Draft Regional Water Strategy

Murrumbidgee: Long list of options

April 2022

NSW GOVERNMENT

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

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

Acknowledging Aboriginal people: The NSW Government acknowledges Aboriginal people as Australia's first people and the traditional owners and custodians of the country's lands and water. Aboriginal people have lived in NSW for over 60,000 years and have formed significant spiritual, cultural, and economic connections with its lands and waters. Today, they practise the oldest living cultures on earth.

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

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

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

Options for the Draft Murrumbidgee Regional Water Strategy

As outlined in the Draft Murrumbidgee Regional Water Strategy, we have developed a long list of options that could be included in the final strategy.

The options seek to address a diverse range of issues and risks for water management in the Murrumbidgee region. It is important to note that the options have not been assessed, prioritised or costed at this stage.

In preparing this list, we recognise the previous work that has been done to identify initiatives that could improve water management, water security and water reliability in the Murrumbidgee region. We have collated options from previous studies; and supplemented them with further options derived from recent experience, consultation with local councils and current NSW Government initiatives and programs. The options also incorporate insights from other regional water strategies.

The options aim to address the challenges the region may face in the future, while maximising opportunities arising from growing regional centres, emerging and expanding industries, and new investments in transport and purpose-built precincts to drive growth and prosperity in the region. Bringing all of the options together will help to align and better sequence the various water reform processes underway to deliver the best outcomes for the Murrumbidgee region.

The current long list of options focuses on addressing the key challenges in the Murrumbidgee region:

- an inadequate water management framework to meet the needs and aspirations of Aboriginal people
- current water sharing arrangements based on 120 years of data
- insufficiently integrated land and water planning and management
- vulnerability of town water supplies and amenity
- degradation of riverine and floodplain ecosystems
- limitations of existing water infrastructure, delivery and operations
- limits to water availability in times of a changing climate.

Not all options in this long list will be progressed. Only feasible options will be progressed, following the evidence-based assessment process described in the *Regional Water Strategies Guide*.[1] The final package of options will also consider how to stage the implementation of the preferred options.

This document describes the existing government commitments in the Murrumbidgee region and for each option, the potential benefit and the region-specific challenge it seeks to address. Each option is aligned with one or more of the objectives of the regional water strategies (Figure 1) and the overarching priorities of the NSW Water Strategy (Table 1). Additional considerations and further work is required to progress the options identified. This work will need to be supplemented by additional analysis and your feedback. Where possible, links and references are provided for further information on the option.

1. water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/objectives

Figure 1. NSW regional water strategies: objectives

Deliver and manage water for local communities

Improve water security, water quality and flood management for regional towns and communities.

Enable economic prosperity

Improve water access reliability for regional industries.

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

Including Aboriginal heritage assets.

Protect and enhance the environment

Improve the health and integrity of environmental systems and assets, including by improving water quality.

Affordability

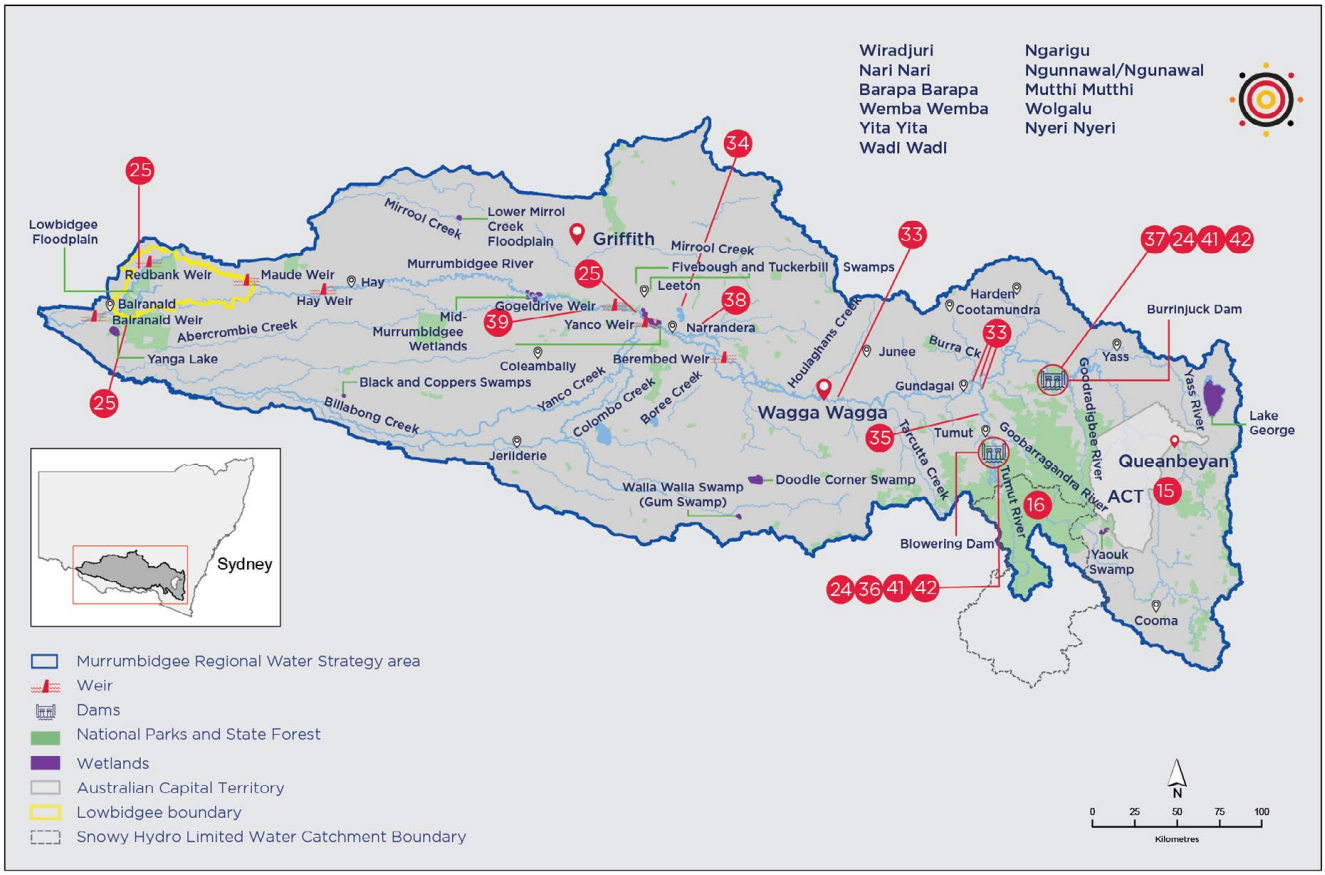
Identify least cost policy and infrastructure options.

Table 1. 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.	**Affordability—identify least cost policy and infrastructure options**
Liveable and vibrant towns and cities	**Priority 2** Recognise First Nations/ Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes	**Recognise and protect Aboriginal water rights, interests and access to water—**including Aboriginal heritage assets.	
Water sources, floodplains and ecosystems protected	**Priority 3** Improve river, floodplain and aquifer ecosystem health, and system connectivity	**Protect and enhance the environment—**improve the health and integrity of environmental systems and assets, including by improving water quality.	
Cultural values respected and protected	**Priority 4** Increase resilience to changes in water availability (variability and climate change)	**Aligned with all** regional water strategy objectives.	
Orderly fair and equitable sharing of water	**Priority 5** Support economic growth and resilient industries within a capped system	**Enable economic prosperity—** improve water access reliability for regional industries.	
	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.	

The list also identifies specific considerations that we need to factor in for each option. These considerations recognise that most options require associated works; further assessments and/ or legislative, policy and planning changes. Our aim is to develop a final strategy with a balanced package of options that delivers on all of the regional water strategy objectives.

Figure 2. Murrumbidgee long list of options map



Options not shown on the map are not location specific.

Existing government commitments

- Sustainable Diversion Limit Adjustment Mechanism Projects

Long list of options

Inadequate water management framework to meet the needs and aspirations of Aboriginal people

1. Improve access to culturally significant areas and waterways for Aboriginal people
2. Review Aboriginal Cultural Water Access Licence framework
3. Assess access arrangements for the Murrumbidgee Aboriginal Cultural Water Access Licence
4. Fund water entitlements for Aboriginal communities
5. Secure flows for water dependent cultural sites
6. Shared benefit project (environmental and cultural outcomes)
7. Support long-term participation of local Aboriginal people in water-related matters
8. Incorporate Aboriginal history of water and culture in the southern Basin into water data

Current water sharing arrangements based on 120 years of data

9. Review drought rules for the Murrumbidgee region
10. Review the allocation and accounting framework in the Murrumbidgee (surface water)
11. Review groundwater extraction limits
12. Provide increased clarity about sustainable groundwater management
13. Investigate Water Access Licence conversion

Insufficiently integrated land and water planning and management

14. Investigate land use change and population growth impacts on water resources
15. Strengthen inter-jurisdictional water management
16. Develop climate risk evidence base to inform the next Snowy Water Licence Review
17. Enhance southern inland floodplain management plans

Vulnerability of town water supplies and amenity

18. Review impediments to water recycling projects
19. Assess potable re-use for towns
20. Managed aquifer recharge investigations and policy
21. Secure and reliable access to groundwater for towns
22. Maintain water-related amenity in the Murrumbidgee region during droughts
23. Improve protection of groundwater dependent ecosystems

Degradation of riverine and floodplain ecosystems

24. Address cold water pollution
25. Improve flows to important ecological sites
26. Develop a river and catchment recovery program for the Murrumbidgee region
27. Investigate water quality improvement measures
28. Manage groundwater salinity
29. Assess pollution from disused mines and mineral occurrences
30. Review environmental water arrangements
31. Re-establish threatened fish species through habitat restoration and conservation restocking
32. Monitor sediment compaction over the long term

Limitations of existing water infrastructure, delivery and operations

33. Investigate alternatives for increased storage capacity
34. Investigate new storage at Lake Mejum–Coolah
35. Install gravity pipeline along Tumut River
36. Raise Blowering Dam
37. Enlarge Burrinjuck Storage Reservoir
38. Expand Bundidgerry off-river storage and a new transfer canal
39. Augment Tombullen Storage and modify operational changes
40. Investigate inter-regional connections
41. Change environmental releases from Murrumbidgee storages
42. Review flood management and airspace operation
43. Investigate groundwater desalination for industry and towns

Limits to water availability in times of a changing climate

44. Better understand water use with data collection and analytics
45. Improve the understanding of groundwater sources and processes, risks and impacts
46. Undertake a water dependent industry resilience study
47. Develop targeted education and capacity building programs
48. Investigate water availability in the Murrumbidgee region
49. Investigate non-residential water efficiency (towns and industries)
50. Investigate the expansion of cloud seeding in key water supply catchments
51. Undertake joint exploration for groundwater with the NSW Geological Survey
52. Review water markets and trade
53. Consider hydrological processes in bushfire management

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

Murrumbidgee: Existing NSW government commitments and long list of options

Photography
Image courtesy of iStock.
Murrumbidgee River, Narrandera.

Existing NSW government commitments

Sustainable Diversion Limit Adjustment Mechanism Projects

Source: Department of Planning and Environment—Water

Description

In 2017, the Basin States and the Australian Government agreed on a package of 36 Sustainable Diversion Limit Adjustment Mechanism (SDLAM) projects across the southern connected Murray–Darling Basin.

NSW is lead or co-proponent in 21 projects across the southern regions and the following projects are complete/nearing completion or underway in the Murrumbidgee region.

Complete or nearing completion

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

Underway

The SDLAM Acceleration Program:

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

- **Yanco Creek Modernisation Project—**to reduce water losses and improve outcomes for water users and the environment, the proposal includes replacing fixed-crest weirs with automated regulators, establishing alternate supply arrangements, changing operating rules, improved riparian management and improving flow monitoring.
- **National Parks (Murray and Murrumbidgee) projects—**the Yanga National Park Project is part of a package of works and measures under the SDLAM Murray and Murrumbidgee National Parks projects. The proposal aims to improve and enhance the movement of environmental flows into and through these water-dependent national parks. Potential works to improve environmental watering regimes in Yanga National Park include upgrading several regulators, road structures and reopening flood paths by removing earthen embankments levees, currently preventing flows.

Reconnecting River Country Program

The Reconnecting River Country Program reimagines the previous Constraints Measures Program and focuses on delivering local community benefits as part of the NSW Government's continued commitment to deliver sensible, community driven Murray-Darling Basin Plan outcomes. In the Murrumbidgee, the program focuses on relaxing or removing constraints or physical barriers impacting the delivery of water for the environment to improve wetland and floodplain connectivity, while achieving balanced economic, social, cultural, and environmental outcomes across the Murrumbidgee region. Currently, the program is conducting community and stakeholder engagement and consultation as part the Government's commitment to the co-design principle. This consultation will inform a Strategic Business Case submission in late 2022.

Better Bidgee Program

The NSW Government is investigating a range of measures for the Murrumbidgee River System as part of rescoping the Yanco Creek Offtake Project. This rescoping will investigate options and evaluate community feedback to develop a suite of measures that will improve connectivity, environmental, cultural and community outcomes. Proposed initiatives could include:

- Yanco Creek Offtake
- Improved fish passage
- Fish friendly water extraction
- Addressing cold water pollution
- Balranald Weir upgrade/Yanga Lake
- Gooragool and Mantangary Lagoons.

Currently, the program is conducting community and stakeholder engagement and consultation as part of the Government's commitment to the co-design principle. There have been several stakeholder initiatives submitted that warrant further examination. This consultation will directly inform a Strategic Business Case submission in mid-2022.

Enhanced environmental water delivery—This project seeks to achieve enhanced environmental outcomes by increasing the ability of environmental water holders to synchronise the delivery of environmental water with increases in natural flows caused by rainfall.

Sustainable Diversion Limit Adjustment Mechanism Projects (continued)

Further information	**Department of Planning and Environment—Water: NSW SDLAM projects:** www.dpie.nsw.gov.au/water/water-infrastructure-nsw/sdlam **Murray–Darling Basin Authority/—Murray–Darling Ministerial Council: Strategic discussion joint statement:** www.mdba.gov.au/publications/mdba-reports/murray-darling-basin-ministerial-council **Reconnecting River Country Program:** water.dpie.nsw.gov.au/water-infrastructure-nsw/sdlam/reconnecting-river-country-program

Photography
Image courtesy of Destination NSW.
Township, Narrandera.

Long list of options

Inadequate water management framework to meet the needs and aspirations of Aboriginal people

Water is deeply entwined with Aboriginal culture and Aboriginal peoples' connection to Country. As the first managers and carers of this natural resource, Aboriginal people have rights and a moral obligation to care for water under their law and customs.

Aboriginal people told us that the way NSW's rivers and groundwater sources are currently managed does not meet the needs and aspirations of Aboriginal people in the region. We also heard that we need to improve Aboriginal peoples' involvement in managing water; recognise and protect their water rights; and deliver cultural, environmental, social and economic benefits to Aboriginal communities in the Murrumbidgee region.

Due to the COVID-19 pandemic, our face-to-face engagement with Aboriginal people on the Draft Murrumbidgee Regional Water Strategy was limited. The few options included in our long list are based on the preliminary conversations we had already undertaken; however, we commit to an ongoing dialogue with Aboriginal people in the development of the Murrumbidgee Regional Water Strategy.

Option 1. Improve access to culturally significant areas and waterways for Aboriginal people	
Source: Department of Planning and Environment—Water	
Description	This option would investigate the benefits and constraints of developing formal access arrangements between Aboriginal people and landholders in the Murrumbidgee region. During our preliminary consultation with Aboriginal people in the Murrumbidgee region, we have heard that Aboriginal people encounter challenges in accessing their culturally significant areas and waterways. Currently, access arrangements are often informal, built on past relationships and subject to change if land ownership or occupancy changes.
Existing problem or issue	Aboriginal people experience challenges in accessing culturally significant areas and waterways located on private land.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • improve Aboriginal people's access to Country to maintain healthy waterways and engage in cultural practices • improve the wellbeing of Aboriginal people and better recognise the connection of Aboriginal people with water and Country.
Considerations	This option would need to consider: • existing provisions contained in the *Aboriginal Land Rights Act 1983* (NSW) (ALRA) as it provides avenues for Local Aboriginal Land Councils to pursue access to land to hunt, gather or fish for domestic purposes on both public and private land • Section 47 of the *Aboriginal Land Rights Act 1983* (NSW) allows Local Aboriginal Land Councils to negotiate agreements with the owner, occupier or person in control of any land to permit specified Aboriginal community members or groups to gain access to land to hunt, gather and fish.

Option 1. Improve access to culturally significant areas and waterways for Aboriginal people (continued)

NSW Water Strategy priority	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.3:** Provide Aboriginal ownership of and access to water for cultural and economic purposes.
Regional water strategy objectives	
Further information	**NSW Aboriginal Land Council culture and heritage factsheet *Accessing Country*:** alc.org.au/accessing-country/

Photography
Image courtesy of Destination NSW.
Tumut, Kosciuszko.

Option 2. Review Aboriginal Cultural Water Access Licence framework

Source: Department of Planning and Environment—Water

Description	This option would undertake a review of water access licences (surface water and groundwater) for Aboriginal cultural uses, to determine their effectiveness and identify opportunities for improvement. The review could focus on: • clearly defining what the licence can be used for • reviewing the provisions of the *Water Sharing Plan for the Murrumbidgee Regulated Water Source 2016*, which constrains how these licences are granted • reviewing and simplifying the licence application process to make it easier for Aboriginal people to apply and consider whether cultural access licences could be traded between Aboriginal communities • optimising water sharing mechanisms that support cultural values and uses, both traditional and contemporary, recognising that Aboriginal cultural values and uses have adapted over time. Aboriginal Cultural Water Access Licences can only be held by Aboriginal people to access water for a specific cultural purpose.
Existing problem or issue	• The *Water Sharing Plan for the Murrumbidgee Regulated Water Source 2016* constrains how this type of licence is granted (section 67(3)). • The application process is difficult and complex and leads to confusion about who can apply for the licence and where these licences can be used. • Aboriginal people have limited access to water allocations to use for cultural purposes.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • simplify the application process, making these licences more accessible to Aboriginal people in the Murrumbidgee region • allow Aboriginal people to practice their culture and have water available for cultural purposes.
Considerations	This option would need to consider: • current provisions and limitations within the relevant NSW water sharing plans • how the applications process would need to be adapted to provide better access • what information and support is needed to simplify the application process • how the licences fit with the extraction and allocation limits within the region • whether changes to the current process would have any third-party impacts • how this option is progressed at a state level through the proposed Aboriginal Water Strategy.
NSW Water Strategy priority	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.3:** Provide Aboriginal ownership of and access to water for cultural and economic purposes.
Regional water strategy objectives	
Further information	**Water Sharing Plan for Murrumbidgee Regulated River Water Source 2016:** legislation.nsw.gov.au/view/html/inforce/current/sl-2016-0367 **Water Sharing Plan for Murrumbidgee Unregulated River Water Sources 2012:** legislation.nsw.gov.au/view/html/inforce/current/sl-2012-0492 **Water Sharing Plan for Murrumbidgee Alluvial and Groundwater Sources Order 2020:** legislation.nsw.gov.au/view/html/inforce/current/sl-2020-0345 **Water sharing Plan for NSW Murray–Darling Basin Fractured Rock Groundwater Sources Order 2020:** legislation.nsw.gov.au/view/html/inforce/current/sl-2020-0348 **Water Sharing Plan for NSW Murray–Darling Basin Porous Rock Groundwater Sources Order 2020:** legislation.nsw.gov.au/view/html/inforce/current/sl-2020-0349

Option 3. Assess access arrangements for the Murrumbidgee Aboriginal Cultural Water Access Licence

Source: Aboriginal stakeholders

Description	This option would consider opportunities to expand the use of the Murrumbidgee Cultural Water Access licence. In particular, the analysis would consider: • existing impediments to effectively and efficiently use the Murrumbidgee Cultural Water Access Licence • opportunities to cost-effectively use existing water-related infrastructure—including town water supply systems and irrigation channels—to deliver cultural water or achieve improved outcomes for Aboriginal people in the Murrumbidgee • establishing effective partnerships with local councils and environmental managers to achieve enhanced cultural watering outcomes, for example co-management of different water delivery or reduction in local water bills for Aboriginal communities • existing governance arrangements for the existing Murrumbidgee Cultural Water Access Licence for the greatest benefits for Aboriginal communities in the Murrumbidgee region.
Existing problem or issue	• There are limited opportunities to use the cultural allocations of the Murrumbidgee Cultural Water Access Licence. For example, allocations can only be delivered to four sites in the Murrumbidgee region. • There are high costs associated with using the cultural allocation, such as water-usage charges associated with the licence. • Licensing requirements and the compliance framework prevents more efficient use of the Murrumbidgee Cultural Water Access Licence.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • improve the utilisation of the Murrumbidgee Cultural Water Access Licence • provide Aboriginal people in the Murrumbidgee region with more opportunities to apply for, or access, the Murrumbidgee Cultural Water Access Licence • potentially complement environmental water management.
Considerations	This option would need to consider: • potential impacts on existing users of the Murrumbidgee Cultural Water Access Licence • existing legislative and policy requirements, as well as governance arrangements, imposed on the Murrumbidgee Cultural Water Access Licence • potential impacts on other water users or licence holders if access arrangements for the Murrumbidgee Cultural Water Access Licence are changed • linkages with numerous works approvals that allow water to be used under the Murrumbidgee Cultural Water Access Licence.
NSW Water Strategy priority	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.3:** Provide Aboriginal ownership of and access to water for cultural and economic purposes.
Regional water strategy objectives	
Further information	**Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016:** **www.legislation.nsw.gov.au/view/html/inforce/current/sl-2016-0367**

Option 4. Fund water entitlements for Aboriginal communities

Source: Department of Planning and Environment—Water

Description	This option would provide funding to support Aboriginal people to purchase water entitlements and related water infrastructure—such as pumps—that can be used to improve economic and cultural outcomes across the Murrumbidgee region.
Existing problem or issue	• Aboriginal people's rights and interests are not adequately recognised or provided for in current water laws and policies, and there are limited opportunities to influence management decisions. • Aboriginal people have limited access to water allocations to use for cultural and economic purposes. • Aboriginal knowledge and science are not effectively integrated into water management in culturally appropriate ways. • Ongoing payment of licence fees and usage charges is a significant financial barrier for some Aboriginal people.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • enable Aboriginal people to receive more secure access to water for spiritual, cultural, social, environmental and economic purposes • provide opportunities for investment in water-dependent economic initiatives and cultural projects.
Considerations	This option would need to consider: • the Australian Government's existing funding commitment to support the acquisition of water entitlements for Aboriginal people across the Murray–Darling Basin • providing sufficient funding to meet ongoing Aboriginal water needs—investigation would need to be undertaken into the level of demand • Government policy position on water buybacks • assessment of whether this option could contribute to the National Agreement on Closing the Gap targets • education and training support needs • how this option is progressed through the state-wide Aboriginal water strategy.
NSW Water Strategy priority	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.1:** Strengthen the role of First Nations/Aboriginal people in water planning and management • **Action 2.2:** Develop a state-wide Aboriginal water strategy • **Action 2.4:** Work with First Nations/Aboriginal people to improve shared water knowledge • **Action 2.5:** Work with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes.
Regional water strategy objectives	
Further information	**National Cultural Flows Research Project:** www.culturalflows.com.au

Option 5. Secure flows for water dependent cultural sites

Source: Department of Planning and Environment—Water

Description	This option would investigate opportunities to improve the timing, rate and consistency of flows to places of cultural significance. The places would be identified by Aboriginal community members.
Existing problem or issue	• Aboriginal people have a close spiritual connection with waterways. In the southern Basin, water-dependent cultural sites—including places of spiritual significance and places of traditional hunting, recreation and cultural uses—are susceptible to dry conditions. We have heard through consultations and in other regions that Aboriginal communities are deeply affected during dry periods and drought because they are less able to access water for cultural purposes. • Aboriginal people's rights and interests are not adequately recognised in current water laws and policies, and there are limited opportunities to influence management decisions. • Aboriginal people have limited access to water allocations to use for cultural purposes. • Aboriginal knowledge and science are not effectively integrated into water management in culturally appropriate ways. • Aboriginal cultural values are not adequately acknowledged.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee, it would: • improve the quality and consistency of flows at water dependent cultural sites • improve recognition of cultural sites and their protection and management • ensure that cultural sites are appropriately considered and supported in the Murrumbidgee water management system.
Considerations	This option would need to consider: • identification and mapping of cultural sites, places of spiritual significance and places used by Aboriginal communities for traditional and contemporary uses, such as hunting, recreation and economic uses. The identification of sites would also include a description of the timing of the use of the site. Intellectual property and cultural knowledge would be protected and retained by Aboriginal people • the Aboriginal Waterways Assessment tool that has been piloted by the Murray–Darling Basin Authority and is currently being used across the Basin • where water would be sourced • how water would be delivered and whether new infrastructure is needed to deliver water • protecting groundwater discharges to springs and streams • using planned and held environmental water if it coincides with an environmental outcome or an environmental watering requirement • assessment of potential impacts on the environment and other water users.
NSW Water Strategy priority	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.1:** Strengthen the role of First Nations/Aboriginal people in water planning and management • **Action 2.2:** Develop a state-wide Aboriginal water strategy • **Action 2.4:** Work with First Nations/Aboriginal people to improve shared water knowledge • **Action 2.5:** Work with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes.
Regional water strategy objectives	
Further information	**Murray–Darling Basin Authority. 2015. Aboriginal Waterways Assessment Program: www.mdba.gov.au/publications/mdba-reports/aboriginal-waterways-assessment-program**

Option 6. Shared benefit project (environment and cultural outcomes)

Source: Department of Planning and Environment—Water

Description	This option would investigate opportunities to work more closely with environmental water holders for shared benefits from using water for the environment that would also achieve cultural environmental outcomes. Shared benefits could include fish movement and support for populations of nesting fish species such as Murray cod.
Existing problem or issue	• Aboriginal people's rights and obligations are not adequately recognised or provided for in current water laws and policies, and there are limited opportunities to influence management decisions. • Aboriginal people have limited access to water allocations to use for cultural and economic purposes.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • enable cultural outcomes to also be achieved—where possible—from environmental water • enable Aboriginal ecological knowledge to be supported, incorporated and implemented into water management action plans for the environment • enable a cultural connection of Aboriginal people to water-sustained environments.
Considerations	This option would need to consider: • the development of capacity and resources within Aboriginal communities to support their participation in environmental water planning • appropriate channels for Aboriginal community members to engage with environmental water holders to identify shared watering needs • the need and frequency of water at different times of the year to achieve cultural outcomes • that environmental water holders are responsible for the use of environmental water and that the primary consideration in using this water is achieving environmental outcomes.
NSW Water Strategy priority	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.1:** Strengthen the role of First Nations/Aboriginal people in water planning and management • **Action 2.2:** Develop a state-wide Aboriginal water strategy • **Action 2.4:** Work with First Nations/Aboriginal people to improve shared water knowledge • **Action 2.5:** Work with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes.
Regional water strategy objectives	

Option 7. Support long-term participation of local Aboriginal people in water-related matters

Source: Department of Planning and Environment—Water

Description	This option would provide support for local Aboriginal groups to be actively involved in consultation and decision-making processes for managing water in the Murrumbidgee region. This would include facilitating the input in and application of Aboriginal knowledge to water management decisions. Local groups could be responsible for matters such as: • promoting informed discussion to support Aboriginal values through existing water management processes • defining the cultural water flow needs for Aboriginal people in the region • providing representation for the wider Aboriginal community including those not part of a peak organisation or representative body • further informing the decisions of the environmental water managers in using their water holdings by representation on the Environmental Water Advisory Groups • progressing on-ground initiatives to access and care for Country.
Existing problem or issue	• We heard from Aboriginal people in the southern Basin that state government consultation with their communities on water-related issues has been poorly executed. Community sentiment is that they do not feel like they are being heard—government agencies often come out to 'tick a box'. • Aboriginal people's rights and values are not adequately recognised or provided for in current water laws and policies, and there are limited opportunities to influence management decisions. • Aboriginal people lack representation in the water management decision process. • Aboriginal knowledge and science are not effectively integrated into water management in culturally appropriate ways.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • improve representation of Aboriginal people in decision-making • be an additional point of contact for water managers to engage with the region's Traditional Owners • provide opportunities to ensure the values, rights and knowledge of Aboriginal people can be reflected in NSW water management decisions.
Considerations	This option would need to consider: • whether committee members are Aboriginal people with an interest in water and have the cultural authority to speak for Country • all local Aboriginal people and affiliations are invited to contribute • how the regional committee will interact and be involved with other groups • the process for identifying and electing representatives to sit on the committee and for developing a governance framework • how Aboriginal people are involved in water decision-making • the priority areas under the National Agreement on Closing the Gap.
NSW Water Strategy priority	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.1:** Strengthen the role of First Nations/Aboriginal people in water planning and management • **Action 2.2:** Develop a state-wide Aboriginal water strategy • **Action 2.4:** Work with First Nations/Aboriginal people to improve shared water knowledge • **Action 2.5:** Work with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes.
Regional water strategy objectives	
Further information	**National Agreement on Closing the Gap:** **www.closingthegap.gov.au**

Option 8. Incorporate Aboriginal history of water and culture in the southern Basin into water data

Source: Department of Planning and Environment—Water and Connectivity Stakeholder Panel—Aboriginal Stakeholders from the Western Regional Water Strategy area

Description	This option would aim to document and integrate Aboriginal science and culture to help better understand the region's past climate and enable an improved management of water sources in the Murrumbidgee region. This gathering of knowledge could include: • Aboriginal history of living near groundwater sources, the rivers, creeks, billabongs and floodplains of the southern Basin • Aboriginal people's experiences of the river systems and conditions, interaction between surface and groundwater and cultural connections to the waterways of the Murrumbidgee region • the importance of rivers, floodplains, and groundwater sources to Aboriginal people. The department recognises and acknowledges that the intellectual property of this knowledge sits with Aboriginal people and any work to gather this information must be done in a culturally appropriate way.
Existing problem or issue	• The NSW Government water management decisions have been insufficiently informed by Aboriginal people's history, knowledge and experience, which is based on many thousands of years of living on Country. • Aboriginal people's rights and obligations are not adequately recognised or provided for in current water laws and policies, and there are limited opportunities to influence management decisions. • Aboriginal knowledge and science are not effectively integrated into water management in culturally appropriate ways.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • enable local knowledge to be used to improve water management outcomes in a way that is culturally appropriate and respects cultural knowledge and intellectual property • provide employment opportunities for Aboriginal people • ensure cultural sites are appropriately considered and supported in the southern Basin water management system • ensure work is done collaboratively to document and acknowledge Aboriginal history in the southern Basin.
Considerations	This option would need to consider: • how to ensure the protection of intellectual property of Aboriginal people and how ownership of information will be retained • how information will be applied to water management decisions • where the current gaps in information are and what information should be collated • that development of this information will not replace the need for Aboriginal stakeholder engagement on future strategies and projects • research for this project being led by Aboriginal organisations or Aboriginal people or by groups outlined in Option 7: Support long-term participation of local Aboriginal people in water-related matters • partnerships between governments, Aboriginal organisations and other organisations such as universities to ensure knowledge is captured in a culturally appropriate way.
NSW Water Strategy priority	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.1:** Strengthen the role of First Nations/Aboriginal people in water planning and management • **Action 2.2:** Develop a state-wide Aboriginal water strategy • **Action 2.4:** Work with First Nations/Aboriginal people to improve shared water knowledge • **Action 2.5:** Work with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes.

Option 8. Incorporate Aboriginal history of water and culture in the southern Basin into water data (continued)

Regional water strategy objectives	
Further information	Note that this option has been adapted from the Draft Western Regional Water Strategy, but included here based on feedback from southern Basin representatives about the need for an Aboriginal perspective on the new regional water strategy climate datasets.

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

Current water sharing arrangements based on 120 years of data

Our NSW water management framework and associated rules, regulations and policies are based on our understanding of the last 120 years of historical climate information. Although this historical data shows us variation in the region's climate, it paints an incomplete picture of how vulnerable we could be to future extreme events.

The climate datasets and updated modelling for the regional water strategies will give us a better understanding of the natural climate variability and plausible future climate conditions in the Murrumbidgee region. These new datasets and modelling will enable us to review our existing rules, regulations and policies.

Options listed under this category focus on reviewing our current NSW water sharing, water management and licensing arrangements to ensure they remain fit-for-purpose, so that we share water resources equitably and sustainably, as well as improve our future planning for extreme events.

Option 9. Review drought rules for the Murrumbidgee region	
Source: Department of Planning and Environment—Water	
Description	This option would review the adequacy and effectiveness of the Incident Response Guides applicable to the Murrumbidgee Region by testing them against the new climate data and updated modelling being developed for the Murrumbidgee Regional Water Strategy. In addition, the option could look at: • the merits and consequences of changing river operations during extreme dry periods and changing current drought trigger levels • opportunities for NSW local council and local water utilities' drought management plans to be more closely integrated with the incident response guides • merits and consequences of changing existing 'drought management reserves'. The incident response guides outline the framework for managing extreme events in the Murrumbidgee region based on the principles contained in the Extreme Events Policy. The incident response guides provide an expanded toolkit of approaches for water managers to select from as extreme events develop in the region.
Existing problem or issue	• There are limited datasets and potential knowledge gaps in our understanding of possible and likely extreme events in the Murrumbidgee region. • Some towns and communities in the Murrumbidgee region have a strong reliance on surface water sources.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • improve extreme event management planning and provide assurance that the current policies and regulatory settings to share water during extreme events are fit-for-purpose • ensure that high priority and critical water needs can be protected in accordance with the objectives of the *Water Management Act 2000* • provide greater clarity and certainty to water users about the interventions that might be introduced as conditions deteriorate and the likelihood that these interventions are needed • provide an opportunity for the Department of Planning and Environment to provide more specific advice to local water utilities about the security and reliability of their (regulated river) licences.

Option 9. Review drought rules for the Murrumbidgee region (continued)

Considerations	This option would need to consider: • a more detailed assessment of the 'need for change' based on the Murrumbidgee Regional Water Strategy modelling and the risks to high priority and critical needs in the region • an assessment of any potential environmental impacts (e.g. direct impacts on threatened species and ecological communities) and implications on held and planned environmental water and possible (environmental) offsets to ensure Basin Plan requirements are met • an assessment of any potential impacts on Aboriginal people's water rights, interests and values, including any impact on Native Title rights and the Murrumbidgee Cultural Water Access Licence, established under the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* • an assessment of any potential impacts on existing water entitlement holders in different parts of the catchment (e.g. those linked to specific operational change scenarios being considered) • an assessment of any equity considerations between different water users within and across the catchment • the outcomes of a 'critical human needs review' which aims to clarify the definition of 'critical human needs' and how much water is needed for critical human needs. A Department of Planning and Environment—Water discussion paper was reviewed by the connectivity stakeholder review group in late 2021 and is expected to be released in 2022 for community feedback before critical needs targets are finalised • a review of the current drought operation tools applied to (or being considered for) groundwater, including actions developed under the NSW Groundwater Strategy • how to provide more specific and tailored advice to local water utilities about drought preparedness • an assessment of whether changes to the incident response guide would trigger a 'review and amendment' requirement under the Basin Plan and any possible consequences • feedback on public acceptance of this option.
NSW Water Strategy priority	**Priority 4:** Increase resilience to changes in water availability (variability and climate change) • **Action 4.1:** New actions to improve and apply our understanding of climate variability and change • **Action 4.3:** Improve drought planning, preparation and resilience.
Regional water strategy objectives	
Further information	**Extreme events policy:** www.industry.nsw.gov.au/water/what-we-do/legislation-policies/eep **Murrumbidgee Valley Drought Snapshot:** www.industry.nsw.gov.au/water/allocations-availability/droughts-floods/drought-update/previous-valleys-in-drought **Draft Incident Response Guide for the Murrumbidgee Surface Water Resource Plan Area:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/murrumbidgee-surface **Draft Murrumbidgee Alluvium Water Resource Plan: Incident Response Guide:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/murrumbidgee-alluvium **Murray–Darling Basin Fractured Rock Water Resource Plan: Incident Response Guide:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/nsw-fractured-rock **NSW MDB Porous Rock Incident Response Guide:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/nsw-mdb-porous-rock

Option 10. Review the allocation and accounting framework in the Murrumbidgee (surface water)

Source: Department of Planning and Environment—Water

Description	This option would review several settings of the current NSW water accounting and allocation process in the Murrumbidgee regulated river system and consider whether and how the new climate data could be used when making allocation decisions. In addition, the option could look at: • reviewing the water allocation process to explore risk management approaches for a more adaptive water allocation and accounting process (e.g. in response to extreme events) • exploring what 'critical human needs' means in the Murrumbidgee region and mechanisms to safeguard water for human needs during extreme events, including developing a policy position on alternative water supplies where water security for towns cannot be guaranteed in extreme events • investigating the impact of including provisions for cultural flows in the allocation process • investigating improvements to current account debiting rules to minimise or discourage water over-ordering, rain rejection and cancelling orders at short notice • investigating the merits and consequences of a 'wet-year allocation policy' • investigating changes to account limits to better facilitate trade • investigating opportunities for the new climate datasets and modelling to inform the determination of the volumes required to 'run the river', for example enhance our understanding of future transmission and evaporation losses in the system because of climate change • investigating the merits and consequences of changing carryover provisions, including accounting for losses from carryover • investigating the potential impact of trading allocations from high security entitlements to general security entitlements to take advantage of carryover provisions • scoping further opportunities to improve the transparency and reporting of the available water determination • the timing of allocation announcements and whether additional supporting information about the likelihood of further allocation increases, based on statistical exceedance probabilities, would help water user decision-making.
Existing problem or issue	• There are knowledge gaps in our understanding of possible and likely extreme events in the Murrumbidgee region. • Some towns and communities in the Murrumbidgee region have a strong reliance on surface water sources. • Demand patterns and water use are changing and there is increased competition for limited water resources. • In addition to existing risks to water security, climate change scenarios result in heightened risks to the imposition of future water restrictions. • High transmission and distribution losses exist along the long delivery system.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • provide better data and evidence to inform the assumptions underpinning the current water allocation process and inform consideration of future changes to the accounting system • enable the Department of Planning and Environment to test the consequences of changing the current allocation process—for example assessing the balance between providing water for productive, environmental and cultural uses; and improving water security for towns and communities in the future • provide an opportunity to start a conversation with communities about an acceptable level of water security risks for towns and communities • provide an opportunity to analyse possible actions to optimise access to water when it is available for productive use • provide greater transparency and reporting for all water users about the mechanics of the water allocation process • assist in meeting recommendations 15 and 16 of the Australian Competition and Consumer Commission's *Murray–Darling Basin Water Markets Inquiry*.

Option 10. Review the allocation and accounting framework in the Murrumbidgee (surface water) (continued)

Considerations	This option would need to consider: • work being progressed under the NSW Water Strategy (Action 4.2) • previous work and analysis undertaken on the allocation and accounting processes in the Murrumbidgee region • analyses undertaken for other regional water strategies and the NSW Water Strategy • the need for change, based on the new climate data and modelling, and an assessment of the trade-offs from changing the current allocation and accounting process • the needs and requirements of all water users about transparency and reporting • any environmental impacts, including impacts on aquatic ecosystems.
NSW Water Strategy priority	**Priority 4:** Increase resilience to changes in water availability (variability and climate change) • **Action 4.2:** Review water allocation and water sharing in response to new climate information.
Regional water strategy objectives	
Further information	**Department of Planning and Environment—Resource Assessment Process:** www.industry.nsw.gov.au/water/allocations-availability/allocations/how-water-is-allocated/resource-assessment-process **Murrumbidgee Water Resource Plan—Surface Water (SW9)—Status and Issues Paper:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/status

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

Option 11. Review groundwater extraction limits

Source: Department of Planning and Environment—Water

Description	This option would review the existing groundwater extraction limits to incorporate up-to-date information, including scientific studies that incorporate the new climate change datasets. This would provide an improved understanding of groundwater processes such as recharge, insights into ways to improve the integration of surface water and groundwater management, and knowledge about social and economic impacts under different development scenarios. In addition, the option would investigate: • present and predicted trends in water levels and recharge rates to aquifers using the updated modelling and climate change data • the connection between groundwater and surface water resources, including the impact of water efficiency projects on return flows • resource extraction limits needed in the future to ensure sustainable access to groundwater by consumptive users and the environment.
Existing problem or issue	• Climate variability and climate change create risks of reduced groundwater availability in the Murrumbidgee region. • There is limited understanding about the interaction between surface water and groundwater systems.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • ensure ongoing and sustainable access to groundwater by both consumptive water users and the environment • provide a better understanding of the connection between groundwater and surface water resources.
Considerations	This option would need to consider: • the commitments made under the Murray–Darling Basin Plan and the mandatory review of the sustainable diversion limits in 2026 • actions being progressed under the *NSW Groundwater Strategy* • the needs and requirements of groundwater users, including the potential socio-economic impacts of a reduction in groundwater use • any environmental impacts, including impacts on groundwater dependent ecosystems • future reviews of the sustainable diversion limits or long-term annual average extraction limits • the adequacy of monitoring to inform an assessment of extraction limits, including groundwater extraction behaviour, potential demand increases, water levels and water quality • previous actions to reduce take to within extraction limits, primarily in the Lower Murrumbidgee Deep Groundwater Source • data and knowledge gaps about recharge, groundwater dynamics and connectivity, as well as potential impacts of climate change.
NSW Water Strategy priorities	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management. **Priority 4:** Increase resilience to changes in water availability (variability and climate change) • **Acton 4.1:** New actions to improve and apply our understanding of climate variability and change.
Regional water strategy objectives	
Further information	**Basin Plan evaluation framework:** **www.mdba.gov.au/publications/mdba-reports/basin-plan-evaluation-framework**

Option 12. Provide increased clarity about sustainable groundwater management

Source: Department of Planning and Environment—Water

Description	This option would review, revise and develop policies to give water users greater clarity and certainty in how groundwater is managed in New South Wales. The policies to be reviewed could consider: • **Extraction within sustainable diversion limits:** This would require the development of a decision framework for making available water determinations. Account rules, such as compliance triggers and carryovers, which are essential to the annual groundwater allocation process, would need to be reviewed. • **Groundwater systems where the entitlements plus basic landholder rights exceed the extraction limit e.g. mid-Murrumbidgee Zone 3, Wagga Wagga Alluvial and Gundagai Alluvial groundwater sources:** This project could look at better ways to proactively manage these systems. This project could include investigating and managing risks associated with the activation of inactive licences. It would give clarity to water users about how such groundwater systems will be managed, as activation and use increases over the next 20 years. • **Areas where groundwater extraction is causing declines in water levels, e.g. Wagga Wagga Alluvial Groundwater Source:** This project could develop a policy with a series of escalating management actions corresponding to stages of water level decline. It could provide certainty to all water users about what actions government will take and when.
Existing problem or issue	• There are gaps in community understanding about groundwater management. • Declining groundwater levels and quality pose risks to groundwater users and the environment.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • improve community understanding about water resource management • ensure groundwater extraction is sustainable.
Considerations	This option would need to consider: • policy or regulatory changes required • how it supports the recommendations of the Australian Competition and Consumer Commission's *Murray–Darling Basin Water Markets Inquiry*: – Recommendation 13: Implement a Basin-wide Water Market Education Program – Recommendation 15: Increase the transparency of allocations decisions and the drivers of water availability.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management.
Regional water strategy objectives	
Further information	**Department of Planning and Environment—Water: Available water determinations for groundwater:** www.industry.nsw.gov.au/water/science/groundwater/awd-for-groundwater **Australian Competition and Consumer Commission—Murray-Darling Basin water markets inquiry:** www.accc.gov.au/publications/murray-darling-basin-water-markets-inquiry-final-report

Option 13. Investigate Water Access Licence conversion

Source: Department of Planning and Environment—Water

Description	This option would test the potential risks and benefits of allowing voluntary conversion from general security to high security, and high security to town water supply water access licences in the Murrumbidgee Regulated River Water Source. This is a common option across all (inland) regional water strategies to test the level of security that could be achievable in each region. The Water Sharing Plan for the Murrumbidgee Regulated River Water Source currently prohibits conversion of access licence to a new category (section 52).
Existing problem or issue	• Climate variability and climate change create risks for reduced water availability in the Murrumbidgee region. • Changes in industry mix are changing water use and demand patterns and are increasing competition for limited water resources. • There is a high reliance on general security water access licences to support industry water needs and the environment. • Existing physical constraints, including channel capacity constraints, are limiting water delivery during peak times.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee, it would: • improve reliability for towns partly reliant on NSW water access licences, other than local water utility licences • provide an opportunity to offset or minimise channel capacity constraints in peak periods (e.g. summer) • test the level of security in the Murrumbidgee region • provide water entitlement holders an opportunity to change their portfolio mix.
Considerations	This option would need to consider: • experiences and lessons learnt from past licence conversion processes • stakeholders' feedback on past licence conversion processes and conversion rates, as well as feedback on acceptability of allowing licence conversion in the Murrumbidgee region • restrictions around licence conversions, including under existing NSW water sharing plans and Australian Competition and Consumer Commission rules, and past feedback from agencies, including the Murray–Darling Basin Authority, as part of the accreditation of the NSW water resource plans • potential risks and third-party impacts on other water licence holders and the environment, including planned environmental water • likelihood of unintended consequences if licence conversion was allowed in the Murrumbidgee, for example additional conveyance losses in the system, increased risks of depleting storages during dry periods, impacts on trade, and increased vulnerability of existing industries • environmental implications—especially of meeting ecological water requirements—such as changes to the flow regimes, water availability and flow delivery • how the conversion rate is determined • if a policy is needed to ensure towns can meet their future water needs, including processes for towns to increase their entitlement holdings if their population growth exceeds their local water utility entitlement limit • implications for the water trade market.

Option 13. Investigate Water Access Licence conversion (continued)

NSW Water Strategy priorities	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water. **Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.2:** Work collaboratively with local water utilities to reduce risks to town water supplies. *If undertaken by environmental water holders:* **Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health.
Regional water strategy objectives	
Further information	**Water access licences:** **www.industry.nsw.gov.au/water/licensing-trade/licences/types/water-access**

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

Insufficiently integrated land and water planning and management

Access to water is often critical for particular land uses, but water resources are not always considered up-front in the planning process. Insufficiently considering and integrating water resources can lead to population and industry growth in areas with pre-existing water availability constraints, and also result in increased pressures on already-stressed water resources.

There are opportunities to better integrate water resources in strategic planning in the Murrumbidgee region, including by assessing current land uses and land use trends to better understand spatial changes in water uses, and any emerging pollution and flooding risks.

Options in this category focus on better integrating and aligning different policy and planning areas that could improve the efficient and effective use of water resources in the Murrumbidgee region, and ensure water resources are better protected.

Option 14. Investigate land use change and population growth impacts on water resources	
Source: Department of Planning and Environment—Water	
Description	This option would investigate opportunities to better integrate the NSW land use planning and water resource management frameworks. In particular, the option would: • 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 • assess projected population growth trends, and regional and local development trends, to identify spatial changes in water demand, growth in town water demands and sources of potential future flood risks (e.g. new developments) • 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 • review opportunities to effectively disseminate information to developers and councils about water availability and water quality in their areas and any known or identified risks to water resources. This option would also look at how to better integrate future iterations of the Murrumbidgee regional water strategy and the South-East and Tablelands and Riverina–Murray regional plans to establish a more integrated strategic land and water management plan.
Existing problem or issue	• Areas with existing or emerging water availability and deliverability constraints are growing. • In certain areas of the catchment there is increased competition for limited water resources. • There are potential deficiencies in existing water and planning policy and regulation. • Existing land uses, land clearing, and developments impact on water availability, water quality, and flows within surface water systems. • Water resources (e.g. availability and risks to water sources) are not often considered early or strategically through the planning system.

Option 14. Investigate land use change and population growth impacts on water resources (continued)

Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • assist in identifying opportunities for the planning system to support and protect water resources in the region • improve access to information about water availability, critical water dependent ecosystems and cultural values to guide development proponents as early as possible in their development application process • ensure improved communication and early engagement to inform councils and development proponents about existing (or emerging) risks to water resources in their area • assist the NSW Government and local councils to make decisions about current and future land use applications • enable the regional water strategies to inform future reviews of the regional plans • better link approvals for land use with approvals for water access • enable an early consideration of how stormwater management and wastewater management can be better integrated.
Considerations	This option would need to consider: • close collaboration with other agencies and local councils • existing pressure points and stressors on water availability and water quality related to land use • existing planning controls and gaps between land use planning and the water management framework • impacts of population growth on water availability and water quality as well as consequences on the riverine environment.
NSW Water Strategy priority	**Priority 4:** Increase resilience to changes in water availability (variability and climate change) • **Action 4.4:** Better integrate land use planning and water management.
Regional water strategy objectives	
Further information	**Environmental Planning and Assessment Act 1979:** **www.legislation.nsw.gov.au/view/html/inforce/current/act-1979-203** **NSW Regional plans:** **www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans**

Option 15. Strengthen inter-jurisdictional water management

Source: Department of Planning and Environment—Water, Canberra Region Joint Organisation and Riverina Water

Description	This option would investigate improvements to the inter-jurisdictional water management arrangements in the upper Murrumbidgee region in consultation with the ACT Government and the Australian Government. During our preliminary engagement on the Murrumbidgee regional water strategy, we understand that there may be opportunities to: • improve the transparency and integration of cross-border water resource planning and management • promote a consistent approach to the assessment of climate risk to strengthen town water security in the upper Murrumbidgee region and better integrate local council work on climate change risk into broader strategic planning processes • collaborate on climate adaptation research to improve cross-border catchment management activities, including those that could help minimise future bushfire impacts and protect water quality • investigate new infrastructure options, including new storage opportunities in the upper Murrumbidgee (e.g. those that may cross the NSW and the ACT border) • consider the costs and constraints for local councils to meet different environmental regulations implemented in the NSW and the ACT jurisdictions • consider inter-jurisdictional water trade between NSW and the ACT. This option would need to consider the ACT/NSW Memorandum of Understanding around Regional Collaboration (June 2020).
Existing problem or issue	• Differences in assessing risks of future climate variability and climate change lead to uncertainties for state, territory and local governments to adequately assess future water security risks and develop proportionate risk mitigation strategies. • Significant population growth is projected in and surrounding the ACT, including in areas with existing water supply constraints. The current supply capacity of several towns surrounding the ACT will exceed long-term projected demand based on local governments' integrated water cycle management strategies. • NSW local governments are reliant on ACT water supplies and are being subjected to two sets of regulation. • There is confusion and lack of clarity about cross-border water resource planning and management. • There is a lack of funding and coordination around cross-border catchment management activities.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • enhance future water security for communities reliant on cross-border water supplies • support projected population growth surrounding the ACT • improve the integration of land use planning and water management around the ACT to ensure extreme event management responses are well integrated, coordinated and understood by communities reliant on cross-border water supply • assist to proactively manage climate risks in the upper Murrumbidgee region (e.g. water supply and bushfire risks) • provide confidence to communities about the robustness of inter-jurisdictional water management • reduce cost and regulatory burdens on local governments.

Option 15. Strengthen inter-jurisdictional water management (continued)

Considerations	This option would need to consider: • existing agreements, regulations and memorandums of understanding governing water management between NSW and the ACT • existing water supply arrangements through Icon Water to provide water to NSW towns and communities • ACT's long-term water strategy, including growth and climate change assumptions • existing work undertaken by local councils and joint organisations on climate risk, infrastructure solutions and existing water management challenges in the upper Murrumbidgee region • existing catchment management programs in the upper Murrumbidgee region to avoid duplication and overlap with existing work undertaken by Local Land Services and equivalent bodies • impacts on the environment, Aboriginal people (including cultural heritage), and other licence holders from any proposed augmentation or construction of water-related infrastructure • legislative and policy constraints to change existing inter-jurisdictional water management arrangements.
NSW Water Strategy priorities	**Priority 4:** Increase resilience to changes in water availability (variability and climate change) • **Action 4.1:** New actions to improve and apply our understanding of climate variability and change • **Action 4.3:** Improve drought planning, preparation and resilience • **Action 4.4:** Better integrate land use planning and water management. **Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.4:** Identify infrastructure and operational options for each region of NSW. **Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.2:** Work collaboratively with local water utilities to reduce risks to town water supplies • **Action 6.7:** Proactive support for water utilities to diversify sources of water.
Regional water strategy objectives	
Further information	**ACT and NSW Memorandum of Understanding for Regional Collaboration (Renewed June 2020):** www.regional.nsw.gov.au/our-work/ocbc/cross-border-agreements/act-nsw **2020–21 Ongoing Cross-Border Issues:** www.regional.nsw.gov.au/our-work/ocbc/cross-border-agreements/act-nsw **Memorandum of Understanding between the ACT, NSW and the Commonwealth of Australia on ACT and NSW Cross Border Water Resources 2006:** www.infrastructure.gov.au/department/media/publications/act-cross-border-water-resources **Queanbeyan Water Supply Agreement 2008:** www.industry.nsw.gov.au/water/what-we-do/legislation-policies/intergovernmental-agreements **South East and Tablelands Regional Plan 2036:** www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/South-East-and-Tablelands **ACT Water Strategy 2014–44—Striking the Balance:** www.environment.act.gov.au/water/water-strategies-and-plans/act_water_strategy

Option 16. Develop climate risk evidence base to inform the next Snowy Water Licence Review

Source: Snowy Licence Review, WaterNSW, Riverina Joint Organisation, Department of Planning and Environment—Water and Environment and Heritage

Description

This option would seek to gather information and evidence to inform the next Snowy Licence Review in 2027:

- using new climate datasets and improved integrated models of the southern connected system to better understand:
  - how Snowy Hydro Limited's system yield and operations could be impacted by increased climate variability and a dry climate change scenario
  - the potential flow-on impacts for downstream Murray and Murrumbidgee regulated river systems
  - changes in flow patterns and any impacts on environmental water delivery in the Snowy Scheme.
- develop a climate risk assessment of the Snowy Scheme in collaboration with other basin states and Snowy Hydro Limited that could help inform future climate risk assessments in the southern Basin—noting the need to balance competing demands on water for hydro-electricity generation, the environment and consumptive water users in the basin informing further discussions around the potential need to change:
  - delivery of environmental flows to achieve more natural flow patterns
  - releases from Tantangara Dam to alleviate the impact of the Tumut River constraints
  - extraction rules in the upper Murrumbidgee to protect town water supplies and environmental releases.

Note: Advances in climate modelling that are also being undertaken by other states could inform/enrich this option through collaboration and information sharing of climate work. The NSW Government is progressing the implementation of 23 proposed actions from the *Ten-year review of the Snowy Water Licence* (2018). Work on implementing the 23 actions is ongoing and may lead to amendments to this regional water strategy option once this work is complete. This option is a common option across the Draft Murray and Murrumbidgee regional water strategies and the wording of the option is identical across both strategies.

Existing problem or issue

- The yield and operation of the Snowy Scheme may be impacted by greater climate variability and climate change. Submissions to the *Ten-year review of the Snowy Water Licence* (2018) have suggested a need to consider the effectiveness of the Snowy Water Licence provisions/rules in the context of climate change.
- Several provisions in the Snowy Water Licence have hydrologic or operational links to the upper Murrumbidgee, regulated Murrumbidgee and Murray rivers. Previous Snowy hydrologic models were not well integrated with other models of the Murrumbidgee and Murray systems, and were limited to around 120 years of historical data.
- Release rules and accounts are linked to the assessment of 'target volume' in the scheme, which is how much storage is needed to ensure the scheme can release a required annual volume during a repeat of the design drought (period of inflows between 1936 and 1946) without running out of water. The effectiveness of these rules has not been tested under more extreme droughts and future climate change.
- Snowy Montane Rivers Increased Flows may be impacted by a more variable and changing climate, potentially limiting delivery of environmental water in dry years and more unnatural flows patterns, particularly in:
  - Goodradigbee River
  - Falls Creek, a tributary of the Snowy River below Guthega
  - Tolbar and Diggers creeks, tributaries of the Snowy River below Island Bend
  - Middle Creek, a tributary of the Geehi River below Geehi Dam.
- Limited protection of Tantangara releases to ensure adequate and reliable water supply for the environment and Cooma, may be exacerbated under a more variable climate.

Option 16. Develop climate risk evidence base to inform the next Snowy Water Licence Review (continued)

Benefit of introducing the option	If the option is progressed it would: • support the next review of the *Snowy Water Licence* by providing data and evidence informed by sophisticated climate data and information • assess the effectiveness of the Snowy Scheme release requirements under a more variable and changing climate • identify opportunities to improve efficiency of environmental water releases to Snowy Montane and Snowy rivers • identify potential future actions to enhance the water availability for the downstream system • identify potential actions to improve water security for Cooma and New South Wales towns supplied from the Australian Capital Territory water supply scheme • potentially identify actions to reduce dam imbalance issues between Blowering and Burrinjuck dams • potentially identify actions to reduce erosion risk in the Tumut River due to unnaturally high flows • potentially enable the introduction of carry over for allocations across years to improve management of Snowy River Increased Flows and Snowy Montane Rivers Increased Flows • potentially consider releases from Tantangara to Burrinjuck Dam to address dam imbalances issues during peak demand periods.
Considerations	This option would need to consider: • status, outcomes and outstanding actions from the 2017 *Ten-year Review of the Snowy Licence—Implementation Plan* • potential changes to NSW water sharing plan rules and the Snowy Water Licence resulting from the 2017 Snowy Water Licence Review • any potential impacts on energy generation and Snowy Hydro Limited and the potential for compensation to be paid • engagement with other jurisdictions, including the Australian Government, the Victorian Government and the South Australian Government • any potential third-party impacts.
NSW Water Strategy priorities	**Priority 4:** Increase resilience to changes in water availability (variability and climate change) • **Action 4.1:** New actions to improve and apply our understanding of climate variability and change • **Action 4.3:** Improve drought planning, preparation and resilience • **Action 4.4:** Better integrate land use planning and water management. **Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW. **Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.2:** Work collaboratively with local water utilities to reduce risks to town water supplies • **Action 6.7:** Proactive support for water utilities to diversify sources of water.
Regional water strategy objectives	

Option 16. Develop climate risk evidence base to inform the next Snowy Water Licence Review (continued)

Further information

Snowy Licence Review:

The Department of Planning and Environment is overseeing implementation of Snowy Licence Review recommendations with the support of Snowy Hydro Limited and other state and federal agencies.

Due to the complexity of investigations related to water releases, a staged approach is being taken.

Ten of the recommendations have been completed as part of the first-round of administrative licence amendments. The remaining 13 recommendations, including 9 actions related to water release requirements, are due to be completed by December 2022.

In particular, the key areas of the current investigations include:

- water availability for licence holders (announced allocations), including the severity of drought periods
- effects on below-target water and above-target water in the Snowy scheme
- timing and volume of spills from downstream storages
- cost impacts to Snowy Hydro Limited
- potential ecological benefits, where relevant.

The recommendations for further work from stage 1A have been assessed for priority, taking into consideration the following:

- issues significantly impacting water users/environment
- issues that could improve outcomes for water users or the environment
- potential for cost impacts of proposals
- options that could be developed in the time frame for this review (December 2022).

Snowy Water Licence 2002:
www.industry.nsw.gov.au/water/basins-catchments/snowy-river/corporate-licence

Ten-Year Review of the Snowy Water Licence:
www.industry.nsw.gov.au/water/basins-catchments/snowy-river/corporate-licence/review

Ten-Year Snowy Water Licence Review—Update June 2021:
www.industry.nsw.gov.au/water/basins-catchments/snowy-river/corporate-licence/review

Option 17. Enhance southern inland floodplain management plans

Source: Department of Planning and Environment—Environment and Heritage and the Department of Planning and Environment—Water

Description

This option would support the development of a valley-wide floodplain management plan for the Murrumbidgee region, and then implement actions to identify and address flood works that pose a risk to life and property, the environment and Aboriginal cultural assets on the floodplain.

The department has recently completed a review under Section 43 of the *Water Management Act 2000* and will replace the current flood management plans for the Murrumbidgee region potentially consolidating these into one valley-wide flood management plan. This option would support the completion of this review and identify existing flood works that pose a risk. This would involve:

- addressing the findings and recommendations from the review of the floodplain management plans for the Murrumbidgee, Murray and Lachlan to ensure that the plans are adequate and appropriate to ensure that water management principles, as required under Section 43 of the *Water Management Act 2000*, are effectively implemented
- addressing the findings and recommendations from the Natural Resource Commission's Audit of the implementation of the floodplain management plans for Murrumbidgee, Murray and Lachlan (e.g. criteria 1–6) to ensure the provisions of the floodplain management plans are being given effect, as required under Section 44 of the *Water Management Act 2000*
- stakeholder and community engagement
- new datasets—including existing flood works and ecological, cultural and heritage assets
- new two-dimensional flood models to inform the delineation of floodway networks and management zones
- updates to floodplain management plan implementation guidelines as needed
- packaging of geospatial and model datasets for handover to WaterNSW and Natural Resources Access Regulator
- the recommendations of the Murrumbidgee Long-Term Water Plan, with respect to Murrumbidgee Valley Floodplain Management Plans, including improved stakeholder education and resources to increase the community's understanding of floodplain inundation.

Existing problem or issue

As a result of the *NSW Healthy Floodplains Project*, the focus on floodplain management, and the development of floodplain management plans, has been on the five northern NSW valleys (Gwydir, Namoi, Barwon-Darling, Macquarie and Border Rivers regions). Floodplain management plans have been prepared for these five northern NSW regions.

In contrast, there has been limited reform around the 10 existing and fragmented local floodplain management plans in the southern NSW regions. The Natural Resources Commission has audited the 10 floodplain management plans and found several shortcomings that, if unaddressed, could:

- increase the risk to life and property from the effects of flooding
- have adverse impacts to the health of riverine and floodplain ecosystems (e.g. that depend on flood inundation) and to groundwater recharge
- increase the likelihood of unauthorised or non-compliant flood works and uncoordinated floodplain development
- limit the ability of the floodplain management plans to give effect to the objects and principles of the *Water Management Act 2000*.

The Murrumbidgee Long-Term Water Plan also identified that the lack of an integrated floodplain management plan in the region, and the associated framework for coordinated development of flood plans on a whole-of-valley basis, poses potential risks that include:

- floodplain structures and barriers restricting flows that could meet overbank and wetland inundation environmental watering requirements
- delivery constraints to avoid potential effects on third-parties on the floodplain constraining the ability to meet some environmental watering requirements.

Option 17. Enhance southern inland floodplain management plans (continued)

Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • improve integrated flood and floodplain management • ensure provisions of the floodplain management plans are being given effect, as required under Section 44 of the *Water Management Act 2000* • ensure that rules and criteria regarding existing and proposed flood works are being applied consistently and fairly • ensure floodplain structures are managed for acceptable levels of risk to life, property, and public or private assets • help identify flood-dependent cultural assets and values by engaging with Aboriginal people in the region • acknowledge and establish protections for flood-dependent Aboriginal cultural assets as part of the flood work assessment process • ensure flood flows are maintained to environmental and cultural assets that require periodic flooding, including areas of groundwater recharge • build capacity in and provide information to communities about floodplain inundation • create connected floodplain management plans that provide better information and predictive capability of flood behaviour and develop standardised rules for flood works approvals • improve our ability to take urban floodplain risk management plans into account (although delegation of power with urban floodplain management plans rests with councils).
Considerations	This option would need to consider: • findings of the *Natural Resources Commission audit of the implementation of the floodplain management plans for the Lachlan, Murray and Murrumbidgee* (August 2000) • recommendations from the Murrumbidgee Long-Term Water Plan • establishing relevant agency partnerships to effectively progress the option • the NSW intention to reform floodplain management plan work in southern NSW valleys based on learnings from northern NSW valley work (e.g. including potential consolidation of floodplain management plans). The NSW Government is currently considering future implementation of the NSW Floodplain Harvesting Policy in areas outside the northern basin • possible interactions with the Reconnecting River Country Program • existing policy and associated floodplain regulation.
NSW Water Strategy priorities	**Priority 1:** Build community confidence and capacity through engagement, transparency and accountability • **Action 1.1:** Improve engagement, collaboration and understanding. **Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.1:** Consider NSW Long Term Water Plans to protect and enhance ecological systems • **Action 3.2:** Take landscape scale action to improve river and catchment health.
Regional water strategy objectives	
Further information	**Murrumbidgee Long-Term Water Plan:** www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/murrumbidgee **Natural Resources Commission's water management plan audits:** www.nrc.nsw.gov.au/wsp-audits **Review process for the 10 southern floodplain management plans:** www.industry.nsw.gov.au/water/plans-programs/plans/rural-fmp-under-part-8 **Floodplain management plan program's Healthy Floodplains Project:** www.industry.nsw.gov.au/water/plans-programs/healthy-floodplains-project/plans **Reconnecting River Country Program:** www.industry.nsw.gov.au/water/plans-programs/sdlam/reconnecting-river-country-program

Vulnerability of town water supplies and amenity

The quality and conservation of green spaces and water dependent amenity are key factors in fostering liveable and vibrant regional towns, and maintaining the wellbeing of communities. Information and regulatory hurdles, as well as funding constraints, can impede the maintenance of green spaces and amenity during extended dry periods.

There are opportunities to consider new and innovative ways to use water—including moving to alternative, non-climate-dependent water sources; and implementing water efficiency measures that could improve water security for regional towns and communities, and ensure adequate water is available to maintain amenity.

Options listed under this category focus on improving policy and planning around water re-use and recycling, and strengthening water security for local communities and important water-related amenity and ecosystems in the region.

Option 18. Review impediments to water recycling projects

Source: Department of Planning and Environment—Water

Description	This option would review impediments to water recycling projects in the Murrumbidgee region. This option could include: • a comprehensive assessment of all barriers impeding the implementation of water re-use projects in the region; such as cost, pricing, regulatory or engineering constraints, or community acceptance • undertaking trial projects around reconfiguration costs or regulatory requirements • plans to support the implementation of industry onsite re-use projects. Re-use of wastewater and stormwater can play an important role in reducing demands on potable water supplies. Re-use projects are becoming more accepted by the community, and have been successfully implemented at different scales and with various end uses across Australia and internationally. Examples include the Ballina–Lennox Head, Mawson Lakes (South Australia) and Rouse Hill recycled water schemes (dual reticulation); Shoalhaven Water's Reclaimed Water Management Scheme, and the Singapore NEWater Project (indirect potable and dual reticulation). Although a few water re-use projects have been constructed across the region, local water utilities have suggested there are cost and regulatory barriers that are impeding their ability to implement re-use projects in towns like Wagga Wagga and Temora.
Existing problem or issue	• Several towns are reliant on unregulated river sources (Yass) or are reliant on a single water source (Cooma and Balranald) and, therefore, have higher water security risk. • Increased streamflow variability, and reduced groundwater recharge is likely to escalate this risk for these and other communities in the Murrumbidgee region under future climate change.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would possibly reduce demand on potable water supplies and raw water river extractions, creating benefits such as: • reduced nutrient and contaminant loads going into rivers • reduced demand and stress on surface water and groundwater resources, by providing alternative water supplies • improved security of town water supply by making a more climate-independent source accessible • local improvements for aquatic ecosystems by reducing pressures on water supplies in drought • strengthened security of town water supply by making an alternative supply (recycled water) available to industries that rely on town water supplies, therefore reducing potable water demand.

Option 18. Review impediments to water recycling projects (continued)

Considerations	This option would need to consider: • the *Australian Guidelines for Water Recycling* • NSW Government regulations, such as approval for water recycling schemes granted through Section 60 of the *Local Government Act 1993* • the diverse demographics of the region, and that concerns and impediments may vary at the local scale • the impact of and management of waste products from re-use projects, such as salts and nutrients • that the Safe and Secure Water Program may be an avenue for funding re-use projects • any recommendations from the Town Water Risk Reduction Program • the impact of return flows from sewage treatment plants or stormwater drains that are important for environmental sites or towns downstream—projects will need to be considered on a whole-of-catchment scale to ensure no negative impacts to downstream users • an assessment of guidelines or a possible effluent exchange policy for beneficial re-use to help small towns, including an understanding that the economies of scale are important and that discharging to a river may be the best solution.
NSW Water Strategy priority	**Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.7:** Proactive support for water utilities to diversify sources of water • **Action 6.11:** Foster the circular economy in our cities and towns.
Regional water strategy objectives	
Further information	**Australian guidelines for water recycling:** www.waterquality.gov.au/guidelines/recycled-water **Section 60 approval for water recycling schemes:** www.industry.nsw.gov.au/water/water-utilities/regulatory-assessments/s60-approval-water-recycling-schemes **Wagga Wagga case study:** waterrecyclinginvestment.com/resources-and-outputs/case-studies/ **Ballina–Lennox Head recycled water scheme:** www.ballinawater.com.au/general-information/urban-water-cycle/recycled-water-overview.html **PUB NEWater (Singapore):** www.pub.gov.sg/watersupply/fournationaltaps/newater **South East Queensland Western Corridor Recycled Water Scheme:** www.water-technology.net/projects/western-corridor/ **Town Water Risk Reduction Program:** www.industry.nsw.gov.au/water/plans-programs/risk-reduction **Safe and Secure Water Program:** www.industry.nsw.gov.au/water/water-utilities/infrastructure-programs/safe-and-secure-water-program

Option 19. Assess potable re-use for towns

Source: Department of Planning and Environment—Water

Description	The option would assess the benefits and costs of potable re-use in the Murrumbidgee region. Highly-treated water from sewage treatment plants has the potential to be a reliable, safe and mostly climate-independent source of potable water, which is suitable for human consumption. The level of treatment required depends on whether the water will be stored or conveyed by rivers or groundwater (indirect) or piped to a water treatment plant (direct) and what the end-use will be. Water for drinking generally requires higher levels of treatment and purification than water used by industry. Both direct and indirect potable re-use schemes could use current sewage and water treatment plants with potential upgrades. Indirect potable re-use involves augmenting drinking water supplies through: • managed aquifer recharge, where purified recycled water is used to recharge groundwater aquifers before it is extracted, treated to *Australian Drinking Water Guidelines* standards and added to the water supply network • discharging purified recycled water directly into or upstream of an existing dam or other major water storage, where it mixes with surface water before being treated again to *Australian Drinking Water Guidelines* standards and supplied to customers. This option would investigate potential locations for new and expanded re-use schemes from sewage treatment plants such as Coolamon sewage treatment plant.
Existing problem or issue	• Several towns are reliant on unregulated river sources (Yass) or are reliant on a single water source (Cooma and Balranald) and, therefore, have a high water security risk. • Increased streamflow variability and reduced groundwater recharge is likely to escalate this risk for communities in the Murrumbidgee region under future climate change.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would reduce demand on traditional potable water supplies and raw water river extractions. The benefits would include: • reduced nutrient and contaminant loads into rivers • reduced demand and stress on water resources such as groundwater and rivers by providing alternative (climate-independent) water supplies • increased water quality for water treatment plant source water—with a direct potable re-use scheme, water quality variability would be significantly less than traditional sources (such as rivers that can have flood-related high turbidity or potentially toxic algal blooms) due to the level of treatment already completed • recycling of valuable nutrients.
Considerations	This option would need to consider: • the *Australian Drinking Water Guidelines* and the *Australian guidelines for water recycling: Augmentation of drinking water supplies* • the diverse demographics of the region and that concerns and impediments may vary at the local scale • re-use projects may impact return flows from sewage treatment plants or stormwater drains that are important for environmental sites and/or towns downstream; therefore, projects will need to be considered on a whole-of-catchment scale to ensure no negative impacts to downstream users • the impact of and management for waste products from re-use projects, such as salts and nutrients • the possible need for a councillor awareness program run by NSW Health, the Environment Protection Agency and the Department of Planning and Environment to help people understand where there could be a barrier for small communities.
NSW Water Strategy priority	**Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.7:** Proactive support for water utilities to diversify sources of water • **Action 6.11:** Foster the circular economy in our cities and towns.

Option 19. Assess potable re-use for towns (continued)

Regional water strategy objectives	
Further information	**Australian guidelines for water recycling:** www.waterquality.gov.au/guidelines/recycled-water **Section 60 approval for water recycling schemes:** www.industry.nsw.gov.au/water/water-utilities/regulatory-assessments/s60-approval-water-recycling-schemes **Town Water Risk Reduction Program:** www.industry.nsw.gov.au/water/plans-programs/risk-reduction **Australian Drinking Water Guidelines:** www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Photography
Image courtesy of Destination NSW.
Sunset, Yass River.

Option 20. Managed aquifer recharge investigations and policy

Source: Department of Planning and Environment—Water

Description	This option would investigate opportunities to undertake managed aquifer recharge in the Murrumbidgee region, including investigating the recharge capacity of sites (including in the mid-Murrumbidgee region) for temporary storage of stormwater, river flow or purified recycled water in aquifers. In addition, the investigations would consider the feasibility of potential recharge, including cost effectiveness and efficiency to access the storage water.
Existing problem or issue	• There are existing pressures on groundwater sources in the Murrumbidgee region, for example high and concentrated groundwater extraction in some areas. • There is competition for groundwater sources to support town water security and new industries in the mid-Murrumbidgee region (e.g. Wagga Wagga Alluvial Groundwater Source). • There is a high rate of water loss by evaporation in existing surface water storages.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • enable a more efficient use of stored water in areas where demand is high • assist in minimising evaporation (e.g. from stored water) • provide additional recharge to groundwater sources to increase the reliability for groundwater dependent users • increase the resilience and town water security of regional communities in the Murrumbidgee region • reduce pressure on surface water supplies during drought, which could improve environmental outcomes for riverine environments.
Considerations	This option would need to consider: • rising water tables in the mid-Murrumbidgee Alluvium • developing a supporting policy to regulate the storage and recovery of this water (Department of Planning and Environment—Water is currently developing this policy) • the *Australian guidelines for water recycling—managed aquifer recharge* • policy and legislative changes to progress this option • the licensing and accounting framework for surface water temporarily stored as groundwater • the engineering and economic challenges of managed aquifer recharge • the distribution of benefits (e.g. additional water because of reduced evaporation) among consumptive water users and the environment • equity issues between industries and cross-subsidies in implementing a managed aquifer recharge policy • public acceptance of this option, including undertaking specific pilot schemes • risks to both human and ecological health associated with transferring water from surface water (especially stormwater or recycled water) to groundwater • the need to install pumping screens • the impacts on Aboriginal cultural heritage.
NSW Water Strategy priority	**Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.8:** Investigate and enable managed aquifer recharge.
Regional water strategy objectives	
Further information	**Australian Guidelines for Water Recycling—Managed aquifer recharge (Phase 2):** www.waterquality.gov.au/guidelines/recycled-water#managed-aquifer-recharge-phase-2 **The Potential for Water Banking in Australia's Murray–Darling Basin to Increase Drought Resilience:** www.mdpi.com/2073-4441/12/10/2936 **Ross, A., Hasnain, S. 2018, *Factors affecting the cost of managed aquifer recharge (MAR) schemes*, Sustainable Water Resource Management, 4, pp.179–190:** link.springer.com/article/10.1007/s40899-017-0210-8

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

Option 21. Secure and reliable access to groundwater for towns

Source: Department of Planning and Environment—Water, Riverina Water, Goldenfields Water, Yass Valley Council, Queanbeyan-Palerang Regional Council

Description	This option would provide a strategic review of current and potential groundwater use by towns across the region to improve understanding of the regional need, challenges and opportunities for towns to access groundwater. A strategic review is particularly important in the mid-Murrumbidgee region where there is significant forecast population and industry growth, which will increase competition for groundwater. This option would identify: • towns and communities where reduced surface water availability combined with increased industry demands could mean the current capacity of groundwater resources, groundwater entitlements or current infrastructure is insufficient to meet water demands • other groundwater resources that could be used as a complementary water supply (e.g. fractured rock groundwater sources) • regulatory issues potentially slowing or preventing access to groundwater resources; for example, if additional town water supply should be accessed by the government granting entitlements or by councils buying entitlements on the open market, particularly when the groundwater source is fully committed • whether maintenance or replacement of existing groundwater infrastructure is needed, including bore fields and pipelines • the potential of accessing saline groundwater and water treatment requirements to meet health guidelines and acceptable aesthetic levels • impacts on Aboriginal cultural values and heritage • potential impacts of increasing groundwater access by local water utilities on other users in fully-allocated groundwater sources, such as potentially reduced available water determinations and declining groundwater levels. This option would not replace the need for councils to have integrated water cycle management strategies; rather, this regional review would likely be informed by the integrated water cycle management strategies.
Existing problem or issue	• Increased climate variability and climate change is likely to reduce water security and reliability for towns and industries. • Forecast regional growth will increase competition for groundwater resources, particularly in the mid-Murrumbidgee region.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • increase the security, diversity and resilience of town water supplies • ensure groundwater sources are shared fairly and sustainably between towns and other users.
Considerations	This option requires consideration of the roles and responsibilities of state and local governments in ensuring secure access to town water supplies. The level of risk to security diversity and reliability for specific towns would need to be confirmed through a secure yield analysis as part of the development of an integrated water cycle management strategy or regional town water strategy prepared by local councils. Further investigation is needed into: • better understand the access to reasonable quality groundwater for towns • potential impacts on existing groundwater users, groundwater dependent ecosystems and adjacent river flows • the potential of accessing and treating saline groundwater for town water supply • the impacts on cultural values and heritage • how compliance with the sustainable diversion limit will be maintained • how to meet the Murray–Darling Basin Plan requirement for no net reduction in the protection of planned environmental water • government funding to enable small towns in the Murrumbidgee to obtain licences on the open market.

Option 21. Secure and reliable access to groundwater for towns (continued)

NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management.
Regional water strategy objectives	
Further information	**Groundwater annual reports—mid-Murrumbidgee alluvial groundwater sources and Lower Murrumbidgee groundwater sources:** www.industry.nsw.gov.au/water/science/groundwater/document-library

Photography
Image courtesy of Department of Primary Industries.
Rice crops, Murrumbidgee.

Option 22. Maintain water-related amenity in the Murrumbidgee region during droughts

Source: Department of Planning and Environment—Water

Description	This option would investigate opportunities to maintain water-related amenity, including town water lakes, local parks and recreational areas, in and around towns in the Murrumbidgee region during droughts or extended dry periods. This would apply to both surface water and groundwater sources. Past issues (raised by stakeholders) related to maintaining the region's town amenity include: • maintaining adequate water storage levels and water quality in Lake Albert to meet Wagga Wagga's recreational needs (this work is already underway) • addressing water quality issues in Lake Wyangan, Griffith; including salinity and blue-green algae (refer to Considerations) • investigating water source options to maintain Urana's town lake, including potential access to water from Lake Urana. The option would include: • considering the issues of maintaining water-related amenity in the Murrumbidgee region during droughts • reviewing current approaches, mechanisms and strategies of local councils to maintain water-related amenity during dry times • assessing any current projects/initiatives underway to address existing issues with maintaining water-related amenity, including work underway for Lake Albert • assessing and supporting relevant actions under the Riverina–Murray and South East and Tablelands Regional Plans, developing regional urban design guidelines to create healthy built environments, promoting high-quality open spaces and incorporating water sensitive urban design into new developments • developing a list of potential policy, planning, drought operations, licensing, and infrastructure initiatives that could help address the existing challenges. The decision to maintain water-related amenity is generally made by local councils and local water utilities based on the utilities' integrated water cycle management strategies (if developed) and agreed service level. However, during droughts and extended dry periods, it has often been challenging to maintain these amenity in some areas, leading to negative economic, social and health and wellbeing consequences.
Existing problem or issue	• Water restrictions during drought may prevent parks, playing fields and green spaces from being watered. • Water quality issues, such as blue-green algae, can make town lakes and waterways unsafe for recreational use. • There can be a loss of town amenity, reduced recreational opportunities and loss of local community events and tourist attractions during drought, which can lead to impacts on the regional economy, community mental and physical health and town aesthetics.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • improve liveability and wellbeing in regional communities • assist in making water-related amenity less climate dependent so they can be a permanent feature of regional communities • improve social, mental and physical health of communities, particularly during droughts • improve recreational opportunities and foster social connections • improve economic prosperity, including community events and tourism • contribute to the protection and conservation of the environment, for example by supporting urban biodiversity, providing greener urban spaces, and protecting and enhancing waterways.

Option 22. Maintain water-related amenity in the Murrumbidgee region during droughts (continued)

Considerations	This option would need to consider: • how this option interacts with individual local council and local water utilities' integrated water cycle management strategies (e.g. current roles and responsibilities to maintain water-related amenity and scope any current issues) and associated 'lessons learnt' during the Millennium Drought and the 2017-2020 drought conditions across NSW to develop appropriate approaches and strategies for drought • outcomes of a critical human needs review which aims to clarify the definition of 'critical human needs', and how much water is needed for critical human needs (Department of Planning and Environment—Water's discussion paper was reviewed by the connectivity stakeholder review group in late 2021 and is expected to be released in 2022 for community feedback before critical needs targets are finalised) • whether impacts would be local or regional • the extent of the challenges (e.g. key amenity that could not be maintained during past droughts), existing limitations through existing integrated water cycle management strategies, other regulatory or policy barriers that prevent water-related amenity to be maintained and the feasibility of certain amenity being maintained • where a strategic pilot study could be trialled in the Murrumbidgee region • possible regulatory or policy options to maintain water-related amenity during 'declared drought stages' (e.g. codified within the Extreme Events Policy, incident response guides and other relevant documents) • whether and how provisions in the *Water Management Act 2000* and in individual NSW water sharing plans support these amenity in regional communities • available alternative water sources, including treated wastewater and harvested stormwater, to maintain water-related amenity (e.g. linkages with re-use or recycling options) • whether maintaining these water-related amenity could also support the protection of Aboriginal peoples' rights and interests • the impacts of drought on regional economies and mental health due to a loss of recreational, sporting, educational and tourism activities • any potential impacts on the environment or other water users in the region.
NSW Water Strategy priority	**Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.9:** Promote and improve Integrated Water Cycle Management • **Action 6.11:** Foster the circular economy in our cities and towns.
Regional water strategy objectives	
Further information	**Integrated Water Cycle Management:** www.industry.nsw.gov.au/water/water-utilities/best-practice-mgmt/iwcm **National Water Grid Lake Wyangan Water Sustainability Project:** www.nationalwatergrid.gov.au/program/new-south-wales-connections-package **CRC for Water Sensitive Cities:** watersensitivecities.org.au/ **Managing Playing Surfaces During Drought:** www.sport.nsw.gov.au/community-sport-infrastructure-resource-library/strategy-and-planning **South East and Tablelands Regional Plan 2036:** www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/South-East-and-Tablelands **Riverina–Murray Regional Plan 2036:** www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/Riverina-Murray

Option 23. Improve protection of groundwater dependent ecosystems

Source: Department of Planning and Environment—Water

Description	This option aims to advance our knowledge and management of groundwater dependent ecosystems in the Murrumbidgee region, such as the mid-Murrumbidgee wetlands, Lowbidgee wetlands, and Great Cumbung Swamp by: • understanding how changes to groundwater, including changes as a result of climate change, affect threshold changes to groundwater dependent ecosystems • updating relevant policies and guidelines to manage and protect groundwater dependent ecosystems, for example, developing state-level sampling methods and environmental impact assessment guidelines for all groundwater dependent ecosystem types • improving methodologies to identify and monitor groundwater dependent ecosystems, such as the vegetation condition of groundwater dependent ecosystems, including root depth and response to drought. A critical element of the water cycle is groundwater and groundwater dependent ecosystems that support a range of species and provide important ecosystem services such as habitat. Groundwater dependent ecosystems also have inherent environmental and, in some instances, amenity value. It is critical that groundwater dependent vegetation is maintained during drought when groundwater is also needed to support communities.
Existing problem or issue	• There are data and knowledge gaps. • Increased climate variability and climate change is likely to reduce water available for ecosystems and species, creating risks to meeting the ecological objectives of the NSW Long Term Water Plans. • During droughts and extended dry periods there is increased competition for limited water resources, including groundwater. • Groundwater dependent ecosystems are impacted by increased groundwater extraction and declining groundwater levels.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • support groundwater dependent ecological processes that support soil, fauna and flora • manage and protect valuable environments and help meet the objectives of the NSW Long Term Water Plans • support associated amenity and recreational opportunities in regional communities • support future reviews of NSW water sharing plans to list high-priority groundwater dependent ecosystems.
Considerations	This option would need to consider: • an expanded bore network to target groundwater dependent ecosystem locations for monitoring and evaluation • educational and communication material to promote awareness of groundwater dependent ecosystems, including the relationship between above ground and underground processes and their benefit to the local environment • inclusion of Aboriginal peoples' cultural connections to groundwater dependent ecosystems.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.1:** Consider NSW Long Term Water Plans to protect and enhance ecological systems • **Action 3.2:** Take landscape scale actions to improve river and catchment health • **Action 3.4:** Invest in long-term and effective monitoring, evaluation, reporting and research • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management.

Option 23. Improve protection of groundwater dependent ecosystems (continued)

Regional water strategy objectives	
Further information	**Groundwater dependent ecosystems:** www.industry.nsw.gov.au/water/science/groundwater/ecosystems **Murrumbidgee Long-Term Water Plan:** www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/murrumbidgee **Specific groundwater dependent ecosystems in the Murrumbidgee region:** Due to its high connectivity with the Murrumbidgee River, groundwater in the region supports patches of groundwater dependent ecosystems of high to very high ecological value along the mid-Murrumbidgee wetlands and Lowbidgee floodplain. These areas include three groundwater dependent river red gum and yellow box woodland forests and wetlands in the floodplain of the Beavers Creek and Old Man Creek within the Berry Jerry National Park and along the Murrumbidgee River floodplain around 5 km upstream of Narrandera and downstream of Maude Weir to Balranald.

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

Degradation of riverine and floodplain ecosystems

Healthy water sources support the region's environment, which in turn support liveable communities.

Existing river regulation, structural and operational barriers, and changes in land use have altered flow regimes in the region's river systems. This has resulted in a loss of native vegetation and wetlands, and a decline in conditions of fish communities and waterbird habitat. It has also led to poor water quality and extreme water quality events in parts of the region, which are likely to get worse under future climate change.

Options listed under this category focus on opportunities to address the risk to the environment, the ecology, and groundwater dependent ecosystems; and improve the health of the region's rivers and groundwater sources.

Option 24. Address cold water pollution

Source: Department of Planning and Environment—Water and Department of Industry Fisheries

Description

This option would build on existing work and help progress planned programs to address cold water pollution in the Murrumbidgee region.

Remediating cold water pollution requires a long-term and collaborative effort between agencies, asset owners and river operators. This option would:

- review work undertaken to date for Blowering and Burrinjuck Dams
- identify temperature suppression mitigation targets for the Murrumbidgee River
- investigate impediments to progress cold water pollution mitigation options for Blowering and Burrinjuck Dams and identify solutions
- review cold water pollution guidelines and set a revised strategic direction to investigate infrastructure options and operational protocols for managing cold water pollution in Blowering and Burrinjuck Dams
- review lessons learnt from cold water pollution trials to date and investigate any new research, technology or innovation.

The NSW Government has recognised the importance of addressing cold water pollution and has previously agreed upon a strategy to investigate, and where possible ameliorate, the impact at high priority dams where it is technically and economically feasible to do so (NSW Cold Water Pollution Strategy 2011).

The assessment that informed the Cold Water Pollution Strategy, ranked Blowering Dam as the highest priority dam in NSW for severe cold water pollution risk, and Burrinjuck Dam as the fourth highest priority. However, the investigation of options for Blowering Dam has been deferred twice and there is no clear date for when this will be progressed.

Delays to implementing the Cold Water Pollution Strategy have been due to the need to coordinate with the NSW Dam Safety Upgrade Program. Another constraint to the full implementation of the strategy is a lack of funding for trials to demonstrate technologies, such as bubble plume interventions, and operational protocols needed to address thermal stratification in storages.

The Ministerial Taskforce on Fish Passage was recently updated to include developing and implementing a strategy on cold water pollution mitigation.

Option 24. Address cold water pollution (continued)

Existing problem or issue	• The dams thermally stratify from summer to spring, resulting in large temperature differences between surface and bottom waters. • Existing dam outlets are deep fixed-level structures that draw cold water from deep levels of both dams. • Severe cold water pollution occurs downstream of Burrinjuck and Blowering Dams and up to 300 km downstream of the Tumut–Murrumbidgee confluence. • Cold water pollution disturbs the growth, breeding and survival of some native fish, including Murray cod and other aquatic fauna. • The depth of these storages, high volume of releases and outlet arrangements pose challenges to developing mitigation solutions.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • overcome impediments and escalate actions to investigate cold water pollution mitigation options for Blowering and Burrinjuck Dams • provide opportunities to pilot new technologies and operational protocols • improve water quality and catchment health outcomes in the Murrumbidgee River • provide a range of ecological benefits for much of the aquatic flora and fauna in the reaches affected by cold water pollution • improve the health and abundance of threatened species • improve social and economic wellbeing of Aboriginal communities by restoring Country.
Considerations	This option would need to consider: • alignment with the NSW Ministerial Taskforce on Fish Passage as it relates to cold water pollution and an assessment of existing temperature metrics against best-practice frameworks for managing impacts on aquatic fauna • alignment with investigations being progressed under the Better Bidgee Program • the potential for, and feasibility of, technologies, such as augmentation of dam outlets, improvements to mixing regimes, and modifications to water delivery mechanisms, to mitigate cold water pollution effects • collaboration between agencies including the Department of Primary Industries—Fisheries NSW, WaterNSW, Department of Planning and Environment—Water, and Department of Planning and Environment—Environment and Heritage • adequate funding and appropriate monitoring to demonstrate ecological benefits.
NSW Water Strategy priorities	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health • **Action 3.3:** Take action to address threats to native fish • **Action 3.5:** Adopt a more intense, state-wide focus on improving water quality. **Priority 7:** Enable a future focused, capable and innovative water sector • **Action 7.1:** Pilot new technologies to increase our water options • **Action 7.2:** Collaborate to harness new research, innovation and technology.
Regional water strategy objectives	
Further information	**NSW Cold Water Pollution Strategy 2011 and Report on implementation of stage one:** www.industry.nsw.gov.au **NSW Cold Water Pollution Strategy—Report on implementation of Stage 2 2010–2015:** www.researchgate.net/publication/319889854_NSW_COLD_WATER_POLLUTION_STRATEGY_Report_on_the_implementation_of_Stage_2_2010-2015_NSW_Cold_Water_Pollution_Interagency_Group_Cold_Water_Pollution_report_on_implementation_of_Stage_2_of_the_Cold_Wate

Option 25. Improve flows to important ecological sites

Source: Department of Planning and Environment—Environment and Heritage

Description	This option would consist of several projects that aim to restore important ecological flows and connectivity between the river and floodplains in the mid-Murrumbidgee region and Lowbidgee. These projects include: • upgrading existing infrastructure (e.g. channels and pumps) to wetlands that cannot be watered through natural flows in the mid-Murrumbidgee region • upgrading old infrastructure within National Parks that restrict flows or no longer support the flows to key sites (e.g. upgrade to rock crossings in the Murrumbidgee Valley National Park, Kooba South, Murrumbidgee Valley National Park and Yanga National Park river levee)—some of this work would complement work proposed under the SDLAM program • installing a new control regulator in the Glen Avon Levee bank at Murrundi/Springbank boundary, Chastons cutting to enable environmental water deliveries to the north of North Redbank system • desilting the North Redbank supply channel to improve the capacity to deliver environmental water to wetland assets—particularly between June and December—to allow for shared channel usage between irrigation and environmental flows during periods of 'peak demand' such as bird breeding events in high allocation years • repairing bridges and constructing two box culverts at creek crossings on Wanganella Station to decrease travel time for flows down forest creek to Rhyolla wetlands • upgrading the Lowbidgee levee system to improve connectivity between the floodplain and river channel • installing additional escapes to enhance connectivity between river and floodplain (e.g. Piggery Escape at Yanga National Park, Lake Marimley and locations between Tala escape and Yanga Creek regulator).
Existing problem or issue	• Changes in flow regimes, land uses (including land clearing) has led to a decline in condition of important ecological sites, including wetlands. • Barriers and associated flow management rules within a highly regulated system constrain effective environmental water delivery. • Old water-related infrastructure does not support flows to important environmental assets in existing National Parks—in the Murrumbidgee region and Yanga in particular. • Channel capacity constraints restrict meeting water needs of a large number of different users, including the environment. • Operational limitations prevent effective environmental water delivery.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • improve the efficient delivery of environmental water to the mid-Murrumbidgee wetlands, Lowbidgee wetlands and floodplains and Murrumbidgee Valley and Yanga National Parks • allow for the recovery of ecosystems at important wetlands on the mid-Murrumbidgee floodplain and Lowbidgee and improve wetland health • improve ecological outcomes for waterbird colonies, threatened species, native fish populations, including improved native fish passage and securing critical refuge and breeding habitats • improve connectivity in the North Redbank system • complement existing government commitments such as the SDLAM program • enhance the capacity to support colonial waterbird breeding events, which will have benefits for the broader southern connected basin.

Option 25. Improve flows to important ecological sites (continued)

Considerations	This option would need to consider: • collaboration with other NSW Government programs (e.g. including the Better Bidgee Program) to ensure alignment and efficient outcomes • application of the same design principles used for the 'Gayini' (Nimmie–Caira) infrastructure modification project such as lay-flat gated structures • compatibility with works proposed under the Yanga National Park SDLAM Project • engagement and collaboration with landholders (e.g. including existing asset owners of channels and pumps where relevant) • regulatory and policy constraints, including the use of existing infrastructure to deliver environmental water • the feasibility to fit Natural Resources Access Regulator-compliant gauges and appropriate carp screens • assessment of funding to ensure ongoing maintenance and support of on-ground activities • ongoing monitoring, evaluation and reviews to assess outcomes • any potential third-party impacts • potential co-benefits to meet Aboriginal cultural objectives • employment opportunities for Indigenous communities to be involved in these projects.
NSW Water Strategy priorities	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purpose • **Action 2.5:** Work with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes. **Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health • **Action 3.3:** Take action to address threats to native fish • **Action 3.5:** Adopt a more intense, state-wide focus on improving water quality.
Regional water strategy objectives	
Further information	**Supply and efficiency measures—NSW-led projects: Nimmie–Caira Infrastructure Modification:** www.industry.nsw.gov.au/water/basins-catchments/murray-darling/supply-efficiency-measures

Option 26. Develop a river and catchment recovery program for the Murrumbidgee region

Source: Department of Planning and Environment—Water

Description	This option would consist of a program aimed at better managing catchment hydrology, addressing erosion issues and restoring riparian and river habitats at priority locations within the catchment. This program would also include a component that undertakes long-term analysis of the impact of climate variability and climate change on future water availability for the catchment with focus on floodplains and river environments. Initiatives under the program could include: • riparian restoration activities, including revegetation and fencing • strategic watercourse works to remediate gully and watercourse erosion • information sharing activities to address knowledge gaps about catchment health, and water quality issues, including salinity • stewardship and certification systems • nutrient trading schemes or continuing work on salt interception schemes • targeted data collection. There are numerous sites within the southern connected system where similar projects have been completed, are proposed, or currently being undertaken. Opportunities exist to build on or improve on these initiatives.
Existing problem or issue	• Land uses, including land clearing, have impacted on riverine and catchment health in the region. • Removal of vegetation, compaction and loss of soils has caused water to move more quickly through the catchment and reduced the amount of water that is stored in the landscape. • The speed of water moving through the catchment is causing greater erosion and increased sediment loads, which is degrading water quality. Specific issues in the Murrumbidgee region, include: • high nutrient loads from Muttama, Hillas, Adjungbilly, Yanco and Billabong Creek catchments and the Murrumbidgee River near Yanco. Nutrient levels accumulate in Burrinjuck Dam, Lake Wyangan, Lake Albert and Yanga Lake and periodically result in algal blooms • high suspended solids and turbidity originating from erosion in Tarcutta, Yanco, Colombo and Billabong Creeks and Murrumbidgee River at Yanco, Carrathool and Balranald Weir • high salinity due to cropping and grazing practices, soil erosion and rising water tables in the mid-catchment tributaries of the Yass River, Muttama, Kyeamba, Tarcutta and Jugiong Creeks—salt mobilised from these streams during high flows contributes to increased salinity down the Murrumbidgee River • 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.
Benefit of introducing the option	If this option was progressed in the Murrumbidgee region, it would: • improve riverine and catchment health • enhance water quality and potentially minimise water quality events like hypoxic blackwater events • improve operational efficiency of town water supply treatment systems • increase biodiversity and the resilience of native and threatened species in the catchment • improve condition and connectivity of soils, watercourses and landscape • enable better (natural) flood management capacity in the catchment • improve social and economic wellbeing of Aboriginal communities and provide employment opportunities through programs that restore Country.

Option 26. Develop a river and catchment recovery program for the Murrumbidgee region (continued)

Considerations	This option would need to consider: • a detailed review of existing and past programs aimed at river and catchment recovery in the Murrumbidgee • similar programs and projects in other catchments, including coastal catchments • engagement, collaboration and coordination between government agencies, land management groups, local councils, and landholders • strategic planning to identify suitable locations to target activities • assessment of funding sources to ensure ongoing maintenance and support of on-ground activities • ongoing monitoring, evaluation and reviews of projects to assess the effectiveness of activities and implement improvements • financial incentives to encourage improvements of land management initiatives on private properties • potential co-benefits to meet Aboriginal cultural objectives • employment opportunities for Aboriginal communities • appropriate pest species management to ensure that pest plants and animals do not offset the positive environmental gains or receive a disproportionate share of the benefits.
NSW Water Strategy priorities	**Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.5** Work with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes. **Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health • **Action 3.3:** Take action to address threats to native fish • **Action 3.4:** Invest in long-term and effective monitoring, evaluation, reporting and research • **Action 3.5:** Adopt a more intense, state-wide focus on improving water quality.
Regional water strategy objectives	
Further information	**Bidgee Banks, 2000 to 2003:** www.riverspace.com.au **Refreshing River Management to improve river health:** www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/grants-available/river-connections/refreshing-river-management-to-improve-river-health **Upper Murrumbidgee Demonstration Reach, 2009:** www.riverspace.com.au/item/upper-murrumbidgee-demonstration-reach/ **Rivers of Carbon—Upper Bidgee Phase 2!:** riversofcarbon.org.au/rivers-of-carbon-upper-bidgee-river-rehab/rivers-carbon-upper-bidgee-phase-two/ **Griffith University led project to address impacts on catchments—Building Catchment Resilience Project:** www.griffith.edu.au/advancement/giving/areas-investment/sustainability-environment **Gould, L. (n.d.) *Key ingredients for the successful implementation of riparian rehabilitation programs. A Greening Australia review of river and catchment restoration projects,* in Wilson, A.L., Dehaan, R.L., Watts, R.J., Page, K.J., Bowmer, K.H., & Curtis, A. 2007, *Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference*. Charles Sturt University:** www.csu.edu.au/research/ilws/events/5asm **Griffith University—Understanding nutrient run-off to help protect waterways:** news.griffith.edu.au/2020/09/14/understanding-nutrient-runoff-to-help-protect-waterways/

Option 27. Investigate water quality improvement measures

Source: Department of Planning and Environment—Water

Description

This option would conduct a gap analysis of surface water and groundwater quality information to identify opportunities to support water quality management in the Murrumbidgee region. This option could identify the need for:

- further research around sources of pollution and specific hotspots in the region as well as the potential health impacts
- improved coordination and collaboration between departments and agencies that have a role in managing diffuse source water pollution and address acute water quality incidents in the region (create central information/data points) including the investigation of additional long-term monitoring, evaluation and reporting programs around water quality
- improve the way co-regulators of point source pollution work with each other, including agreeing on roles and responsibilities, communication, frequency of meetings, who takes the lead on issues, and how to resolve any disagreements or disputes. The Town Water Risk Reduction Program is progressing this action for co-regulators of local water utilities
- develop a risk management plan for contaminated groundwater sources, to inform strategic planning for town water supplies
- additional sampling and testing for algal toxins and possible identification of more cost-effective methods for testing (e.g. rapid single-use kits) and risk assessment (e.g. risk matrix incorporating toxin presence/concentration)
- baseline groundwater quality monitoring
- changes to the groundwater quality management policy to ensure its effectiveness in managing point and diffuse water quality issues
- increasing the scope and responsibility of industries to collect groundwater quality data and collate industry and government data into one database
- additional infrastructure to improve water quality monitoring and enhance the early warning networks (e.g. water quality loggers to monitor dissolved oxygen, electrical conductivity (salinity) and temperature in weir pools, such as Redbank and Maude, to provide early warnings of stratification and hypoxic events that can result in fish deaths)
- review the availability and use of decision-making tools to address water quality events, including the Blackwater Risk Assessment Tool (refer to Further information)
- further work to enhance the Department of Planning and Environment's modelling capabilities to detect and plan for water quality issues in the region, relying on coordination and data gathering.

Existing problem or issue

- Poor water quality and extreme water quality events in parts of the region affect the ecology and survival of aquatic organisms, and impact Aboriginal peoples' health and wellbeing and their cultural and spiritual values.
- Poor water quality affects supplies for towns, as well as domestic and stock uses and water-based recreation.
- High river flows after a period of low flow can transfer debris with elevated organic content from floodplains to the river. This can lead to high turbidity and nutrient loads and periodically results in hypoxic blackwater events, mainly in the lower Murrumbidgee region. This impact can lead to low dissolved oxygen and potential fish deaths.
- Stratification of weir pools during dry periods can lead to blue-green algal blooms and can lower dissolved oxygen levels, resulting in potential fish deaths. There is a lack of monitoring of dissolved oxygen and temperature to detect elevated risks of this occurring.
- Poor water quality can also render treatment plant intake water unsuitable or excessively expensive to treat.
- A long-term increasing salinity trend in the Lower Murrumbidgee Alluvial Deep Groundwater Source, within the irrigation areas east of Hay, poses a future risk to irrigation use. High salinity west of Hay precludes groundwater use for town water supply and some irrigation.
- Contamination risks to groundwater supply require coordination of all levels of government and all users of the groundwater source. For example, the Department of Planning and Environment is working with local water utilities, the Environment Protection Authority, NSW Health, and the Australian Government to better understand the medium- and long-term risks of per and poly-fluoroalkyl substance contamination to water supply from the Wagga Wagga Alluvial Groundwater Source.
- Declining groundwater levels and quality pose risks to water users and the environment.
- There are knowledge gaps about the risk of elevated levels of nutrients, pesticides and pathogens in groundwater systems.

Option 27. Investigate water quality improvement measures (continued)

Benefit of introducing the option	Introducing this option in the Murrumbidgee region would: • potentially lead to a better response to water quality issues and improved water quality over time • potentially improve water security for regional communities, productive industries and the environment • potentially improve operational efficiency of town water supply treatment systems • potentially improve water quality for the benefit of aquatic ecosystem health.
Considerations	This option would require collaboration between the Department of Planning and Environment's policy, planning, water quality, regional and drought response, WaterNSW, and local councils to share a common understanding of the existing work and review all relevant data, information and research on water quality risks and mitigation measures including: • water quality and salinity technical reports that support the water quality management plans for the Murrumbidgee region • dissolved oxygen monitoring in NSW • water quality incident management plans • scope of WaterNSW's monthly water quality sampling • management of the *Extreme events policy* and the *Murrumbidgee Incident Response Guide*. The review of this information would need to be considered in the context of new climate modelling and may lead to amendments of the NSW water sharing plans. The review will also need to be considered in line with any proposed changes to the *Australian Drinking Water Guidelines*.
NSW Water Strategy priorities	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health • **Action 3.3:** Take action to address threats to native fish • **Action 3.4:** Invest in long-term and effective monitoring, evaluation, reporting and research • **Action 3.5:** Adopt a more intense, state-wide focus on improving water quality • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management. **Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.2:** Work collaboratively with local water utilities to reduce risks to town water supplies.
Regional water strategy objectives	
Further information	**NSW Health's drinking water quality and incidents:** www.health.nsw.gov.au/environment/water/Pages/drinking-water-quality-and-incidents.aspx **Fish deaths in NSW:** www.dpi.nsw.gov.au/fishing/habitat/threats/fish-kills **Algal alerts:** www.waternsw.com.au/water-quality/algae **Managing Hypoxic Blackwater—Blackwater Risk Assessment Tool and Blackwater Intervention Assessment Tool:** www.riversandwetlands.com.au/managing-hypoxic-blackwater/ **Murray–Darling Basin Authority's water resource plans:** www.mdba.gov.au/basin-plan-roll-out/water-resource-plans **Extreme events policy:** www.industry.nsw.gov.au/water/what-we-do/legislation-policies/eep **The Basin Plan—Draft Incident Response Guide for the Murrumbidgee Surface Water Resource Plan:** www.industry.nsw.gov.au **Characterisation of hydrogeochemistry and risks to groundwater quality:** www.industry.nsw.gov.au/water/science/groundwater/document-library **Groundwater quality and groundwater vulnerability maps:** www.industry.nsw.gov.au/water/science/groundwater/quality **The NSW Government PFAS Investigation Program:** www.epa.nsw.gov.au/your-environment/contaminated-land/pfas-investigation-program

Option 28. Manage groundwater salinity

Source: Department of Planning and Environment—Water

Description	To address groundwater salinity challenges in the Murrumbidgee region, this option would: • increase collaboration across NSW Government (e.g. within the department and with Local Land Services) to develop a unified salinity management policy to address salinity risks in a holistic way • investigate surface and groundwater interaction, particularly in alluvial landscapes, and continue to monitor both sources • perform a state-wide stocktake of available groundwater salinity information, including studies, to identify knowledge and data monitoring gaps across the state • quantify the entrained salt load in alluvial aquifers to better forecast groundwater quality if changes to water level or chemistry mobilise the salt • quantify risk of urban salinity by groundwater rise • quantify subcatchment salinity risk to surface and groundwater resources in high salinity risk subcatchments • improve data quality by implementing data management methods, including enhanced telemetry • undertake a quantitative risk assessment of salinity induced by land management and pumping for all groundwater sources including irrigation and dryland areas • monitor the management of local extraction levels to prevent pumping induced salinity in high risk groundwater sources • investigate groundwater quality and irrigation risk in areas with high sodium adsorption ratios.
Existing problem or issue	• Contamination of high-quality groundwater from the intrusion of saline groundwater due to pumping. • Groundwater in some aquifers can be too saline to be useful. • Mobilisation of salt as groundwater chemistry and groundwater levels change, often in response to overwatering from irrigation. • Allowing pollution of saline 'poor' groundwater with other contaminants. • Catchment-induced salinity impacts on groundwater.
Benefit of introducing the option	Introducing this option in the Murrumbidgee would: • prevent further salinisation of groundwater sources and increase the usability of groundwater in areas threatened by salinity.
Considerations	This option would need to consider: • inter-jurisdictional coordination for groundwater sources shared across borders • coordination between different government agencies is required to carry out tasks involving reviewing legislation and auditing the bore network (asset is owned by WaterNSW) • coordination with relevant activities in Option 27: Investigate water quality improvement measures.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management.
Regional water strategy objectives	
Further information	**Murray–Darling Basin Authority's salinity information:** **www.mdba.gov.au/issues-murray-darling-basin/salinity** **Water Resource Plan:** **www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts**

Option 29. Assess pollution from disused mines and mineral occurrences

Source: Department of Planning and Environment—Water

Description	This option would investigate the need to understand and mitigate pollution from disused mines and quarries in addition to the work undertaken by the Legacy Mines Program. Mines are required to close in a safe, stable, non-polluting way to ensure sustainable future land uses. In the past, different standards, regulations and community expectations have given rise to legacy mines that do not meet current standards. Abandoned mines are largely historic, have no clear ownership, and rarely meet current community and regulatory mine rehabilitation and closure expectations. The Legacy Mines Program is a NSW Government initiative that assists landholders by delivering and managing works to reduce environmental risks arising from historic and abandoned mines and focuses on public safety and improving the environment through remediation of sites. Projects that cannot demonstrate a clear and significant link to former mining operations cannot be funded by the Legacy Mines Program. This option would look to support current and future Legacy Mines Program projects in the Murrumbidgee region and potentially provide an avenue for project progression where a clear link to historical mining cannot be met. The Captains Flat (Lake George) Mine site is being rehabilitated under the Legacy Mines Program, with the major soil remediation beginning soon and the plan progressing to treat residual acid mine drainage and heavy metals, including zinc, seeping from the site to the Molonglo River.
Existing problem or issue	Abandoned and disused mines present an unknown water quality and, therefore, water security risk for the Murrumbidgee region. There are numerous sites within the catchment that pose a potential risk to the Murrumbidgee River, and associated creeks, from contaminated run-off and increased sediment loads. Within the Murrumbidgee surface water catchment and associated aquifers, there are over 30 sites of interest from the Legacy Mines Program database, in addition to hundreds of erosion-prone mineral occurrences.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • potentially lead to improved water quality through the remediation of erosion-prone sites and seepage of contamination to water sources • result in significant improvement in the long term ecological condition of rivers such as the Molonglo River.
Considerations	In collaboration with the Legacy Mines Program, this option would need to consider: • the water quality risks and potential impacts from all relevant sites in the Murrumbidgee catchment that could be assessed as part of the data collection and analytics in Option 44 • individual sites for likely pollutants and appropriate data collection to inform the relative priority of sites within the region, and future works potentially needed, including site rehabilitation.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health • **Action 3.3:** Take action to address threats to native fish • **Action 3.5:** Adopt a more intense, state-wide focus on improving water quality.
Regional water strategy objectives	
Further information	**NSW Legacy Mines Program:** **www.resourcesandgeoscience.nsw.gov.au/landholders-and-community/minerals-and-coal/legacy-mines-program**

Option 30. Review environmental water arrangements

Source: Department of Planning and Environment—Water

Description	This option would use the new climate datasets and updated hydrological models (once completed) to review the effectiveness of existing NSW water sharing plan rules to meet the environmental watering requirements as outlined in the Murrumbidgee Long-Term Water Plan under long-term climate change projections. Specific aspects that could be reviewed include: • effectiveness of translucent and transparent release rules, including opportunities to simplify rules • adequacy of low-flow rules, end-of-system-flow rules and water set aside as environmental water allowance, including access to environmental water allowance during extreme events • effectiveness of rules protecting planned environmental water during extreme events. In addition, the review could also investigate: • opportunities to protect environmental releases from Tantangara Dam through the unregulated upper-Murrumbidgee region—may include protection of Snowy Montane Rivers Increased Flows from extraction; new provisions for an annual schedule of adjusted daily cease-to-pump threshold; and a review of rules and licence conditions between the NSW and ACT governments to ensure environmental releases are protected through the ACT • the benefits and costs of implementing a 'first flush' rule in unregulated streams to protect first flows after cease-to-flow periods • opportunities to better integrate the management of held and planned environmental water to optimise environmental outcomes • optimising the rate and timing of releases (in regulated systems) to avoid extraction from peaks of wetland connecting events • future water needs of the environment in response to climate change. This work would build on the *Scoping plan: Review of translucency rules in NSW inland rivers—Effectiveness and alternative scenario review (2018)*.
Existing problem or issue	• Climate change could lead to increased temperatures, reduced rainfall, higher evaporation and less water availability, including for the environment and water-dependent species. • Existing transparent and translucent rules are complex and, at times, challenging to implement due to physical constraints. • Current NSW water sharing plans (in regulated rivers) do not specify the priority of access for environmental water allowance when supply capability is insufficient to satisfy all water requirements in sections of the river. • Current NSW water sharing plans (unregulated river) do not specifically protect Snowy Montane Rivers Increased Flows releases from Tantangara from extraction. • The ecosystem of the upper-Murrumbidgee region is in poor health and environmental releases from the Snowy Scheme to the Snowy Montane Rivers are set at fixed annual volumes, with limited flexibility to achieve a more natural flow pattern. • Environmental releases in the upper-Murrumbidgee region flow through both NSW and ACT and cross-border communication is essential.
Benefit of introducing the option	If this option was progressed in the Murrumbidgee region, it would: • assist in meeting the environmental watering requirements, as specified in the Murrumbidgee Long-Term Water Plan under future climate change • provide more effective environmental water management and environmental water delivery during extreme events • help simplify existing environmental water rules and provide more clarity and transparency about the rules for stakeholders • protect environmental water from extraction in the upper-Murrumbidgee region to ensure environmental outcomes can be met • improve environmental and ecosystem health in the catchment • help identify gaps ahead of future reviews of existing NSW water sharing plans.

Option 30. Review environmental water arrangements (continued)

Considerations	This option would need to consider: • past analysis undertaken as part of the *Scoping plan: Review of translucency rules in NSW inland rivers—Effectiveness and alternative scenario review* • the original intent for Snowy Montane releases agreed by governments under the Snowy Water Inquiry Outcomes Implementation Deed and Snowy Scientific Committee (2010) • past recommendations of the Natural Resources Commission's review of NSW water sharing plans for meeting environmental outcomes in the Murrumbidgee region • any interaction with the pre-requisite policy measures in the Murrumbidgee region • the environmental watering requirements of the Murrumbidgee Long-Term Water Plan • legislative and policy constraints that would arise if the review suggest future changes to NSW water sharing plans to better meet environmental outcomes, including those outlined in the Basin Plan • any impacts on existing entitlement holders in the Murrumbidgee region, including potential reliability impacts from changing NSW water sharing plan provisions • the risk of any unintended consequences from attempting to simplify current NSW water sharing plan rules • concerns relating to inundation of property for environmental outcomes on floodplains.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health • **Action 3.3:** Take action to address threats to native fish • **Action 3.5:** Adopt a more intense, state-wide focus on improving water quality.
Regional water strategy objectives	
Further information	**Controlled allocations:** www.industry.nsw.gov.au/water/allocations-availability/controlled **Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016:** www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/status/murrumbidgee-region **Water Sharing Plan for the Murrumbidgee Unregulated River Water Sources 2012:** www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/status/murrumbidgee-region **Murrumbidgee Long-Term Water Plan:** www.environment.nsw.gov.au/research-and-publications/publications-search/murrumbidgee-long-term-water-plan-part-a-catchment **Scoping review: Translucency rules in NSW inland rivers—Effectiveness and alternative scenario review:** www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/environmental-rules/transparent-and-translucent-flows

Option 31. Re-establish threatened fish species through habitat restoration and conservation restocking

Source: Department of Planning and Environment—Water and Department of Industry Fisheries

Description	This option aims to improve the conditions, connectivity, and resilience of native fish by restoring their habitat, doing so by protecting and improving priority areas using best practice management; and building the skills and sharing the knowledge of local landholders, community groups, and Aboriginal people. There are numerous priority native fish species in the Murrumbidgee valley. Some species are locally extinct therefore a reintroduction program would be required: • Mannus Creek, Adjungbilly Creek and Tantangara Creek: Macquarie perch (endangered) are found in high-conservation value sections of the unregulated upper-Murrumbidgee region • unregulated Tantangara Creek: Stocky galaxias (critically endangered) • mid-Murrumbidgee between Gundagai and Narrandera: Murray crayfish (vulnerable) and trout cod (endangered) • mid-Murrumbidgee wetlands, Coppabella Creek, Billabong Creek: olive perchlet (endangered), locally extinct. The program may be structured as a five-year partnership with a scoping study in the first phase to identify high-priority targeted works, project partners and detailed costs. On-ground works and evaluation would proceed in later stages. Potential works in identified priority habitat areas could include: • planting native vegetation on riverbanks and in waterways to diversify and extend habitat for threatened species, native fish and other water-dependent organisms • managing weeds and managed watering to protect newly established vegetation and improve the habitat value of remnant vegetation • stabilising banks through replanting, vegetated buffers, log and rock revetment, sandbagging or removal of stock to reduce sediment input to rivers, in turn improving water quality • mapping habitats to improve environmental water management • monitoring and evaluating to confirm ecological benefits • providing opportunities for private landholder and general community participation • reviewing the effectiveness of previous measures to manage invasive species, such as carp redfin and gambusia, to inform effective long-term actions • conservation restocking.
Existing problem or issue	• Reduced and degraded habitat for native fish in the Murrumbidgee region has led to many species becoming threatened or locally extinct. • River regulation, drought, reduced water availability and cold water pollution has impacted native fish habitat. • Reduced fish abundance impacts Aboriginal cultural connection to Country, and community wellbeing, recreation and tourism. • Reduced fish abundance impacts nutrient cycling and the complex food web, including the abundance of insects and smaller fish, and as a food source for larger fish and waterbirds.
Benefit of introducing the option	If this option was progressed in the Murrumbidgee region, a range of environmental and social benefits could be through: • planting or fencing off native vegetation to improve habitat for threatened species, native fish and other water-dependent organisms • managing weeds to protect newly established vegetation and improve the habitat value of remnant vegetation • improvements in water quality (particularly for reduced nutrient input and algal blooms) arising from vegetated buffers and providing off-stream stock watering points • reduced erosion and bank stabilisation through replanting or removal of stock to result in less sediment input to rivers, in turn improving water quality • habitat mapping to improve environmental water management • opportunities for private landholder and general community participation.

Option 31. Re-establish threatened fish species through habitat restoration and conservation restocking (continued)

Considerations	This option would need to consider: • any interaction with existing government commitments such as the SDLAM program • coordination with other programs including the Murray–Darling Basin Authority's *Native Fish Recovery Strategy* and the Department of Primary Industry's threatened species projects • long-term planning and maintenance of on-ground activities • suitable environmental water management settings to maintain habitat and threatened species • appropriate pest species management to ensure that pest plants and animals don't offset the positive environmental gains or receive a disproportionate share of the benefits • coordination with Option 26: Develop a river and catchment recovery program for the Murrumbidgee region, to avoid duplication of works in riparian restoration • distribution and population growth of threatened species and native fish in the long term • the potential to produce major improvements to the river, on a large scale • engagement of private landholders • engagement and partnerships with Aboriginal people, including assistance in identifying native plant species that will help improve riparian habitat and provide biodiversity benefits • multi-stakeholder partnerships and collaboration with government and non-government agencies • employment opportunities for Indigenous communities • opportunities for training and capacity building for community groups.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health • **Action 3.3:** Take action to address threats to native fish • **Action 3.5:** Adopt a more intense, state-wide focus on improving water quality.
Regional water strategy objectives	
Further information	**Murray–Darling Basin Authority's Native Fish Recovery Strategy:** www.mdba.gov.au/issues-murray-darling-basin/fish-deaths/native-fish-recovery-strategy **Current threatened species projects:** www.dpi.nsw.gov.au/fishing/species-protection/current-threatened-species-projects **Freshwater pests:** www.dpi.nsw.gov.au/fishing/aquatic-biosecurity/pests-diseases/freshwater-pests **National Carp Control Plan:** carp.gov.au/

Option 32. Monitor sediment compaction over the long term

Source: Department of Planning and Environment—Water

Description	This option would develop a long-term monitoring program for the Murrumbidgee region to ensure sediment compaction does not occur in the future, reducing risks to groundwater storage and long-term bore yields. In particular, the option would: • review whether the current bore water level monitoring program (in areas at risk of sediment compaction) collects data at a sufficient frequency to capture the peak maximum drawdown near production bores • design and install land subsidence monitoring benchmarks and expand if necessary • establish a land subsidence benchmark monitoring program • build on recommendations from existing CSIRO research and explore collaboration with other research agencies to monitor ground surface displacement in areas of high extraction.
Existing problem or issue	• In the Murrumbidgee region, the Wagga Wagga Alluvial, mid-Murrumbidgee Zone 3 Alluvial and Lower Murrumbidgee Deep Alluvial Groundwater Sources have been identified as medium risk for sediment compaction. However, there are some data limitations in groundwater levels resulting in low confidence in the metrics used. There are data gaps include low frequency of monitoring and lack of observation bores in risk areas. A long-term monitoring program is needed to help ensure sediment compaction does not occur in the future. • Sediment compaction can occur when large amounts of water are extracted from an aquifer via pumping. The sediments compact because the water is partly responsible for holding the ground up. When the water is withdrawn, the sediments collapse. Sediment compaction can cause the land surface to subside and damage infrastructure such as roads, pipelines and foundations, and cause the collapse of bores. It can permanently reduce how much water can be stored within an aquifer. • Declining groundwater levels and quality pose risks to towns, groundwater dependent ecosystems and other water users who are completely reliant on groundwater.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • advance knowledge about the long-term risk of sediment compaction in aquifers • develop an effective management strategy to target hotspots of declining groundwater levels in high-risk and high-priority aquifers.
Considerations	This option would need to consider: • findings of the 2021 CSIRO study into InSAR deformation mapping and the relationship to groundwater storage change in the Perth Basin, Northern NSW (Border Rivers, Gwydir, Namoi and Condamine-Culgoa) catchments and Southern NSW (Murrumbidgee, Lachlan, Murray Riverina and Billabong–Yanco) • transferability of the assessment method and coordination in other regions.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management.
Regional water strategy objectives	
Further information	**Murrumbidgee Alluvium Water Resource Plan: Risk Assessment for the Murrumbidgee Alluvium Water Resource Plan Area (GW9):** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/murrumbidgee-alluvium **CSIRO Research Publications Repository: Interpreting C-band InSAR ground deformation data for large-scale groundwater management in Australia:** publications.csiro.au/publications

Photography
Image courtesy of Destination NSW.
Murrumbidgee River, Balranald.

Limitations of existing water infrastructure, delivery and operations

Surface water resources in the Murrumbidgee region are highly regulated with several major dams, weirs and regulators along the entire length of the system.

Storage capacity, physical constraints and operational limitations can hinder efficient water delivery, limit the ability to make pre-releases to create airspace during flood operations and reduce the reliability of supply. In addition, the length of the system can result in high transmission losses during dry periods and over-ordering and rainfall rejections that contribute to operational surplus.

Options listed under this category focus on existing and new water-related infrastructure opportunities, improved system efficiencies (infrastructure and delivery) and enhanced river operations.

Option 33. Investigate alternatives for increased storage capacity

Source: WaterNSW

Description	This option would investigate alternative infrastructure projects to increase the storage capacity in the Murrumbidgee region downstream of Blowering and Burrinjuck dams. Possible new water storage sites could include a: • new dam on the Murrumbidgee River, near Mingay/Darbalara • new dam on the Murrumbidgee River, near Gundagai • new dam on the Murrumbidgee River, near Oura • new weir near Gundagai on the lower Tumut River.
Existing problem or issue	• There are storage capacity limitations, which: – risk long-term water reliability and water security – risk uncontrolled spills and increased flood risk. • Tumut River channel capacity constraints limit releases from Blowering Dam, which can result in dam storage imbalance between Blowering and Burrinjuck dams and supply shortfalls during summer peak demands. • Murrumbidgee River channel capacity constraint downstream of Gundagai limits water delivery, including environmental water during summer months.
Benefit of introducing the option	If any of the new storages are progressed in the Murrumbidgee region, they would: • enable more efficient re-regulation of releases from the upstream dams, alleviating the impacts of the upstream Tumut River channel capacity constraints • potentially alleviate impacts of Murrumbidgee River capacity constraint (Oura option only) • potentially address some deliverability issues by enabling delivery of higher flows in the summer months, and greater flexibility to deliver environmental flows • potentially alleviate dam imbalance problems and associated delivery issues, reducing supply shortfalls • increase active storage, providing flexibility to better manage Snowy Scheme releases, re-regulate uncontrolled spills and mitigate flood risk • potentially mitigate cold water pollution from Blowering Dam and/or Burrinjuck Dam by reducing the volume of cold water that needs to be released for deliveries • potentially mitigate bank erosion issues in the Tumut River by reducing the volume and flow rate of releases.

Option 33. Investigate alternatives for increased storage capacity (continued)

Considerations	This option would need to consider: • distribution of potential benefits, including how compliance with the sustainable diversion limits will be maintained • feasibility of the options, including: – potential configurations, dam/weir types and storage volumes – preliminary site assessments, considering constructibility – preliminary cost estimates and cost implications on water users – potential operation of the storages. • alternatives that address the Tumut capacity constraint, such as Option 35: Install gravity pipeline along Tumut River • potential impacts and benefits of the new storages, including: – impact on yield and reliability for water entitlement holders in the Murrumbidgee region – interactions with existing NSW water sharing plan rules and considerations of impacts on Basin Plan requirements (e.g. including no net reduction in the protection of planned environmental water) – potential impacts on the environment, water-dependent ecosystems and dependent biota (including threatened species) from altered hydrology and surface water availability, such as reduced flow variability, reduced in-channel habitat, reduced connectivity, reduced fish passage (downstream and upstream of the storages) and cold water pollution – potential impacts on private land-owners and existing infrastructure within proposed inundation areas – ongoing operation and maintenance requirements – potential impacts on Aboriginal people's water rights, interests and access to water, including cultural heritage – possible impact mitigation measures such as biodiversity offsets, environmental flows and fish passage in accordance with requirements of the *Fisheries Management Act 1994*.
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**WaterNSW—20-Year Infrastructure Options Study: Rural valleys:** **www.waternsw.com.au/projects/infrastructure-studies/20-year-infrastructure-options-study**

Option 34. Investigate new storage at Lake Mejum–Coolah

Source: WaterNSW, Narrandera Shire Council, Leeton Shire Council

Description	This option would review previous investigations into additional storage capacity in the mid-Murrumbidgee to address deliverability issues and to improve system efficiency.
Existing problem or issue	• There is a lack of storage capacity in the mid-Murrumbidgee and the upstream channel capacity constraints in the Tumut and Murrumbidgee rivers impact delivery of both productive and environmental water to the mid- and lower-Murrumbidgee regions during the peak summer demand. • There is a risk of dam storage imbalance and supply shortfall. • There is limited ability to make pre-releases to create airspace during flood operations. • There is a risk of uncontrolled spills from upstream dams. • Delivery distance and times are long, with high transmission losses.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee, it would: • potentially reduce the need to meet demands from upstream dam releases • potentially meet peak summer demands in the mid-Murrumbidgee more efficiently • free up Murrumbidgee River channel capacity and provide an opportunity to meet both the irrigation and environmental water demand in summer • potentially reduce transmission losses, which may increase future water reliability • reduce supply shortfalls • significantly reduce water delivery time for mid- to lower-Murrumbidgee regions • potentially create recreational amenity for nearby towns.
Considerations	This option would need to consider: • distribution of potential benefits, including how compliance with the sustainable diversion limits will be maintained • past studies that investigated the feasibility of the Lake Coolah/Mejum Project • impact on yield and reliability for water entitlement holders in the Murrumbidgee region • interactions with existing NSW water sharing plan rules and considerations of impacts on Basin Plan requirements (e.g. including no net reduction in the protection of planned environmental water) • potential impacts of reduced surplus flows (including unregulated tributary inflows) on meeting environmental water requirements for water-dependent ecosystems, ecological function and dependent biota including consideration of the need to provide more environmental water from elsewhere to restore any lost ecological function • potential impacts on Aboriginal people's water rights, interests and cultural values • potential operational costs due to the need for pumping • evaporation losses due to its large surface area • risk of eutrophication and algal blooms • social impacts of land acquisition and road realignment • possible conflict with other options around improving fish habitat, overall river health and cold water pollution and impact mitigation measures such as biodiversity offsets, environmental flows and fish passage in accordance with requirements of the *Fisheries Management Act 1994* • ongoing operation and maintenance requirements.
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	The current proposal considered pumping water from the Murrumbidgee River just upstream of the Bundidgerry regulator to the southern end of Lake Coolah, and into Lake Mejum, to provide a storage of up to 450 GL. The scheme would be filled over winter and release water for irrigation or environmental watering during summer peak periods. This would enable storage of surplus water (carryover water, upstream dam spills, over-ordering and rainfall rejection, dam releases for airspace) and free up channel capacity in the Murrumbidgee River. A permanent storage of 50 GL has been proposed in the past for recreational use. **WaterNSW—20-Year Infrastructure Options Study: Rural valleys:** **www.waternsw.com.au/projects/infrastructure-studies/20-year-infrastructure-options-study** **Water Resources Commission, 1980. Discussion Paper: Lake Mejum storage proposals:** **www.parliament.nsw.gov.au**

Option 35. Install gravity pipeline along Tumut River

Source: WaterNSW

Description	This option would investigate the feasibility of installing a gravity pipeline along the Tumut River from Blowering Dam to the Murrumbidgee River. This option would address the channel capacity constraint in the Tumut River by enabling release of higher flows downstream of Blowering Dam. This option would require approximately 70 km of 3.5 m diameter pipe, with a capacity of 2,000 ML/day. This option would enable maximum controlled releases from Blowering Dam to increase from 9,000 ML/day to 11,000 ML/day.
Existing problem or issue	• The Tumut River channel capacity constraint (9,000 – 9,300 ML/day at Tumut) limits releases from Blowering Dam. • Blowering Dam release limitations can result in dam storage imbalance between Blowering and Burrinjuck dams and supply shortfalls during summer peak demands. • There is bank erosion along the Tumut River due to sustained high flows in summer. • There is a risk of flooding at Tumut from uncontrolled spills and pre-releases from Blowering Dam.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • potentially enable an additional 2,000 ML/day (22% increase) to be released from Blowering Dam and alleviate dam storage imbalance issues • potentially prevent further erosion of the Tumut River channel • potentially improve capacity to meet downstream irrigation and environmental water needs • potentially provide flood risk mitigation along the Tumut River.
Considerations	This option would need to consider: • distribution of potential benefits, including how compliance with the sustainable diversion limits will be maintained • options for construction and operation of the pipeline, including: – potential configuration, engineering design and alignment – preliminary site assessments, considering constructibility – preliminary cost estimates, operational and maintenance costs and cost implications on water users – potential operation of the storages • the potential impacts and benefits of the new pipeline, including: – impact on reliability for water entitlement holders in the Murrumbidgee region – additional water reliability benefits when combined with the Blowering Dam raising option – interactions with existing NSW water sharing plan rules and considerations of impacts on Basin Plan requirements (e.g. including no net reduction in the protection of planned environmental water) – impacts on the environment, water-dependent ecosystems and dependent biota (including threatened species) from altered hydrology and surface water availability, such as reduced flow variability, reduced in-channel habitat, reduced connectivity, reduced fish passage (downstream and upstream of the storages) and cold water pollution – potential impacts on private landholders and existing infrastructure – ongoing operation and maintenance requirements – potential impacts on Aboriginal people's water rights, interests and cultural values, including cultural heritage – possible conflict with other options around improving fish habitat, overall river health and cold water pollution and impact mitigation measures such as biodiversity offsets, environmental flows and fish passage in accordance with requirements of the *Fisheries Management Act 1994.* • the need for changes to the Tumut River Works Agreement, the Blowering Airspace Deed and the Snowy Water Licence flood mitigation provisions (Clause 12.4 Schedule 4), linking permissible releases to Tumut River channel capacity • previous studies, including assessment of alternatives such as the widening of a Tumut River channel alternative not being progressed by WaterNSW due to significant social and environmental impacts.

Option 35. Install gravity pipeline along Tumut River (continued)

NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**WaterNSW—20-Year Infrastructure Options Study: Rural valleys:** www.waternsw.com.au/projects/infrastructure-studies/20-year-infrastructure-options-study

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

Option 36. Raising Blowering Dam

Source: WaterNSW

Description	This option would investigate the feasibility of increasing the active storage of Blowering Dam. Alternatives to be considered could include: • raising Blowering dam by 4 m to increase active storage in the Murrumbidgee region by 200 GL, with a corresponding increase in the dam capacity of 12% • additional downstream or adjacent off-stream storage.
Existing problem or issue	• System storage capacity and operational limitations. • Current airspace rules limit the ability to manage Snowy Scheme releases and prevent uncontrolled spills.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • increase active storage in Blowering Dam, to potentially better manage Snowy Scheme releases and reduce uncontrolled spills • provide potential for more airspace for flood mitigation.
Considerations	This option would need to consider: • construction and operation of the enlarged dam, including: – potential configuration, engineering design and constructibility, including any dam safety issues and structural integrity – preliminary cost estimates, operational and maintenance costs and cost implications on water users – potential changes to the operation of the dam, including airspace management. • the potential impacts and benefits of the new storages, including: – impact on yield and reliability for water entitlement holders in the Murrumbidgee region – distribution of potential benefits (including how compliance with the sustainable diversion limits will be maintained) – interactions with existing NSW water sharing plan rules and considerations of impacts on Basin Plan requirements (e.g. including no net reduction in the protection of planned environmental water) – potential changes to Snowy Water Licence or Blowering Airspace Deed – potential impacts of dam raising on the Snowy Scheme, including potential encroachment into Snowy Scheme storages, flooding of Jounama Small Hydro Power Station, reduced operability and potential damage to Jounama Dam spillway gates – potential impacts on the environment, water-dependent ecosystems and biota, (including loss of forested area and threatened species) from altered hydrology and surface water availability, such as reduced flow variability, reduced in-channel habitat, reduced connectivity, reduced fish passage (downstream and upstream of the storages) – potential impacts on Aboriginal people's water rights, interests and cultural values (including cultural heritage) – potential impacts on cold water pollution and opportunities to address cold water pollution as part of the dam augmentation – possible impact mitigation measures such as biodiversity offsets, environmental flows and fish passage in accordance with requirements of the *Fisheries Management Act 1994.* • alternatives and combination with other options, including: – relative costs and benefits compared with the enlarged Burrinjuck Reservoir storage option – potential benefits of combining with Tumut pipeline option – potential benefits of combining with any of the new/augment storage options (downstream of Blowering Dam).

Option 36. Raising Blowering Dam (continued)

NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**WaterNSW—20-Year Infrastructure Options Study: Rural valleys:** www.waternsw.com.au/projects/infrastructure-studies/20-year-infrastructure-options-study **Preece, R. 2004, *Cold Water Pollution below Dams in NSW—A desktop Assessment*, Department of Infrastructure, Planning and Natural Resources.** **NSW Cold Water Pollution Strategy—report on the implementation of stage one 2014:** www.industry.nsw.gov.au

Photography
Image courtesy of Destination NSW.
Blowering Dam, Snowy Mountains.

Option 37. Enlarge Burrinjuck Storage Reservoir

Source: Griffith Business Chamber, Murray–Darling Association, Wagga Wagga City Council, WaterNSW

Description	This option would investigate the feasibility of increasing the storage capacity of Burrinjuck Dam, increasing the region's active storage. Options for further investigation could include: • a new dam wall downstream of Burrinjuck Dam to raise the reservoir level by 20 m and increase the valley's storage capacity to around 3,000 GL. • raising the existing dam wall to increase storage capacity to around 1,700 GL.
Existing problem or issue	• Drought periods and physical constraints in the Tumut River can contribute to storage imbalances between Blowering and Burrinjuck dams, and supply shortfall during peak summer demand. • Current airspace rules allow pre-release that is sufficient for the dam to refill based on minimum forecast recession inflows. This variable airspace and reliance on forecasts of inflows can limit the ability to provide flood mitigation and prevent uncontrolled spills. • Burrinjuck Dam has a high risk of severe cold water pollution due to its depth and outlet configuration. • Burrinjuck Dam is 108 years old. It underwent improvement works in the past to address structural and dam safety issues. It is now heavily anchored, and further upgrade works to the existing dam wall are likely to be very complex and expensive.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • increase the active storage in Burrinjuck Dam, potentially reducing dam imbalances and uncontrolled spills • potentially allow for more airspace for improved flood mitigation • potentially reduce cold water pollution through the integration of multi-level outlets with the construction of a new dam wall • potentially reduce risk of system shortfalls.

Photography
Image courtesy of iStock.
Gogeldrie Weir, Murrumbidgee River.

Option 37. Enlarge Burrinjuck Storage Reservoir (continued)

Considerations	This option would need to consider: • options for construction and operation of the enlarged dam, including: – potential configuration, engineering design and constructibility, including any dam safety issues and structural integrity – preliminary cost estimates, operational and maintenance costs and cost implications on water users – potential changes to operation of the dam, including airspace management. • the potential impacts and benefits of the new storages, including: – impacts on yield and reliability for water entitlement holders in the Murrumbidgee – distribution of potential benefits (including how compliance with the sustainable diversion limits will be maintained) – interactions with existing NSW water sharing plan rules and considerations of impacts on Basin Plan requirements (e.g. including no net reduction in the protection of planned environmental water) – potential impacts on the environment, water-dependent ecosystems and biota, (including loss of forested area and threatened species) from altered hydrology and surface water availability, such as reduced flow variability, reduced in-channel habitat, reduced connectivity, reduced fish passage (downstream and upstream of the storages) and cold water pollution – potential impacts on Aboriginal people's water rights, interests and cultural values (including cultural heritage) – impacts of property acquisition required around Wee Jasper and re-routing of existing roads – potential impacts on cold water pollution and opportunities to address cold water pollution as part of dam augmentation – possible impact mitigation measures such as biodiversity offsets, environmental flows and fish passage in accordance with requirements of the *Fisheries Management Act 1994*. • alternatives and combination with other options, including: – relative costs and benefits compared with the Blowering Dam raising option – relative costs and benefits compared with any new mid-Murrumbidgee storage options – potential benefits of combining this option with any of the new/augmented storage options (downstream of Burrinjuck Dam). • status of the pre-investment studies for the Burrinjuck Hydro Energy Storage Project (pumped hydro) and potential impacts of the project on potential enlargement of Burrinjuck Dam.
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**WaterNSW—20-Year Infrastructure Options Study: Rural valleys:** www.waternsw.com.au/projects/infrastructure-studies/20-year-infrastructure-options-study **Preece, R. 2004, *Cold Water Pollution below Dams in NSW—A desktop Assessment*, Department of Infrastructure, Planning and Natural Resources.** **NSW Cold Water Pollution Strategy—report on the implementation of stage one 2014:** www.industry.nsw.gov.au **Yass Tribune—*Burrinjuck hydro power station expansion could provide more than 150 local jobs*, 9 October 2019:** www.yasstribune.com.au/story/6425255/burrinjuck-hydro-power-station-expansion-could-provide-more-than-150-local-jobs/

Option 38. Expand Bundidgerry off-river storage and a new transfer canal

Source: WaterNSW

Description	This option would investigate augmenting the existing Bundidgerry storage in the mid-Murrumbidgee region to address deliverability issues in the summer months, such as supply shortfalls, and to improve system efficiency. The option could consider adding a weir to Bundidgerry off-river storage with a height of 2 m, an embankment of 5.8 km and a gravity transfer canal 18 km in length with a capacity of 6,500 ML/day. This would increase the storage capacity from 4 GL to 10 GL.
Existing problem or issue	• Storage capacity limitations in the mid-Murrumbidgee region contribute to deliverability issues such as: – reliance on releases from upstream dams – physical constraints in the Tumut and Murrumbidgee rivers limit flow that can be released from these dams, which can result in storage imbalance and supply shortfall – upstream physical constraints can also limit ability to make pre-releases to create airspace during flood operations, resulting in uncontrolled spills and downstream flood risk – impact on delivery of productive and environmental water during the irrigation season. • Long delivery distances and times can result in over-ordering, rainfall rejection and operational surplus. • There are high conveyance losses.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • potentially increase the ability to meet demands in the Murrumbidgee Irrigation area from the new storage, rather than releasing from upstream dams, thereby reducing transmission losses • potentially reduce supply shortfalls and water delivery times for customers in the mid-Murrumbidgee region • potentially improve delivery efficiencies • potentially provide an opportunity to meet both the irrigation and environmental water demand in summer • as irrigation orders can be supplied from Bundidgerry storage, there will be available capacity in the Murrumbidgee River for the delivery of water to the wetlands downstream.
Considerations	This option would need to consider: • distribution of potential benefits (including how compliance with the sustainable diversion limits will be maintained) • options for construction and operation of the weir and storage • preliminary cost estimates, operational and maintenance costs and cost implications on water users • impact on yield and reliability for water entitlement holders in the Murrumbidgee region • interactions with existing NSW water sharing plan rules and considerations of impacts on Basin Plan requirements (e.g. including no net reduction in the protection of planned environmental water) • potential impacts on the flow regime, the environment, water-dependent ecosystems and biota from altered hydrology and surface water availability, such as changed flow regime, changes to connectivity, reduced fish passage (downstream and upstream of the storage) and cold water pollution impacts (located in an already modified landscape) • potential impacts on Aboriginal people's water rights, interests and cultural values (including cultural heritage) • comparison against alternative mid-Murrumbidgee storage options (Lake Coolah, Tombullen Storage upgrade, new Oura storage).
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**WaterNSW—20-Year Infrastructure Options Study: Rural valleys:** **www.waternsw.com.au/projects/infrastructure-studies/20-year-infrastructure-options-study**

Option 39. Augment Tombullen Storage and modify operational changes

Source: WaterNSW

Description	This option would investigate the feasibility of two options to improve the efficiency of Tombullen Storage: • augmenting the storage capacity of Tombullen Storage to increase the re-regulating storage in the mid-Murrumbidgee region and improve security and reliability of supply • investigating potential operational changes for Tombullen Storage to mitigate water quality issues. The existing off-river storage (11 GL) is currently used to re-regulate surplus flows, which is then used to supply private irrigators and environmental water below Gogeldrie Weir. The storage is supplied off the Coleambally Main Canal and releases water back to the Murrumbidgee via Tombullen Creek. Increased capacity and utilisation of this storage can improve delivery efficiency to the mid- and lower-Murrumbidgee regions. Operational changes that increase utilisation of the storage and improve the turnover of water in the storage will reduce the risk of eutrophication and algal blooms. This provides a 'no-build' alternative to address water quality issues. This would require initial research to better understand the phytoplankton community composition and potential drivers for blue-green algae blooms, including investigating mitigation measures such as nutrient trapping and artificial mixing.
Existing problem or issue	• There are frequent occurrences of toxic blue-green algal blooms at Tombullen off-river storage. • Water is unavailable to downstream users in times of low flow and drought, due to low levels, inaccessible dead storage and poor water quality. • There is high evaporation due to the relatively shallow storage. • There is risk to water availability, reliability and security of supply.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • potentially improve reliability and security of supply by improving water availability when required throughout the year • potentially reduce the delivery time to water users downstream of Gogeldrie weir • potentially increase utilisation and turnover rate of the storage to alleviate water quality issues • assist in overcoming upstream physical constraints by enabling off-peak transfers to Tombullen storage to deliver peak summer demand • potentially provide more flexibility for delivery of environmental water to the mid- and lower-Murrumbidgee regions.
Considerations	This option would need to consider: • impacts on yield and reliability for water entitlement holders in the Murrumbidgee region • distribution of potential benefits (including how compliance with the sustainable diversion limits will be maintained) • interactions with existing water sharing plan rules and considerations of impacts on Basin Plan requirements (e.g. including no net reduction in the protection of planned environmental water) • changes required to existing infrastructure to enable operational changes • potential need to amend the *Tombullen Storage Act 1978* • potential impacts on the flow regime, the environment, water-dependent ecosystems and biota from altered hydrology and surface water availability • potential impacts on Aboriginal people's water rights, interests and cultural values.
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**WaterNSW—20-Year Infrastructure Options Study: Rural valleys:** **www.waternsw.com.au/projects/infrastructure-studies/20-year-infrastructure-options-study** ***Tombullen Storage Act 1987*, No. 23:** **www.legislation.nsw.gov.au**

Option 40. Investigate inter-regional connections

Source: Department of Planning and Environment—Water, Canberra Region Joint Organisation, Hilltops Council, Yass Valley Council, Queanbeyan-Palerang Council, Lachlan Regional Water Strategy

Description	This option would investigate the construction of inter-regional pipeline connections between the Murrumbidgee region and neighbouring regions. Potential inter-regional connections could include: • Young (Goldenfields Water County Council) to Cowra bi-directional pipeline • extending the Albury regional scheme to the Riverina Water County Council scheme • inter-regional connections to not fully allocated groundwater sources, such as the Oaklands Basin.
Existing problem or issue	• Several NSW town water supplies rely on single water sources and have high, to very high water security risks. • Several towns experience intermittent water quality issues. • Significant growth is projected around Wagga Wagga, putting pressure on limited water resources. • There is a risk to future water availability due to climate change.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee, they would: • provide NSW towns with access to more than one water source • improve NSW town water security • reduce supply shortfalls during drought • reduce the imposition of water restrictions, enabling maintenance of town amenity • support regional growth.
Considerations	This option would need to consider: • water sharing arrangements between parties, including inter-jurisdictional issues • long-term average annual extraction limits • possible triggers or conditions when this option would be progressed • the risk to town water supply, informed by regional water strategy modelling • operating costs (e.g. pumping) • potential impact on the environment, water-dependent ecosystems and biota • existing background information and status—some potential options are seeking funding under the Safe and Secure Water Program, and some options have already undertaken scoping studies, for example the Boorowa to Goldenfields Water scheme is under active consideration and the Department of Planning and Environment received extensive comments on town water security needs during consultation on the water resource plan development • existing projects under the National Water Grid Connections package • review of not fully allocated groundwater sources under the *NSW Groundwater Strategy.*
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action: 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**Canberra Region Joint Organisation: Water and Wastewater Prospectus:** www.crjo.nsw.gov.au **National Water Grid—NSW Connections package:** www.nationalwatergrid.gov.au/program/new-south-wales-connections-package

Option 41. Change environmental releases from Murrumbidgee storages

Source: WaterNSW

Description	This option would investigate changes to operations related to the release of discretionary environmental water. The suggested change would be to release more from Blowering Dam and less from Burrinjuck Dam during winter and would include review of: • current storage and accounting of Environmental Water Allowances • current decision-making processes regarding release of held (licensed) environmental water • winter flow regime in the Tumut River and ecological outcomes • hydrologic impacts on timing and frequency of dam imbalance and supply shortfalls.
Existing problem or issue	• Delivery of discretionary environmental water from Burrinjuck Dam in winter exacerbates dam storage imbalance, which can result in supply shortfall. • Risk of supply shortfall in summer. • Consistent high flows in the Tumut River during summer peak delivery contribute to bank erosion issues. • Low to very low winter flow in the Tumut River.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee, it would: • potentially alleviate dam storage imbalance issues • potentially increase water available in Burrinjuck Dam in summer to meet peak demand • potentially reduce supply shortfalls • potentially increase reliability of supply • potentially improve winter flow variability in the Tumut River • provide potential increases to airspace in Blowering Dam, reducing the need for pre-release, under certain circumstances.
Considerations	This option would consider: • Snowy Water Licence Review ongoing actions and any potential future changes • outcomes of the scheduled unregulated river water sharing plans reviews • combination with options investigating revised operation and/or augmentation of Tombullen Storage and additional mid-Murrumbidgee storage options, and operations required to transfer water to these storages for re-regulation • Commonwealth Environmental Water Holder, Department of Planning and Environment and Murrumbidgee Environmental Water Advisory Groups decision making in regard to timing and accounting of held environmental water releases • interactions with existing NSW water sharing plan rules and considerations of impacts on Basin Plan requirements (e.g. including no net reduction in the protection of planned environmental water) • relative improvements and impacts on the environment, water-dependent ecosystems and biota, in both the Tumut River and Murrumbidgee River • potential impacts on Aboriginal people's water rights, interests and cultural values.
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	

Option 42. Review flood management and airspace operation

Source: WaterNSW, Department of Planning and Environment—Water, Riverina Water, and Queanbeyan-Palerang Regional Council

Description	This option would review existing operations and rules governing flood operation of Blowering and Burrinjuck dams and the interaction with airspace rules and relevant Snowy Water Licence rules. It would also investigate potential operational or rule changes to improve flood mitigation functions. This would involve the following components: • review current WaterNSW operations for Blowering and Burrinjuck dams in the lead up to, and during, floods and spills and identify any potential improvements • investigate the effectiveness of current Blowering and Burrinjuck dams' airspace rules for flood mitigation, and identify any limitations • use the new climate datasets to better inform future climate risks for extreme wet conditions and potential risk of increased flood probability in the future • review the interaction between the Snowy Water Licence and the Blowering Airspace Deed and its appropriateness in the context of a changing climate • investigate the benefits and impacts of increasing the airspace in Blowering Dam • review the flood operation and data sharing arrangements for the ACT's storages and investigate potential operational improvements.
Existing problem or issue	• Current dam operations during floods and spills are required to balance dam safety and flood mitigation for downstream communities with regional water security (i.e. ensuring the storage is as full as possible at the end of the flood event). Uncertainty associated with weather forecasts and the balancing of the two storages present challenges for decision making on the timing and magnitude of pre-releases to provide adequate airspace. • Some current rules can contribute to physical spills from Blowering Dam or the need for releases to prevent it from exceeding full storage level, under a return to expected minimum inflow conditions prior to an onset of water supply demands. These uncontrolled spills can impact on downstream flooding and affect subsequent water availability. • The water sharing plan does not explicitly require the Tumut River channel capacity constraints to be complied with. • Flooding is a vital, natural process that supports the region's environment and facilitates longitudinal and lateral connectivity across the Murrumbidgee system. Flood mitigation needs to be balanced with the water needs of the environment.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • support the implementation plan of the *Ten-Year Review of the Snowy Water Licence* • improve integrated flood management by coordinating Snowy Scheme releases and flood operation of Murrumbidgee region's major storages and airspace • potentially reduce unused spills from Blowering Dam • potentially reduce the potential future flood risk in the Murrumbidgee catchment.
Considerations	This option would need to consider: • any reviews and recommendations by the Regional Airspace Advisory Panel • work underway for Actions 15 and 16 from the implementation plan of the *Ten-Year Review of the Snowy Licence* • combining this option with other options that propose additional active storage in the system, including the potential to use downstream re-regulating storages to facilitate greater airspace in Blowering Dam • potential changes to water sharing plan rules and WaterNSW Operating Licence • any potential impacts on Snowy Hydro Limited and the potential for compensation to be paid • potential impacts on the flow regime, environment, water-dependent ecosystems and biota • engagement with other jurisdictions.

Option 42. Review flood management and airspace operation (continued)

NSW Water Strategy priorities	**Priority 1:** Build community confidence and capacity through engagement, transparency and accountability • **Action 1.3:** Enhance modelling capabilities and make more data and models openly available. **Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**Murrumbidgee River Operations Plan (WaterNSW):** www.waternsw.com.au **Snowy Water Licence:** www.industry.nsw.gov.au **Ten-year Review of the Snowy Water Licence:** www.industry.nsw.gov.au/water/basins-catchments/snowy-river/corporate-licence/review **Review of water management during the 2010 flood events in the Tumut River and Murrumbidgee River:** www.flooddata.ses.nsw.gov.au/flood-projects/tumut-murrumbidgee-river-review-of-water-management-during-the-2010-flood-events **Initial Assessment of Potential Flood Mitigation for Downstream Communities from Googong Dam:** www.iconwater.com.au

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

Option 43. Investigate groundwater desalination for industry and towns

Source: Department of Planning and Environment—Water

Description	This option would investigate the opportunities associated with desalination of groundwater to make it suitable for industrial and town uses. This option could provide an additional source of water that can be treated to different levels depending on the use, for example, some industries do not require potable water. This option would: • investigate opportunities to install advanced water treatment technologies such as modular reverse osmosis treatment facilities to supply rural communities and towns in NSW • identify and survey suitable areas and assess groundwater conditions (quality, quantity) to support industry development—potential sources include the Lower Murray Shallow Alluvium, Western Porous Rock or Oaklands Basin • map and quantify the most cost-effective groundwater sources • investigate the use of saline groundwater, including assessing long-term sustainability of the water source, impacts to the environment and existing water users • understand the hydrogeological impacts of groundwater extraction at the local and regional level • assess funding options by local, state and federal governments for infrastructure to support these technologies for towns and industry • investigate innovative solutions for the management of brine created during treatment of saline waters • investigate opportunities for activities (such as mineral sand-mining near Balranald) to be categorised as surrogate salt inception schemes which could be linked with credit programs in the *Basin Salinity Management 2030*.
Existing problem or issue	• Increased climate variability and climate change is likely to reduce water security and reliability for towns and industries. • Increasing demand and changing water needs are due to population growth and expanding or new industries. • Balance water needs between different water users. • Potable water sources need to be retained for where they are needed most.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • improve water security for existing NSW towns and industrial water users • make use of deeper groundwater sources, such as the Oaklands Basin, which are considered climate independent • reduce pressure on other water supplies and improve environmental outcomes.
Considerations	This option would need to consider these factors: • a high volume of water is required to operate a desalination plant efficiently • the site of a desalination facility would depend on the location, volume and quality of saline groundwater sourced • the infrastructure requirements and costs, operating costs and energy demands indicate this option would likely be developed over the longer term (if the groundwater supply is feasible) • disposal of brine created during the desalination process can be challenging; however, methods and technologies for brine disposal are advancing and it is possible to mitigate possible aesthetic and environmental impacts • some disposal methods can have economic benefits (e.g. salt production) • collaboration with industry stakeholders on desalination options could improve resilience in water supplies over the long term.
NSW Water Strategy priorities	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management. **Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.4:** Identify infrastructure and operational options for each region of NSW. **Priority 7:** Enable a future focused, capable and innovative water sector • **Action 7.1:** Pilot new technologies to increase our water options.
Regional water strategy objectives	
Further information	**Murray–Darling Basin Ministerial Council's Basin Salinity Management 2030:** www.mdba.gov.au/publications/mdba-reports/basin-salinity-management-2030

Limits to water availability in times of a changing climate

Water needs across the Murrumbidgee region are changing—recent growth in permanent plantings and alterations in annual crops are changing water demand patterns and changing the spatial use of water in the region. Industrial and commercial growth in key regional centres is expected to be driven by increased agricultural outputs, diversification of agribusinesses, and new value-added processing and manufacturing.

There are opportunities to investigate better ways to use water through implementing efficiencies, researching, and managing demand that will allow the region to maintain its productive capacity and build resilience in a variable and changing climate. There are also opportunities to improve our understanding of water use, share knowledge, and build capacity and trust in water management across all water users.

Options listed under this category focus on better understanding water use behaviour, identifying the information needs of water users, and developing strategies to improve resilience and the productive capacity of the region.

Option 44. Better understand water use with data collection and analytics

Source: Department of Planning and Environment—Water

Description	This option would undertake a research project to better understand water use and water user behaviour in the Murrumbidgee region. The project would focus on the following areas: • **Industry water use:** Determine whether extractive water use tracks equal to or below the Sustainable Diversion Limit (surface water and groundwater). In addition, this work could also analyse the timing or pattern of water use, including substitution between surface and groundwater. • **Non-residential water use in towns:** Determine water use by non-residential water users reliant on town water supplies. • **Growth in town water use:** Work collaboratively with agencies and councils to better understand growth in town water needs in the next 20 years. • **Environmental water use:** Collect data on water orders and (any relevant) site-specific 'use' of environmental water (state and federal) to gain a better understanding of water demand and environmental watering behaviour. In addition, this option may identify where and how this data could assist in increasing NSW's hydrologic modelling capabilities.
Existing problem or issue	• There are data and knowledge gaps in water use behaviour information. • Agricultural water use patterns are changing. • There is increased competition for water use. • There are barriers to environmental flow delivery and protection of environmental flows in unregulated rivers.

Option 44. Better understand water use with data collection and analytics (continued)

Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would provide a more comprehensive dataset on water use, and changes in water user behaviour over time, which will: • inform future water management decisions in the Murrumbidgee region, including river operations, implementation of NSW water sharing plans/water resource plans • identify existing or emerging risks and help manage these risk as they arise • proactively manage future water security risks to towns due to growth in the Murrumbidgee region—focus on the reliability and licensed volume of local water utilities as all other local water security risks are managed through integrated water cycle management strategies and other programs • evaluate whether current policy and regulatory settings could be improved to efficiently and sustainably use water sources in the Murrumbidgee region • better plan and manage the system during normal and extreme events—to also minimise adverse impacts on other water users • inform the salinity register (credits/debits) to understand water use spatially and at a crop level • address recommendations 17 and 18 of the Australian Competition and Consumer Commission's *Murray–Darling Basin Water Markets Inquiry*.
Considerations	This option would need to consider: • identification of data and information (including the process around collecting data) that is already collected by agencies (or in existence) that could supplement the project, including information that can be obtained from the NSW Government's non-urban water metering reforms • additional infrastructure required to assist in the data collection and assessment process (e.g. river flow gauges, groundwater monitoring bores) • new technologies that could be used to improve the data collection (e.g. satellite images) • other similar data systems (Bureau of Meteorology, Geoscience Australia's Datacube) and links to other programs such as the Murray–Darling Basin Authority's data portal • whether there are any regulatory or policy settings to prevent the data collection process (or for the project not to proceed) • appropriate safety protocols around the collection and storage of any data and information (e.g. privacy) • procedures to deal with multiple data formats and metadata types • how this information will be used and how it will support future analysis • how this information could contribute to the Department of Planning and Environment's monitoring, evaluation and reporting framework (e.g. for the NSW water sharing plans, for the Natural Resources Access Regulator and other processes).
NSW Water Strategy priorities	**Priority 1:** Build community confidence and capacity through engagement, transparency and accountability • **Action 1.2:** Increase the amount and quality of publicly available information about water in NSW • **Action 1.3:** Enhance modelling capabilities and make more data and models openly available. **Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.5:** Adopt a more intense, state-wide focus on improving water quality.
Regional water strategy objectives	
Further information	**Department of Planning and Environment—Water reporting:** www.industry.nsw.gov.au/water/science **Australian Competition and Consumer Commission—Murray-Darling Basin water markets inquiry:** www.accc.gov.au/focus-areas/inquiries-finalised/murray-darling-basin-water-markets-inquiry/final-report

Option 45. Improve the understanding of groundwater sources and processes, risks and impacts

Source: Department of Planning and Environment—Water

Description	Water users and towns need access to data and information about groundwater resources—their availability, quality, levels, use and regulation—as well as the impact of climate change on these resources to enable timely and evidence-based water management decisions. The NSW Government also needs up-to-date data to reduce the uncertainty and therefore risks in managing this precious resource for current and future generations. This option could: • undertake new research to develop and update resource characterisation for NSW groundwater sources, covering five main themes: – recharge or through-flow rates and associated spatial–temporal variations, including the impacts from climate variation and change, on- and off-farm water efficiency projects, and adapting river operations – dynamics of groundwater levels under stressed and evolving development conditions – connectivity between groundwater and surface water systems – how and why groundwater quality changes over time – water needs of ecosystems that are partly or wholly dependent on groundwater, the impact on these ecosystems under different development scenarios, and what ecosystems need in terms of groundwater levels or baseflows from aquifers to river systems. • explore, using digital infrastructure and agriculture technologies, to: – monitor data use – collect groundwater usage data such as pairing spatial analysis, and the use of geographic information system technology and databases and hydrological models to track use in areas of high irrigation demand. • improve groundwater modelling by: – updating groundwater models with shifts in demand that are likely to be driven by climate variability, and incorporate new understanding on interconnectivity between surface water and recharge – developing multidisciplinary models incorporating socio-economic and physical data; agent behaviour; social and economic data; and groundwater volume, level and quality data.
Existing problem or issue	• There is a need for more information about groundwater resources in the Murrumbidgee region to guide future management decisions by governments. • Increased climate variability poses new risks to towns, communities and industries in the Murrumbidgee region. • Increased climate variability, particularly during dry times, will place increased pressure on surface and groundwater resources and the ecosystems they support.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee, it would: • increase scientific knowledge of the processes occurring in NSW's groundwater resources, from areas of recharge to areas of discharge and the complex interactions in-between • reduce the risk of inappropriate groundwater management decisions being made by local and state government.
Considerations	This option would need to consider: • how it could be implemented given the time required for scientific studies and the timing of the revision or replacement of NSW water sharing plans and water resource plans • recommendation 18 of the Australian Competition and Consumer Commission's *Murray–Darling Basin Water Markets Inquiry*.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management.
Regional water strategy objectives	
Further information	**Australian Competition and Consumer Commission—Murray-Darling Basin water markets inquiry:** www.accc.gov.au/focus-areas/inquiries-finalised/murray-darling-basin-water-markets-inquiry/final-report

Option 46. Undertake a water dependent industry resilience study

Source: Department of Primary Industries—Agriculture

Description	This option would include undertaking a comprehensive 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 town water supply systems. This study would make use of the new climate data and updated modelling developed for the Murrumbidgee Regional Water Strategy. In addition, the study would consider recent and projected industry changes in the Murrumbidgee region, including the move towards a greater proportion of permanent plantings. This component would help assess different industries' abilities to flexibly adapt to changes in water availability, which would provide important information about future water demand and usage pattern across the region (e.g. including spatial distribution of water use in the catchment).
Existing problem or issue	• Climate variability and climate change create risks of reducing water availability. • There is increased competition for limited water resources and channel capacity. • Delivery times and distances are long.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • provide insights into the resilience of different industries to increased climate variability and climate change, including sequential years of low water availability • provide a better understanding on how climate variability and climate change may impact on associate industries (e.g. gins, milling, abattoirs) and therefore regional communities • provide information on the types of industries or crops suited to the region in a more variable and drier future • help future planning (land use and water management), policy and regulatory changes as well as water related industries to support and sustain industries and communities, in the context of a capped system • provide evidence to help target and tailor future support packages during droughts and help avoid costly policy mistakes.
Considerations	This option would need to consider: • engagement and collaboration with research institutes, state and federal agencies (e.g. Australian Bureau of Agricultural and Resource Economics and Sciences, the Department of Primary Industries—Agriculture), research and development corporations, industries and local councils • existing research and analysis on industry resilience, including work already undertaken, or currently being progressed, by the Department of Primary Industries—Agriculture and the Department of Regional NSW • existing initiatives, including those related to the Future Ready Regions Strategy • a gap analysis of any data and information required to progress the option • how this option could feed into long-term business planning and training packages for industries and businesses • the type of monitoring needed to understand economic and social implications of prolonged drought periods • interaction with the *Right to Farm Policy Review*.
NSW Water Strategy priorities	**Priority 4:** Increase resilience to changes in water availability (variability and climate change) • **Action 4.1:** New actions to improve and apply our understanding of climate variability and change. **Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water.

Option 46. Undertake a water dependent industry resilience study (continued)

Regional water strategy objectives	
Further information	**Right to Farm Policy:** www.dpi.nsw.gov.au/agriculture/lup/legislation-and-policy/right-to-farm-policy **Future Ready Regions Strategy:** www.nsw.gov.au/regional-nsw/future-ready-regions **Farm Business Resilience Program:** www.awe.gov.au/agriculture-land/farm-food-drought/drought/future-drought-fund/research-adoption-program **Managing farm businesses during drought:** www.dpi.nsw.gov.au/emergencies/droughthub_old/information-and-resources **Drought Resilience Research and Adoption Program:** One of the Drought Resilience Adoption and Innovation Hub is based at Charles Sturt University, Wagga Wagga www.awe.gov.au/agriculture-land/farm-food-drought/drought/future-drought-fund/research-adoption-program

Photography
Image courtesy of Destination NSW.
Cows grazing, Gundagai.

Option 47. Develop targeted education and capacity building programs

Source: Department of Planning and Environment—Water

Description	This option would look at developing targeted education and capacity building programs to build community confidence in NSW water management, with a focus on the Murrumbidgee region, and help communities, industries and the environment to better manage their water needs and water-related risks. This would apply to both surface and groundwater sources. The initial focus areas for this targeted education and capacity building program could include: • climate data and modelling from the new regional water strategies—to build confidence in the new approach and identify opportunities for a wider use of the new datasets • existing or emerging water efficiency opportunities to help identify, promote and provide incentives for use of water efficient technologies, techniques and products • water markets (systems, processes, products, rules)—to assist individuals to better understand the water trading framework and mechanisms • NSW water allocation processes (process, inputs, assumptions)—to better understand the water allocation framework and its underlying assumptions • NSW environmental water management—to provide information to the general public about water needs for the environment and develop their confidence in environmental water management • Aboriginal cultural water management practices—to provide a platform for 'two-way learning' opportunities to help build more cultural knowledge into NSW's water management practices • salinity and water quality management—to provide information and programs to enhance landholders' understanding of how landscapes work and how to manage them for salinity and water quality • flood works—to increase awareness around existing regulation for flood works • flood operations—to provide a better understanding of the operation of Blowering and Burrinjuck dams in the lead up to and during floods, including use of weather forecasting, balancing future water security and flood mitigation, interactions with the Snowy Scheme and physical constraints in the system • consolidation of scientific and practice learnings—from recent studies and trials about climate resilience and improving the productivity of both irrigated and dryland crop systems. This information would be made available on the Department of Primary Industries website and by holding information sessions. These suggested (initial) focus areas are based on frequent enquiries by stakeholders. This option would also consider how best to publicly share data, and any analysis on the regional water strategies options. In addition, it would consider what data analytics and information products are needed for different types of water users, including councils, Aboriginal people, environmental water managers and industries. This option could also include training for councils about water quality and monitoring.
Existing problem or issue	• There are data and knowledge gaps and a lack of education on water conservation. • Limited incentives exist to improve industry water use efficiency. • There is inadequate public information and training opportunities about water resource management, water trading, and latest information regarding farm-scale water management.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee, it would: • assist all water users to make more informed decisions about their water supply security • provide greater transparency about water management and water modelling • inform councils and joint organisations in their development of integrated water cycle management strategies and regional town water strategies • help address recommendation 15 and 23 of the Australian Competition and Consumer Commission's *Murray–Darling Basin Water Markets Inquiry*.

Option 47. Develop targeted education and capacity building programs (continued)

Considerations	This option would need to consider: • coordination with existing work programs underway by the Department of Planning and Environment, WaterNSW and other agencies • an initial review to identify knowledge gaps and tailor capacity building programs for different stakeholders • collaboration with stakeholders on how the information and data should be presented and disseminated (e.g. ensuring the information is targeted for the respective audiences) • web-based delivery opportunities and existing software/programs (e.g. such as eSPADE) that could be used.
NSW Water Strategy priorities	**Priority 1:** Build community confidence and capacity through engagement, transparency and accountability • **Action 1.1:** Improve engagement, collaboration and understanding • **Action 1.2:** Increase the amount and quality of publicly available information about water in NSW. **Priority 2:** Recognise First Nations/Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes • **Action 2.5:** Work with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes. **Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.3:** Improve the operation and transparency of water trade in NSW. **Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.7:** Proactive support for water utilities to diversify sources of water.
Regional water strategy objectives	
Further information	**NSW Water Register:** **waterregister.waternsw.com.au/water-register-frame** **WaterInsights portal:** **www.waternsw.com.au/waterinsights/water-insights** **Allocations dashboard:** **www.industry.nsw.gov.au/water/allocations-availability/allocations/dashboard** **Trade dashboard:** **www.industry.nsw.gov.au/water/licensing-trade/trade/dashboard** **Environmental Water Hub:** **www.industry.nsw.gov.au/water/environmental-water-hub** **Natural Resource Access Regulator's Public Register:** **www.dpie.nsw.gov.au/nrar/progress-and-outcomes/public-register** **Australian Competition and Consumer Commission—Murray-Darling Basin water markets inquiry:** **www.accc.gov.au/focus-areas/inquiries-finalised/murray-darling-basin-water-markets-inquiry/final-report**

Option 48. Investigate water availability in the Murrumbidgee region

Source: Department of Planning and Environment—Water

Description	This option would consider whether there is systemic reduction in available water (e.g. water use tracking below the NSW water sharing plan extraction limits in regulated systems) in the Murrumbidgee region. If systemic reduction in water availability can be established the option would investigate: • possible causes of the reduction and how much each cause contributes to the reduction in water availability • possible policy, regulatory and technical responses to address water availability in the southern NSW regions. The assessment of any responses would include the potential impacts of the proposed responses on all water users and the environment.
Existing problem or issue	• There is increased competition for limited water resources and limited and declining opportunities for general security entitlement holders to access water. • Areas with existing and emerging water availability constraints are growing. • Agricultural water use patterns are changing.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • provide transparency and evidence on whether there is systemic underuse in the southern NSW regions • provide evidence on possible causes of any underuse and for an opportunity to use water up to, but not exceeding the sustainable diversion limit • maximise the efficient use of all available (allocated) water in the Murrumbidgee region noting that all actual water in the southern Basin is allocated each year in accordance with the provisions of the NSW water sharing plan.
Considerations	This option would need to consider: • evidence, and further analysis to establish water availability in the Murrumbidgee region against sustainable diversion limits accounting—for example the need for an accredited water resource plan • review of existing work undertaken by the Murray–Darling Basin Authority and RMCG consultants on the issue of 'underuse' in the southern NSW regions • various possible causes of the reduction in water availability in the southern NSW regions—for example the proportion attributed to climate variability, water use behaviour, modelling or water policy setting including carryover provisions • new climate datasets and updated modelling prepared for the Murrumbidgee Regional Water Strategy • any implications of proposed changes on other water users in the region.
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**Murray–Darling Basin Authority: Trends in water use relative to the sustainable diversion limit in the southern Murray–Darling Basin:** www.mdba.gov.au **Murray–Darling Basin Authority: Murray–Darling Basin sustainable diversion limit compliance outcomes 2019–20:** www.mdba.gov.au

Option 49. Investigate non-residential water efficiency (towns and industries)

Source: Department of Planning and Environment—Water

Description	This option would investigate opportunities to improve non-residential water efficiency under two categories: Non-residential surface water and groundwater use from town water supplies: • supporting NSW towns to undertake water audits, or collate existing information where available, to identify major non-residential water uses • investigating any legislative or regulatory impediments or gaps that prevent non-residential water users from implementing water use efficiency projects • disseminating information about existing programs to assist industries towards greater water use efficiency and, if insufficient information is available, develop a specific program driving water use efficiency in non-residential water users—for example including trials of new water efficient technologies • investigating increased use of recycled water or stormwater by industry, within or near towns in the Murrumbidgee region. This would provide a reliable, climate-independent water source to support industry growth and reduce pressure on town water supplies and other water sources. Off-farm water delivery systems: • reviewing and investigating proposals for state-led projects currently under consideration by the NSW Government, which may not be eligible for or may not receive funding under the Australian Government's Off-Farm Efficiency Program. These would also be outside the current scope of existing SDLAM program • identifying any new off-farm efficiency project opportunities • considering alternative funding sources for proposals that have merit, with potential to reduce water losses, provide water savings, improve the efficiency of water delivery and/or use and improve water availability for the environment, industry and urban purposes. The types of off-farm efficiency projects that would be considered include: • modifying irrigation networks • rationalising inefficient or underutilised sections of water delivery networks • improving delivery of stock and domestic water, including opportunities to extend systems to deliver water to small towns • improving delivery and use efficiency for industry—such as leak reduction, replacement of potable water with fit-for-purpose alternative sources, more water efficient production practices • upgrading urban bulk water delivery systems to reduce losses.
Existing problem or issue	• Increased climate variability and climate change is likely to reduce water security and reliability for towns and industry. • There is increased competition for limited water resources. • There are data and knowledge gaps regarding water use and losses. • There are limited incentives to improve town and industry water efficiency. In some cases impediments exist. • Town water restrictions increase during dry times. This can impact town amenity with reduced recreational opportunities, and negative impacts on community, mental and physical health and town aesthetics.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • reduce demand on potable water supplies and raw water river extractions • assist non-residential town water users to better manage their water security risks • better protect residential town water supplies during dry times • assist in making regional towns and regional economies more resilient to dry periods and protect important town water amenity, which contributes to liveability, health, wellbeing and tourism • assist in the development of programs to drive water-use efficiency • reduce water losses to increase the volume of available water for the environment, irrigation networks, irrigators and communities.

Option 49. Investigate non-residential water efficiency (towns and industries) (continued)

Considerations	This option would need to consider: • collaboration with NSW councils, including considerations of the status of each council's integrated water cycle management strategy • collaboration and coordination with the NSW Town Water Risk Reduction Program • coordination with the NSW Off-Farm and Policy team regarding status of state-led proposals for the Australian Government's Off-Farm Efficiency Program • strategic opportunities within and across the region to implement trials, including collaboration between the state government, local councils and industries dependent on town water supplies to ensure projects are resourced and successfully implemented and monitored • whether incentives are required to improve water use and delivery efficiency • proximity of industry to wastewater treatment plants to access recycled water • potential impacts on waterways of reduced treated effluent discharge resulting from increased use of recycled water.
NSW Water Strategy priorities	**Priority 4:** Increase resilience to changes in water availability (variability and climate change) • **Action 4.3:** Improve drought planning, preparation and resilience. **Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.1:** Provide greater certainty to regional businesses that rely on secure access to water • **Action 5.2:** Invest in R&D and new technologies to lift water productivity in NSW industries. **Priority 6:** Support resilient, prosperous and liveable cities and towns • **Action 6.2:** Work collaboratively with local water utilities to reduce risks to town water supplies • **Action 6.6:** A new state-wide Water Efficiency Framework and Program.
Regional water strategy objectives	
Further information	**Background:** In addition to residential water use, there are a range of other water users of town water supplies. Significant non-residential uses can include motels, schools, hospitals, industrial uses (e.g. abattoirs and food processing), and recreational and amenity uses (water parks, sports ovals, town water lakes). These water uses contribute to the local economy and amenity of towns. Reducing water availability will impact these uses. There is a need to better understand what these major non-residential uses of water are, and scope their ability to implement water use efficiency measures or move to alternative water sources. **Water Services Association of Australia—Water Efficiency Information Pack and Report 2017:** www.wsaa.asn.au/publication/water-efficiency-report-2017 www.wsaa.asn.au/publication/water-efficiency-information-pack **Off-farm Efficiency Program (Communities Investment Package):** www.awe.gov.au/water/policy/mdb/programs/basin-wide/off-farm-efficiency-program **Off-farm Efficiency Program (Water Infrastructure NSW actions):** www.dpie.nsw.gov.au/water/water-infrastructure-nsw/off-farm-efficiency-program **Town Water Risk Reduction Program:** www.industry.nsw.gov.au/water/plans-programs/risk-reduction

Option 50. Investigate the expansion of cloud seeding in key water supply catchments

Source: Department of Planning and Environment—Water

Description	This option would investigate potential additional benefits from expanding current glaciogenic cloud-seeding activities in the mountainous areas surrounding Snowy Hydro Limited catchment area. It would also review available cloud-seeding technologies to determine the most appropriate approach for identified areas. As a minimum, this option would only apply to the Murrumbidgee catchment and the NSW side of the Murray catchment, but joint collaboration with other jurisdictions could potentially see this option broadened into areas of Victoria, if deemed appropriate there. In that case, changes to the project scope would likely be required. Glaciogenic seeding of orographic wintertime clouds is a weather modification technique that introduces a seeding agent into suitable clouds (with super-cooled liquid water) to encourage the formation and growth of ice crystals. This enhances the amount of snow or rain falling from the cloud. This activity has been undertaken by Snowy Hydro Limited, targeting snowfall only, in the Snowy Mountains since 2004. Current Snowy Hydro Limited cloud-seeding operations cover an area of approximately 2,110 km^2 from just south of Thredbo through to Kiandra. An independent scientific evaluation of the trial found cloud seeding increased precipitation (during targeted events) by an average of 14% with no adverse effects on rainfall downwind of the target area and no adverse local environmental effects. Previous studies have highlighted the potential for glaciogenic cloud seeding of orographic wintertime clouds, both within south-eastern Australia and internationally.
Existing problem or issue	• Observed declines in current water availability. • Increased risk of lower water availability under future climate change scenarios.
Benefit of introducing the option	If this option is progressed, it would help understand the potential to increase the amount of precipitation, compared to a 'do nothing' scenario, in the upper catchments of the Murray and Murrumbidgee rivers.
Considerations	This option would need to consider: • existing Snowy Hydro Limited cloud-seeding operations • technical considerations such as understanding the locations, topography, and available cloud-seeding technologies • current scientific literature concerning glaciogenic (orographic) cloud seeding • potential to work with other state and federal agencies and Snowy Hydro Limited • potential social, economic, cultural and environmental costs and benefits • opportunities for private sector investment • potential impacts on the environment and surrounding land uses such as snow-based activities at alpine resorts • statutory requirements • limited public awareness about the processes involved and the scientific underpinnings of glaciogenic cloud seeding.
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	

Option 50. Investigate the expansion of cloud seeding in key water supply catchments (continued)

Further information

Snowy Hydro Limited Cloud Seeding:
www.snowyhydro.com.au/generation/cloud-seeding/

Siems S, Manton M, Caine S, Chubb T, Morrison A, 2011, *Exploring the potential for glaciogenic cloud seeding over Victoria: Analysis of a MODIS-based climatology and low resolution WRF simulations—Final Report*. Department of Sustainability and Environment, Victoria.

Chubb T, Morrison A, Caine S, Siems S, Manton M. 2012, *Case studies of orographic precipitation in the Brindabella Ranges: model evaluation and prospects for cloud seeding*. Accessed 1/12/2021:
www.bom.gov.au

Flossman A, Manton M, Abshaev A, Bruintjes R, Murakami M, Prabhakaran T, Yao Z. 2019, *Review of advances in precipitation enhancement research. American Meteorological Society:*
journals.ametsoc.org/view/journals/bams/100/8/bams-d-18-0160.1.xml

French J, Friedrich K, Tessendorf S, Rauberd R, Geerts B, Rasmussen R, Xue L, Kunkel M, and Blestrude D. 2018, *Precipitation formation from orographic cloud seeding. Proceedings of the National Academy of Sciences of the United States of America*. Vol. 115 No. 6. Accessed 1/12/2021:
www.pnas.org/doi/10.1073/pnas.1716995115

Photography
Image courtesy of Department of Primary Industries.
Snowy River, NSW.

Option 51. Undertake joint exploration for groundwater with the NSW Geological Survey

Source: Department of Planning and Environment—Water

Description	This option would include regional and locally targeted geophysics to identify potential resources (fractured and porous rock systems like the Lachlan Fold Belt and Western Murray Porous Rock) followed by drilling, testing and water quality analysis to assess the resource's suitability for supply. This option could provide information to improve NSW town water supply security and diversify water sources for water dependent industries in the region. This option could also consider how to incorporate Aboriginal knowledge, cultural heritage and science in understanding groundwater resources.
Existing problem or issue	• Groundwater and surface water sources in the region are fully allocated. • Increased climate variability poses new risks to towns, communities and industries. • Increased climate variability, particularly during dry times, will place increased pressure on surface and groundwater resources and the ecosystems they support.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would identify reliable groundwater supplies and storage for future growth.
Considerations	This option would need to consider: • key locations for exploration, chosen according to existing demands • that the groundwater quality could limit its potential use • the cost of water treatment in determining if a groundwater source is viable for NSW town water supply.
NSW Water Strategy priority	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.6:** An enhanced, state-wide focus on sustainable groundwater management.
Regional water strategy objectives	
Further information	**NSW Murray–Darling Basin Fractured Rock Water Resource Plan:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/nsw-fractured-rock **This option has been committed to under the Future Ready Regions Strategy:** www.nsw.gov.au/regional-nsw/future-ready-regions

Photography
Image courtesy of iStock.
Cotter River and Murrumbidgee River conflux, Cotter Crossing.

Option 52. Review water markets and trade

Source: Department of Planning and Environment—Water

Description	This option would progress the implementation of water market reforms based on the recommendations of the Australian Competition and Consumer Commission's *Murray–Darling Basin water markets inquiry*. In addition, this option could consider water market- and trade-related issues raised by stakeholders through the regional water strategy consultation process, including: • the merit and consequences of changing the constraints around trade of local water utilities licences • complexities of inter-jurisdictional water management, water accounting (including carry-over provisions), and trading • restrictions through existing trade zones that may impede on trading in the region. Water markets are an important tool for water users (industry, urban water suppliers, environmental managers and investors) to manage their water needs and drive improvements in productivity and efficiencies. In many instances, water markets provide one of the only opportunities to access water in systems that are fully allocated. This option would apply to both surface water and groundwater.
Existing problem or issue	• There are differences and deficiencies in existing southern-connected water markets and water trading. • There is a lack of adequate market-based information to inform decision-making. • Community understanding about water markets and water trading varies. • Agricultural water-use patterns have changed and there is increased water demand in parts of the catchment. • Areas with existing and emerging water availability constraints are experiencing population growth.
Benefit of introducing the option	If the option is progressed in the Murrumbidgee region, it would: • improve the effectiveness and efficiency of water markets • provide greater transparency and confidence to water users in the southern connected system, as well as educating water users about the operations of and rules governing water trading in the Murrumbidgee region • assist in minimising delivery losses and improve water availability through the potential adoption of market mechanisms • potentially enable more efficient use of water resources • provide flexibility for local councils to meet their future (water) service provisions to their communities.

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

Option 52. Review water markets and trade (continued)

Considerations

This option would need to consider:

- the implementation plan for the Australian Competition and Consumer Commission's recommendations, which is to be developed by the independent expert panel established by the Australian Government
- previous water market and water trading reviews and analysis in the southern NSW regions as part of the development of the water resource plans, the review of the NSW water sharing plans and other inquiries and reviews
- implications to existing trading and market rules and regulations contained in the *Water Management Act 2000* and requirements under the *Commonwealth Water Act 2007* and the *Basin Plan 2012*
- issues raised through submissions to the Department of Planning and Environment—Water's *Transparency in the NSW Water Markets* discussion paper
- issues and options raised in WaterNSW's Murrumbidgee Intervalley Trade review issues and options paper
- issues raised by local councils during the targeted engagement for the Draft Murrumbidgee Regional Water Strategy, including councils' ability to trade without compromising their future growth aspirations
- stakeholders concerns and queries about inter-valley trade, including councils' limitations to transfer water between the Murray and Murrumbidgee catchment when their boundaries cover both catchments
- environmental implications and basic landholder rights, especially around changes to water availability and flow delivery
- work already underway to improve water market effectiveness via the Basin Officials Committee and Ministerial Council work program, including:
  - water demand and supply changes in the southern connected system commissioned by the Victorian Government
  - analysis of the impacts of water demand changes—for example growth in permanent plantings at the end of the system
  - capacity constraints and related issues with managing delivery risks in the Murrumbidgee region to understand broader implications on water markets.

NSW Water Strategy priorities

Priority 1: Build community confidence and capacity through engagement, transparency and accountability

- **Action 1.2:** Increase the amount and quality of publicly available information about water in NSW.

Priority 5: Support economic growth and resilient industries within a capped system

- **Action 5.3:** Improve the operation and transparency of water trade in NSW.

Regional water strategy objectives

Further information

Water in NSW—Trade:
www.industry.nsw.gov.au/water/licensing-trade/trade

Australian Competition and Consumer Commission's Murray–Darling Basin water markets inquiry:
www.accc.gov.au/focus-areas/inquiries-ongoing/murray-darling-basin-water-markets-inquiry

Media Release from the Hon Keith Pitt MP, Member for Hinkler, Minister for Resources and Water—Budget begins process of water market reform:
minister.awe.gov.au/pitt/media-releases/budget-water-market-reform

Transparency in the NSW water market:
www.industry.nsw.gov.au/water/licensing-trade/trade/have-your-say

Option 53. Consider hydrological processes in bushfire management

Source: Department of Planning and Environment—Water

Description	This option would investigate how bushfire management could be strengthened in priority watersheds by including protection of rainfall run-off processes as a key bushfire management priority in national parks and reserves. The project would have two phases: **Research phase:** • identify priority watersheds and vegetation communities with post-fire responses that significantly impact rainfall run-off processes (e.g. alpine ash) • address knowledge gaps in bushfire management relevant to rainfall run-off processes including: – identifying appropriate recurrence intervals and intensity for hazard-reduction activities – undertaking a strength, weaknesses, opportunities and threats analysis of current fire regimes and fire management – developing a clear understanding of potential benefits, costs and risks of managing run-off processes as a strategic priority. • decide whether to undertake the next Phase 2—if the potential benefits are worth pursuing. **Strategic bushfire management planning:** • identify objectives, targets and monitoring, evaluation and reporting requirements • identify resourcing and funding commitments or sources that would be required on an ongoing basis • update existing bushfire management plans. As a minimum, this option would only apply to the Murrumbidgee catchment and the NSW side of the Murray catchment, but joint collaboration with other jurisdictions could potentially see this option broadened into areas of Victoria, if deemed appropriate there. In that case, changes to the project scope would likely be required.
Existing problem or issue	• Following intense bushfires, hydrological run-off processes in catchments can undergo significant changes that initially result in an increase in run-off, but then soon result in significant declines in run-off. When such fires occur in catchments such as the Snowy Mountains and upper Murrumbidgee, they can have profound impacts on water quality and run-off rates. • Estimates of hydrological impact vary depending on factors such as the area burnt, burn intensity and location, mortality rate of vegetation, the vegetation type, antecedent moisture conditions, and post-fire rainfall amounts, to name a few. • Current fire management strategies in the region do not include protection of run-off in key watersheds as a strategic priority and as such management arrangements and resourcing are unlikely to be adequate for protecting the needs of downstream water users. Therefore, protection of hydrological processes needs to be included in bushfire management strategies and plans to preserve future water security and reliability.
Benefit of introducing the option	If this option is progressed in the Murrumbidgee region, it would: • achieve long-term improvements in water availability for environmental and consumptive users • minimise short term-water quality issues associated with sediment and ash wash following intense bushfires.
Considerations	This option would need to consider: • research priorities and knowledge gaps relating to bushfire impacts on run-off • current bushfire management arrangements • additional funding requirements (e.g. planning, implementation and monitoring) • potentially coordinating with Victorian authorities on areas of the NSW Murray catchment that abut the border with Victoria • the potential role of Aboriginal communities, private/public partnerships or private investment • recently replanted private and public plantation forests burnt during the recent bushfires.

Option 53. Consider hydrological processes in bushfire management (continued)

NSW Water Strategy priorities	**Priority 3:** Improve river, floodplain and aquifer ecosystem health, and system connectivity • **Action 3.2:** Take landscape scale action to improve river and catchment health. **Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.4:** Identify infrastructure and operational options for each region of NSW.
Regional water strategy objectives	
Further information	**NSW National Parks and Reserves—Fire management strategies:** www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/fire/fire-management-strategies **eWater CRC—Impacts of wildfire on Water Quality (archived):** www.ewater.org.au/bushfire/background_impactquality.shtml **Kosciuszko National Park—Fire Management Strategy 2008–2013:** www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/park-management/documents/kosciuszko-national-park **Hill, P.I., Mordue, A. Nathan, R.J., Daamen, C.C., William, K., Murphy, R.E. 2008, *Spatially Explicit Modelling of the Hydrologic Response of Bushfires at the Catchment Scale. Australian Journal of Water Resources Vol 12*. No. 3 and Water Down Under 2008 (incorporating 31st Engineers Australia Hydrology and Water Resources Symposium). pp.1472–1480:** www.tandfonline.com/doi/abs/10.1080/13241583.2008.11465354 **US Department of Agriculture—Innovative Finance Model Accelerates Forest Restoration:** www.usda.gov/media/blog/2020/07/09/innovative-finance-model-accelerates-forest-restoration

Photography
Image courtesy of Destination NSW.
Carrathool Bridge, Carrathool.

dpie.nsw.gov.au