minor impact
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	major impact	major impact
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	minor impact	moderate impact
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	minor impact	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Option 37: Enlarge Burrinjuck Storage Reservoir

Purpose	To improve water security in the regulated Murrumbidgee region.
Description	This option involves investigation of adding 674 GL additional storage capacity to Burrinjuck Dam making a full supply volume of 1,700 GL.
Results	Option 37 is deemed not viable due to adverse results in the hydrological modelling, cost-benefit analysis, and environmental assessment. In particular, the option was not considered viable due to producing disbenefits, resulting in extremely poor benefit-cost ratios, indicating its lack of economic viability. Under all climate scenarios, Option 37 shows varying degrees of change in water allocation for HS and GS entitlements, with notable increases in effective allocation ranging from 8% to 25% (GS). There are increases in GS ranging from 13% to 15%. The annual flow at Balranald is almost unchanged. There is an almost complete (-95% to -96%) restriction in diversions for supplementary access due to the restrictions imposed to maintain overall water use consistent with the base case (as a surrogate for SDL compliance). The cost-benefit analysis reveals negligible to no changes in economic outcomes for towns and annual crops under the historical climate scenario. However, there are slight negative changes in outcomes for permanent crops. Despite these minor fluctuations, the net present value indicates no significant deviation from the baseline, suggesting limited economic impact. The environmental assessment rates Option 37 with a likely major to extreme impact, indicating significant environmental concerns, especially with large overbank flows. While there are minor improvements in high flow environmental metrics, such as event frequency at Balranald under a dry future climate, there are also major impacts on the flows for duration and time between events. The size of high flows with a recurrence of 5 and 10 years are also reduced. Overall, the results indicate some preservation of low flows, with numerous impacts on high flows.
Limitations	Given the poor economic results on the historical scenario, the option was not economically assessed on either the long-term historical scenario or the dry future climate scenario, as the results of those are not expected to be significantly different enough to warrant their assessment. Impacts on the Murray system were not assessed but given the small impact on average flows at Balranald there would be limited impact on the NSW Murray water users. Impacts on Aboriginal cultural values and uses were not assessed. Impacts to adjoining properties to the proposed pondage were also not assessed. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (i.e. without option) model run. The cost estimate for this option was based upon: • Capital Expenditure (CAPEX) plus Discounted Cash Flow of Operational Expenditure minus Discounted Residual Value. CAPEX was based on an order of magnitude cost estimate based on other dam projects in south-eastern Australia.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 54. Hydrological results Option 37: Enlarge Burrinjuck Storage Reservoir

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	1%	20%	0%	8%	1%	13%	-96%	0%	0%
Long-term historical climate	1%	24%	0%	7%	1%	14%	-96%	0%	0%
Dry future climate	0%	25%	1.1%	19%	1%	15%	-95%	0%	0%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover

**Supplementary access was restricted (4% of baseline) in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000*.

Table 55. Cost benefit analysis result Option 37: Enlarge Burrinjuck Storage Reservoir

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	-110.4 (-2.9%)	18.1 (0.3%)	3,431.8	-3,524.1	0
Long-term historical climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*
Dry future climate	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*	Not modelled*

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading Values in parenthesis are the % change values to the baseline values.

*These options were not modelled under the long-term historical and dry future climate scenarios as they resulted in such a poor BCR result under the historical scenario.

Environmental assessment

This option was rated with a likely major to extreme impact in the rapid assessment. The analytical results presented below generally support this rating, with numerous impacts on high flows, but no flows, low flows and very low flows show minor improvements.

The high flow environmental metrics (Table 56) show minor improvements with event frequency at Balranald under a dry future climate and in the duration of events at Darlington Point under the long-term historical climate. There is more of a pattern of minor to major impact, especially with the time between events which is important for the resilience of ecosystems. Again, in most cases the median condition suggests that LTWP requirements are usually met, except perhaps for Darlington Point where flows are occurring only 5 in every 10 years under a future dry climate.

The standard statistics results (Table 57) show minor improvements in the preservation of flows above no flow, and above low and very low flow conditions across the 37 gauges, especially under a future climate. There are, however, minor impacts in the size of high flows with a 5- and 10-year recurrence.

Table 56. Predicted environmental effects on high flow metrics for Option 37: Enlarge Burrinjuck Storage Reservoir

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	2 (Abs = 21)	9 (Abs = 12)
Balranald high flow duration (days)	-6 (0, 0) (Abs = 17 (3, 65))	-12 (0, -7) (Abs = 16 (3, 59))
Time between high flow events (years) at Balranald	14 (0, -9) (Abs = 0.2 (0, 1.6))	25 (17, -21) (Abs = 0.4 (0, 3))
Darlington Point high flow frequency (/10 years)	-1 (Abs = 13)	-4 (Abs = 5)
Darlington Point high flow duration (days)	7 (0, 0) (Abs = 15 (8, 38))	0 (0, 0) (Abs = 13 (8, 31))
Time between high flow events (years) at Darlington Point	20 (0, -2) (Abs = 0.2 (0, 2.8))	13 (0, 2) (Abs = 0.8 (0, 8))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 57. Predicted environmental effects on standard metrics for Option 37: Enlarge Burrinjuck Storage Reservoir

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	no effect
Number of no flow events per 130 years	no effect	no effect
Number of years with a no flow event	minor improv	minor improv
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	no effect	moderate improv
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	no effect	minor improv
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	minor impact	minor impact
High flows with a 10-year recurrence (ML/day)	minor impact	minor impact

Option 38. Expand Bundidgerry off-river storage

Purpose	Increase the amount of buffer storage downstream of flow constraints on the Murrumbidgee River to improve efficiency in regulated river system operations.
Description	This option investigates expansion of the storage capacity within Bundidgerry Creek to increase the local supply capacity close to the Murrumbidgee Irrigation Area (MIA). This would help provide flexibility in supply of water to the MIA, to help overcome delivery constraints further upstream, particularly during periods of peak demand.
Results	Viable for further consideration on the shortlist as part of proposed action 3.8: Manage delivery risks in the regulated Murrumbidgee River. The hydrological analysis for this option indicates changes across different climate scenarios. There are practically no changes in HS effective allocations or water diversions, while there are notable increases in terms of GS entitlements ranging from 3% to 12% across all climate scenarios. On the contrary, important reductions are observed in supplementary water diversions ranging from -42% to -45%. Additionally, there is a consistent minor decrease in average annual flow at Balranald across all scenarios (ranging from -1% to -3%). The cost-benefit analysis reveals, across all scenarios, negligible changes in economic outcomes for towns, with small percentage increases in annual and permanent crops, ranging from 0.2% to 1.2%. The environmental assessment suggests overall minor/moderate impacts, including on floodplain and large fresh flows, and low flow impacts during summer. While there are minor improvements in high flow frequency at both Darlington point and Balranald there are also minor to moderate impacts on the time between high flows at Balranald, especially under a dry future climate. The site-averaged standard statistics show few effects, apart from minor impacts with the duration of no flow events. There are some benefits suggested by these environmental results, but there are several impacts that would likely need to be addressed to meet the requirements of the Basin Plan (e.g. s10.28 – no net reduction in planned environmental water).
Limitations	The assessment didn't integrate assessment of this option with other rule-based or infrastructure improvements to the regulated system as they are not known now. Therefore, it is not possible to make a judgement as to how this option would perform as a buffer storage, under a more broadly modified regulated system, and mitigate the risk of water delivery shortfalls during periods of peak demand. This would be undertaken in the implementation of proposed action 3.8. It is expected that evaporation and seepage losses would be very high due to the local climate and topography, and water quality issues may also arise. Ways to minimise these issues would need to be considered. Impacts on Aboriginal cultural values and uses were not assessed Impacts to adjoining properties to the proposed pondage were also not assessed. These, and other matters, would need to be investigated as part of feasibility and environmental impact assessments. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (ie without the option) model run. A full assessment using the accredited SDL model would also be required in future investigations. The cost estimate for this option was based upon: • Capital Expenditure (CAPEX) plus Discounted Cash Flow of Operational Expenditure minus Discounted Residual Value. CAPEX was based on a 'cost-curve' approach, which identifies a cost estimate based on the associated costs of comparable asset construction projects.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e., without the option).

Table 58. Hydrological results Option 38: Expand Bundidgerry off-river storage

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation* (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	0%	3%	0%	4%	1%	5%	-42%	0%	-1%
Long-term historical climate	0%	5%	0%	5%	1%	7%	-45%	0%	-2%
Dry future climate	0%	11%	0%	12%	1%	10%	-41%	0%	-3%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover

**Supplementary access was restricted in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000*.

Table 59. Cost benefit analysis Option 38: Expand Bundidgerry off-river storage

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	7.2 (0.2%)	16.2 (0.2%)	280.4	-257	0.1
Long-term historical climate	Negl	17.2 (0.5%)	10 (0.1%)	280.4	-253.3	0.1
Dry future climate	Negl	20.5 (0.9%)	80 (1.2%)	280.4	-179.9	0.4

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading). Values in parenthesis are the % change values to the baseline values.

Environmental assessment

This option was rated by agency experts with an overall likely major to extreme impact in the rapid assessment, but expert scores ranged from a minor to moderate to major to extreme impact. By comparison, the analytical results presented below suggest some minor to moderate impacts on high flows at Balranald, and some localised impacts on low flows during summer months. Some individual sites experienced extreme impact percentage scores for no and very low flows, but, as with all these options, often such scores are large percentage changes of a small base. As such, a site averaged score that shows an overall direction of change can give more of an indication of an option's effect.

The high flow environmental metrics (Table 60) show minor to moderate impacts on high flows at Balranald for duration and time-between events, and especially for time between events under a dry future climate. The underlying absolute values do not suggest these would have a large impact as LTWP requirements are generally met.

The standard statistics (Table 61) results show minor improvements in the frequency of no flow events, but a minor increase in the duration of such events. This option also shows reduced summer flows compared to the base case under a dry future climate, which means for those minority of sites subject to an extreme impact on no flows or very low flows there could be increased risk of isolation of refugia and/or development of poor water quality conditions.

Table 60. Predicted environmental effects on high flow metrics for Option 38: Expand Bundidgerry off-river storage

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	0 (Abs = 21)	8 (Abs = 12)
Balranald high flow duration (days)	6 (0, -2) (Abs = 19 (3, 64))	-6 (0, -3) (Abs = 15 (3, 57))
Time between high flow events (years) at Balranald	6 (0, -3) (Abs = 0.1 (0, 1.7))	13 (0, -20) (Abs = 0.4 (0, 3))
Darlington Point high flow frequency (/10 years)	3 (Abs = 14)	6 (Abs = 6)
Darlington Point high flow duration (days)	0 (0, 0) (Abs = 14 (8, 38))	0 (0, 3) (Abs = 13 (8, 32))
Time between high flow events (years) at Darlington Point	2 (0, -3) (Abs = 0.2 (0, 2.8))	3 (0, -8) (Abs = 0.7 (0, 7.2))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 61. Predicted environmental effects for Option 38: Expand Bundidgerry off-river storage. Effects on standard ecological metrics

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	minor impact	minor impact
Number of no flow events per 130 years	no effect	no effect
Number of years with a no flow event	no effect	no effect
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	no effect	no effect
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	no effect	no effect
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

Option 39. Augment Tombullen Storage and modify operations

Purpose	The purpose of the component of this option that was assessed was to modify operational changes to improve water quality.
Description	The original option was to increase the storage size of Tombullen storage as well as modify storage operation rules to improve water quality. However, to model an augmented storage, significant design and operation specifications would be needed which aren't available at this time. Therefore, an augmented storage wasn't assessed, and only operational changes to increase through flow, to improve water quality, were considered. The operating rule change aimed at increasing flushing flows was implemented by adding a target regulated supply volume of 8,000 ML for October through April.
Results	The assessed option is viable for further consideration on the shortlist as part of proposed action 3.8. With the assessment of only operational changes (ie no augmentation), there are small benefits to general security water users as shown by the hydrological and cost-benefit analyses results (but these are largely within the error bounds of the model). There are some benefits to environmental flow metrics, but there are several impacts that are minor to moderate, and these would likely need to be addressed in order to meet requirements of the Basin Plan (s10.28 – no net reduction in planned environmental water). Particularly, the hydrological modelling shows minimal changes across different climate scenarios. In the historical climate scenario, there are no significant changes in effective allocations for HS, while GS effective allocations show minimal increases ranging from 1% to 4%. Additionally, there's a slight increase in GS average water diversions ranging from 1% to 2%. In contrast, supplementary water diversions present slight decreases ranging from -7% to -8% across all climate scenarios. The cost-benefit analysis reveals mixed and minimal changes in economic outcomes across all climate scenarios. There is negligible average change in economic outcomes results for towns, and slight percentage changes in economic outcomes for annual and permanent crops across all scenarios, ranging from -0.2% to 0.1%. The net present cost remains relatively stable, with changes within modest negative average net present value for the historical and long-historical scenarios, while the dry future scenario shows a modest positive value. The environmental assessment of Option 39 suggests an on-average minor impact, with some minor benefits. The high flow environmental metrics indicate minor impacts on high flow duration at Balranald, although these are within range prescribed by the LTWP. The standard statistics show minor impacts on the frequency and duration of no flows under both climate scenarios. There were also minor improvements (i.e. decreases) in the frequency of days below the low and very flow thresholds under both climate scenarios.

Limitations	As noted above, the assessment didn't consider an augmented storage. As part of future investigations, under proposed action 3.8, upgrades to the Source Murrumbidgee Model will be required to adequately conceptualise and assess the benefits and impacts of a larger storage and associated operations. The assessment didn't integrate assessment of this option with other rule-based or infrastructure improvements to the regulated system as they are not known now. Therefore, it is not possible to make a judgement as to how this option would perform as a buffer storage, under a more broadly modified regulated system, and mitigate the risk of water delivery shortfalls during periods of peak demand. This would be undertaken in the implementation of proposed action 3.8. Impacts on Aboriginal cultural values and uses were not assessed. Impacts to adjoining properties to the pondage were also not assessed. These, and other matters, would need to be investigated as part of feasibility and environmental impact assessments. Direct assessment of compliance against the SDL was not possible in this assessment. Instead, a proxy SDL estimate was made by ensuring that overall consumptive diversions associated with the option were kept consistent with that of the base case (ie without the option) model run. A full assessment using the accredited SDL model would also be required in future investigations.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 62. Hydrological results Option 39: Augment Tombullen Storage and modify operations

Climate dataset	Change in average (30 Sept.) allocation (%)		Change in average (30 June) allocation (%)		Change in average consumptive water diversions (GL/year)				Change in average annual flow at Balranald
	High security	General security*	High security	General security*	High security	General security	Supp.**	LWU	
Historical climate	0%	0%	0%	1%	0%	1%	-7%	0%	-1%
Long-term historical climate	0%	2%	0%	1%	0%	1%	-8%	0%	-1%
Dry future climate	0%	4%	0%	2%	0%	2%	-7%	0%	-1%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover

**Supplementary access was restricted in order to maintain overall diversions to the amount under the base case (without the option). This was undertaken as a proxy for compliance with the SDL and follows the levels of priority for the allocation of water consistent with the *Water Management Act 2000*.

Table 63. Cost benefit analysis results Option 39: Augment Tombullen Storage and modify operations

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	Negl	-3.2 (-0.1%)	-2.3 (0%)	0	-5.5	NA
Long-term historical climate	Negl	-3.3 (-0.1%)	1.9 (0%)	0	-1.4	NA
Dry future climate	Negl	-5.2 (-0.2%)	6.7 (0.1%)	0	1.5	NA

Note: 'Negl.' refers to negligible (generally less than half the smallest unit or decimal of the heading). Values in parenthesis are the % change values to the baseline values.

Environmental assessment

This option was rated with an overall likely major to extreme impact in the rapid assessment, but individual scores ranged from a minor to moderate to major to extreme impact. The analytical results presented below suggest that this option has an overall minor to moderate impact, but some local impacts could be more extreme.

The high flow environmental metrics (Table 64) show a minor impact on high flow duration when the flow duration is usually met in any case. There are otherwise no effects.

The standard statistics (Table 65) results show minor impacts on the frequency of no flows under a dry future climate, along with an increase in duration of these no flow spells under both scenarios. Darlington point went from zero days of no flows to a one event every century for an average of 4 days. There was also a minor improvement (i.e. a decrease) in the frequency of days below the low flow threshold.

Table 64. Predicted environmental effects on high flow metrics for Option 39: Augment Tombullen Storage and modify operations

	Long-term historical climate	Dry future climate
Metric	**Median (95th – 5th percentile) change* (Absolute value)**	**Median (95th – 5th percentile) change* (Absolute value)**
Balranald high flow frequency (/10 years)	0 (Abs = 21)	1 (Abs = 11)
Balranald high flow duration (days)	0 (0, 0) (Abs = 18 (3, 65))	-6 (0, -2) (Abs = 16 (3, 59))
Time between high flow events (years) at Balranald	0 (0, 0) (Abs = 0.1 (0, 1.7))	1 (0, -1) (Abs = 0.3 (0, 3.7))
Darlington Point high flow frequency (/10 years)	0 (Abs = 13)	1 (Abs = 5)
Darlington Point high flow duration (days)	0 (0, -3) (Abs = 14 (8, 37))	0 (0, 0) (Abs = 13 (8, 31))
Time between high flow events (years) at Darlington Point	2 (0, 0) (Abs = 0.2 (0, 2.9))	1 (0, 0) (Abs = 0.7 (0, 7.8))

*Minimum and Maximum flows are represented by the 95th – 5th percentile as the actual minimum to maximum over 10,000 years of simulation would represent highly rare and extreme numbers. The smaller number is the 95th percentile.

Table 65. Predicted environmental effects on standard metrics for Option 39: Augment Tombullen Storage and modify operations

	Long-term historical climate	Dry future climate
Metric	**Mean or median site effect**	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	minor impact	minor impact
Number of no flow events per 130 years	minor impact	minor impact
Number of years with a no flow event	minor impact	minor impact
Very low flow discharge (95th percentile, ML/day)	no effect	no effect
Days below the very low flow rate	minor improv	minor improv
Low flow discharge (90th percentile, ML/day)	no effect	no effect
Days below the low flow rate	minor improv	minor improv
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

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