Draft Regional Water Strategy

Murray: Long list of options

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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 Bangerang, Barkandji, Barapa Barapa, Maljangapa, Maraura, Mutthi Mutthi, Ngiyampaa, Nyeri Nyeri, Tati Tati, Wadi Wadi, Wemba Wemba, Weki Weki, Wiradjuri, Yorta Yorta, Ngarigu, Walgalu and Bidhawal people as having an intrinsic connection with the lands and waters of the Murray 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 Murray Regional Water Strategy

As outlined in the Draft Murray 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 NSW Murray 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 NSW Murray 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 NSW Murray region.

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

- an inadequate water management framework to meet the needs and aspirations of Aboriginal people
- current water sharing arrangements based on 125 years of data
- insufficiently integrated land and water planning and management
- vulnerability of town water supplies and amenity
- degradation of riverine and floodplain ecosystems
- 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 NSW Murray 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

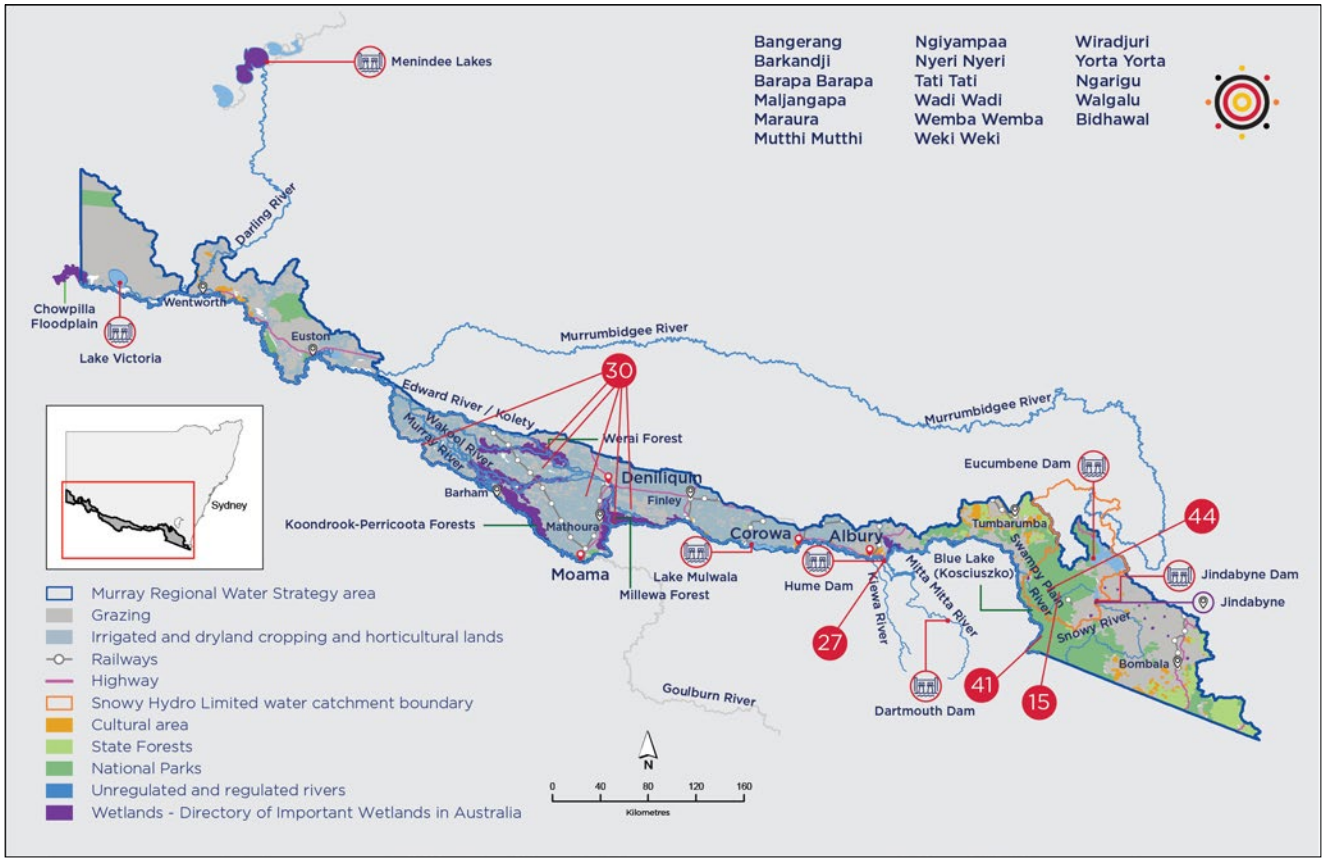
Identify least cost policy and infrastructure options.

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

Current water sharing arrangements based on 125 years of data

8. Review drought rules for the NSW Murray region
9. Review the allocation and accounting framework in the NSW Murray (regulated system)
10. Investigate Murray River system water sharing, delivery and accounting arrangements under the Murray–Darling Basin Agreement
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. Develop climate risk evidence base to inform the next Snowy Water Licence Review
16. Enhance southern inland floodplain management plans
17. Investigate water quality improvement measures
18. Manage groundwater salinity
19. Monitor sediment compaction over the long term

Vulnerability of town water supplies and amenity

20. Review impediments to water recycling projects
21. Managed aquifer recharge investigations and policy
22. Secure and reliable access to groundwater for towns
23. Maintain water-related amenity in the NSW Murray region during droughts
24. Investigate inter-regional connections
25. Investigate groundwater desalination for industry and towns

Degradation of riverine and floodplain ecosystems

26. Improve protection of groundwater dependent ecosystems
27. Address cold-water pollution in the Hume Dam
28. Remediate fish passage
29. Implement fish-friendly water extraction
30. Improve flows to important ecological sites
31. Develop a river and catchment recovery program for the NSW Murray region
32. Review environmental water arrangements
33. Re-establish threatened fish species through habitat restoration and conservation restocking
34. Better understand the economic value of ecosystem services of riverine environmental assets

Limits to water availability in times of a changing climate

35. Better understand water use with data collection and analytics
36. Improve the understanding of groundwater sources and processes, risks and impacts
37. Undertake a water dependent industry resilience study
38. Develop targeted education and capacity building programs
39. Investigate water availability in the NSW Murray region
40. Investigate non-residential water efficiency (towns and industries)
41. Investigate the expansion of cloud seeding in key water supply catchments
42. Undertake joint exploration for groundwater with the NSW Geological Survey
43. Review water markets and trade
44. Consider hydrological processes in bushfire management

Photography
Image courtesy of Destination NSW.
Thredbo Valley Track, Kosciuszko National Park.

Murray: Existing NSW government commitments and long list of options

Photography
Image courtesy of Destination NSW.
The Diggings, Kosciuszko National Park.

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 NSW Murray region. **Complete or nearing completion** • **2011 Snowy Water Licence Schedule 4 Amendments (River Murray Increased Flows)—**To allow greater flexibility in the timing of environmental water deliveries, helping to target better environmental outcomes downstream of Hume Dam. • **Operating rule change to the use of the Barmah–Millewa Environmental Water Allocation (Barmah–Millewa Forest Environmental Water Allocation)—**This project proposes to change the rules for use of the planned environmental water account for the Barmah-Millewa Forest. The change allows the simultaneous use of other environmental water entitlements and is a change to the operation of the Murray River. • **Flexible rates of fall in river levels downstream of Hume Dam—**This project involves a more flexible approach to the rate of fall in river level allowed downstream of Hume Dam. This will reduce the frequency of unseasonal watering for the Barmah-Millewa Forest, in which higher river flows spill into the forest at an undesirable time of year, causing environmental impacts and increased losses. It will also improve the dam's operational efficiency by allowing saved water to be released at another time or allowing flexibility to create flow patterns with additional environmental benefits. • **Operating rule change to Hume Dam airspace management and pre-releases—**This project seeks to gain recognition for efficiencies already achieved by moving to the adaptive management of Hume Dam airspace and pre-release protocols. • **The Living Murray Environmental Works and Measures Projects—**Koondrook–Perricoota, Mulcra Works, Lindsay Island (Stage 1), Hattah Lakes, Gunbower Forest and Chowilla Floodplain. The project focuses on maintaining the health of six iconic sites along the river, chosen for their environmental, cultural and international significance.

Sustainable Diversion Limit Adjustment Mechanism Projects (continued)

Description	**Underway** • **Sustainable Diversion Limit Offsets in the Lower Murray: Locks 8 and 9 Project—**The project has three main components including: changing operating rule for Weirs 8 and 9 to move away from fixed weir operating levels; installing waterway structures allowing for flow regulation and fish passage within the Carrs, Capitts and Bunberoo Creek system; constructing of a new fishway at the Lake Victoria inlet regulator on Frenchmans Creek. • **Murrumbidgee & Murray National Park Project—**This project involves undertaking a series of works, including upgrades to regulators, and removing block banks, to improve and enhance the movement of environmental flows into and through these water-dependent national parks. These works will reduce 'overwatering' of vegetated areas, which is caused by inadequate and obsolete infrastructure that releases or holds water within the parks. Reducing overwatering will decrease both the volume of water required and water lost to evaporation by reducing the inundated area. • **Reconnecting River Country Program Yarrawonga to Wakool Junction and Hume to Yarrawonga—**The NSW Government launched the Reconnecting River Country Program in August 2021, (formerly referred to as the Constraints Measures Program). This program involves working with landholders, councils and public land managers to identify opportunities to address physical and policy constraints to the delivery of environmental flows. NSW is currently undergoing a strategic assessment of flow options for the Murray components of the program, with preferred flow limits to be determined in future Final Business Cases. The program is also considering ways to mitigate any unacceptable impacts to landowners and third parties. The program aims to improve wetland and floodplain connectivity, while achieving balanced economic, social, cultural and environmental outcomes across the southern NSW regions. • **Mid-Murray Anabranches Constraints Demonstration Reach** is one of the projects brought forward through the SDLAM Acceleration Program. It aims to improve the connectivity and function of creek systems between the Murray River and its main anabranch, the Edward-Kolety. Benefits of the project would include an improvement in native fish habitats and the overall health of the creek systems and the Murray River. • **Koondrook-Perricoota Flow Enabling Works** is one of the projects brought forward through the SDLAM Acceleration Program. The project purpose is to mitigate third-party impacts to private landholders to allow flows into the Koondrook-Perricoota (KP) Forest. • **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. The **Menindee Lakes SDLAM Project** sits in the area under the Western Regional Water Strategy, however there are linkages with the Murray Regional Water Strategy because the lakes form part of the shared storages for the Murray system under the Murray–Darling Basin Agreement. The project is currently being re-scoped to ensure that NSW is delivering projects that have broad community support. The NSW Government launched the new Better Baaka Program in October 2021, to incorporate the rescoped Menindee Lakes SDLAM project. Additional initiatives are in the early planning stages and will be shaped by community feedback.
Further information	**Department of Planning and Environment—Water: NSW SDLAM projects:** **www.industry.nsw.gov.au/water/plans-programs/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:** **www.industry.nsw.gov.au/water/plans-programs/sdlam/reconnecting-river-country-program**

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 NSW Murray region.

Due to the COVID-19 pandemic, our face-to-face engagement with Aboriginal people on the Draft Murray 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 Murray 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 NSW Murray region. During our preliminary consultation with Aboriginal people in the NSW Murray 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 NSW Murray 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) 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 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 Neil Andrews.
Olsens Lookout, Geehi Valley – Snowy Mountains.

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 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 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 NSW Murray region, it would: • simplify the application process, making these licences more accessible to Aboriginal people in the NSW Murray 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 application 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 and access to water for cultural and economic purposes.
Regional water strategy objectives	
Further information	**Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Source 2016:** www.legislation.nsw.gov.au/view/html/inforce/current/sl-2016-0366 **Water Sharing Plan for the Snowy Genoa Unregulated and Alluvial Water Sources 2016:** www.legislation.nsw.gov.au/view/html/inforce/current/sl-2016-0379

Option 3. Support long-term participation of local Aboriginal people in water-related matters

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 NSW Murray 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 this option is progressed in the NSW Murray 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 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 NSW Murray 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 this option is progressed in the NSW Murray 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 commitments to support the acquisition of water entitlements for cultural purposes 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 this option is progressed in the NSW Murray region, 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 NSW Murray 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 this option is progressed in the NSW Murray 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. 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 NSW Murray 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 NSW Murray 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 peoples' history, knowledge and experience, which is based on many thousands of years of living on Country. • 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 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 NSW Murray 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 3: 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.
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 iStock.
Hume Dam, NSW.

Current water sharing arrangements based on 125 years of data

Our NSW water management framework and associated rules, regulations and policies are based on our understanding of the last 125 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 NSW Murray 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 8. Review drought rules for the NSW Murray 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 NSW Murray Region by testing them against the new climate data and updated modelling being developed for the Murray Regional Water Strategy. In addition, the option could look at: • opportunities for NSW local council and local water utilities' drought management plans to be more closely integrated with the incident response guides • the merits and consequences of changing existing 'drought management reserves'. The incident response guides outline the framework for managing extreme events in the NSW Murray 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 when extreme events develop in the region.
Existing problem or issue	• There are limited datasets and potential knowledge gaps in our understanding of possible extreme events in the NSW Murray region. • Towns and communities in the NSW Murray region have a strong reliance on surface water sources.
Benefit of introducing the option	If this option is progressed in the NSW Murray 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 8. Review drought rules for the NSW Murray region (continued)

Considerations	The option would need to consider: • a more detailed assessment of the 'need for change' based on the Murray Regional Water Strategy modelling, and the risks to high-priority and critical needs in the NSW Murray 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 cultural values, including any impact on Native Title rights • an assessment of any potential impacts on existing NSW water entitlement holders in different parts of the catchment (e.g. 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'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 • 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 NSW local water utilities about drought preparedness • an assessment of whether changes to the incident response guides 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 **Murray Valley Drought Snapshot:** www.industry.nsw.gov.au/water/allocations-availability/droughts-floods/drought-update/previous-valleys-in-drought **NSW Murray and Lower Darling Surface Water Resource Plan Incident Response Guide:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/nsw-murray-lower-darling **Draft Murray Alluvium water resource plan components for consultation:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/murray-alluvium **NSW Murray Darling Basin Fractured Rock 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 9. Review the allocation and accounting framework in the NSW Murray (regulated system)

Source: Department of Planning and Environment—Water

Description	This option would review several settings of the current water accounting and allocation process in the NSW Murray regulated river system and consider whether and how the climate data could be used when making allocation decisions. In addition, the option could look at: • reviewing the NSW 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 NSW Murray 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 NSW allocation process • investigating improvements to current NSW 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 NSW carryover provisions, including accounting for losses from carryover • investigating the potential impact of trading allocations from NSW high security entitlements to general security entitlements to take advantage of carryover provisions • scoping further opportunities to improve the transparency and reporting of the NSW available water determination • the timing of NSW 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 NSW Murray region. • Towns and communities in the NSW Murray 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 this option is progressed in the NSW Murray region, it would: • provide better data and evidence to inform the assumptions underpinning the current NSW 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 NSW 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 NSW 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 9. Review the allocation and accounting framework in the NSW Murray (regulated system) (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 NSW Murray region, including the Inspector General of Water Compliance's review into the operation of the Murray and Lower Darling Rivers • 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 NSW allocation and accounting process • the needs and requirements of all water users about transparency and reporting • any environmental impacts, including impacts on aquatic ecosystems • the vulnerability of large towns in the region (e.g. Albury) to a repeat of conditions such as the Millennium Drought.
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—Water Resource Assessment Process:** www.industry.nsw.gov.au/water/allocations-availability/allocations/how-water-is-allocated/resource-assessment-process **New South Wales Murray and Lower-Darling Water Resource Plan (Surface Water SW8)—Status and Issues Paper:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/nsw-murray-lower-darling

Photography
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Township, Albury.

Option 10: Investigate Murray River system water sharing, delivery and accounting arrangements under the Murray-Darling Basin Agreement

Source: Department of Planning and Environment—Water

Description	This option would review current water management arrangements with Murray-Darling Basin governments under the Murray-Darling Basin Agreement (the Agreement) in the context of a changing climate and reduced water availability. In collaboration with Victoria, South Australia and the Australian Government, this option would seek to bring together existing and emerging work on climate change—including various climate datasets and hydrological modelling methods to: • review the existing water sharing, delivery and accounting policies and processes under the Agreement and • assess whether finite supplies could be more effectively and efficiently used and delivered. The review could consider the following: • calculations of state shares and entitlements and broader water accounting • existing dilution flow settings • opportunities and costs of switching to climate independent water sources for particular water user groups • annual system planning and delivery arrangements (e.g. river operations) • incorporating channel capacity sharing arrangements into the Agreement • coordination of outflows from tributaries • extending the current trial of the use of s 113(2) of the Agreement (currently only environmental water holders) to loss arrangements more broadly • investigating the use of Lakes Alexandrina and Albert as a water supply storage, within appropriate ecological tolerances • investigation to better understand if Tier 2 sharing facilities including 'borrowing and payback' arrangements should be triggered earlier during a drought. If progressed, this review should be taken forward through existing forums, including the Murray-Darling Basin Ministerial Council and Basin Officials Committee.
Existing problem or issue	• The Murray River system has already experienced a significant decline in water availability and climate change is expected to reduce it further. • Existing water sharing arrangements under the Agreement were developed in the years prior to the 1960s and don't reflect today's water availability conditions, water use patterns or salinity management requirements. • Limited datasets and potential knowledge gaps in our understanding of possible and likely extreme events. • High reliance on climate-dependent surface water sources in the Murray system by NSW, Victoria and South Australia. • Complex inter-jurisdictional water management arrangements. • Changing water use and demand pattern and increased competition for limited water resources. • Limited storage opportunities in the mid and lower Murray River. • Limited and declining channel capacity in the Murray River at the Barmah Choke restricts water delivery dowsntream.

Option 10. Investigate Murray River system water sharing, delivery and accounting arrangements under the Murray–Darling Basin Agreement (continued)

Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • provide further evidence around the appropriateness of the current water sharing, delivery and accounting arrangements under a changing climate and evolving water user needs. • highlight areas of potential improvement that would better serve the needs of all communities, First Nations, industries and the environment in the southern connected system. • address concerns raised by stakeholders around the decline of water availability in the southern connected system.
Considerations	This option would need to consider: • inter-jurisdictional engagement, collaboration and consensus agreement through the Murray-Darling Basin Ministerial Council, including negotiation and incorporation of the needs and requirements of other jurisdictions and dialogue on climate change work undertaken by each southern Basin jurisdiction, the Murray-Darling Basin Authority, National Water Grid Authority and CSIRO • consideration of existing or planned initiatives, reforms, projects and reviews in the Murray-Darling Basin between now and when this option would be implemented • involvement and detailed engagement with all water users including communities, First Nations, industry and the environment • a thorough understanding of legislative and policy frameworks, including rules under the Water Act 2007 and the Basin Plan 2012 • having regard to how potential changes may impact on downstream communities and water users.
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	**Water Act 2007—Schedule 1. The Murray-Darling Basin Agreement:** www.legislation.gov.au/Details/C2021C00539 **MDBA's river operations:** www.mdba.gov.au/water-management/river-operations **The Inspector General of Water Compliance's review into the operation of the Murray and lower Darling Rivers will look into some of the key drivers of allocation decisions. These include how well water is being measured and modelled at both the Basin and valley scale for conveyance losses and bulk state water shares. There will be an assessment of hydrometric data coverage and quality, and associated data analysis processes:** www.igwc.gov.au/media-releases/inspector-general-water-compliance-examining-water-allocation-concerns

Option 11. Review groundwater extraction limits

Source: Department of Planning and Environment—Water

Description	This option would review the existing NSW 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 NSW 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 NSW Murray region. • There is limited understanding about the interaction between surface water and groundwater systems.
Benefit of introducing the option	If this option is progressed in the NSW Murray 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 NSW 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 NSW extraction limits, including groundwater extraction behaviour, potential growth in use, water levels and water quality • previous actions to reduce take to within extraction limits • 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 NSW. The policies to be reviewed could consider: • **Extraction within NSW 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. • **NSW groundwater systems where the entitlements plus basic landholder rights exceed the extraction limit (e.g. upper Murray Groundwater Source):** 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, giving clarity to water users about how such groundwater systems will be managed as activation and use increases over the next 20 years. • **NSW areas where groundwater extraction is causing declines in water levels (e.g. Lower Murray (deep) 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 NSW Murray region, it would: • improve community understanding about groundwater 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 risk and benefits of allowing voluntary conversion from general security to high security, and high security to town water supply water access licences in the New South Wales Murray Regulated River Water Source. This is a common option across all (inland) regional water strategies to test the level of security that could be achieved in each region. The Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016 currently prohibits conversion of access licences to a new category (section 57).
Existing problem or issue	• Climate variability and climate change create risks for reduced water availability in the NSW Murray 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. • In some council areas, there are insufficient town water supply entitlements. Instead, they rely on high security entitlements, which are not as reliable as local water utility licences. • Existing physical constraints, including channel capacity constraints, are limiting water delivery during peak times.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • improve reliability for towns partly reliant on 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 water security in the NSW Murray 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 NSW Murray 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 • the likelihood of unintended consequences if licence conversion was allowed in the NSW Murray; for example, additional transmission or distribution losses in the system, increased risks of depleting storages during dry periods, impacts on trade, and increased vulnerability of existing industries • environmental implications, especially on 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 NSW 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

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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 NSW Murray 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 NSW Murray 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 NSW Murray 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 versions of the Murray Regional Water Strategy and the South East and Tablelands, Far West and Riverina–Murray regional plans to establish a more integrated strategic land and water management plan.
Existing problem or issue	• NSW 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 NSW planning system.

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

Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • assist in identifying opportunities for the NSW 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 NSW 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 NSW 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 NSW 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:** 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. 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, Energy and Science

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

Benefit of introducing the option	If this option is progressed in the NSW Murray region, 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 NSW 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 15. 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**

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Hume Dam, Albury.

Photography
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Hume Lake, Albury.

Option 16. Enhance southern inland floodplain management plans

Source: Department of Planning and Environment—Environment, Energy and Science, and the Department of Planning and Environment—Water

Description	This option would support the development of a valley-wide floodplain management plan for the NSW Murray 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 floodplain management plans for the NSW Murray region potentially consolidating these into one valley-wide floodplain 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 Murray–Lower Darling Long-Term Water Plan, with respect to Murray 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 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 Murray–Lower Darling 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 prevent flows that could meet overbank and wetland inundation environmental watering requirements • delivery constraints to avoid potential effects on third-parties on the floodplain constrains meeting some environmental watering requirements.

Option 16. Enhance southern inland floodplain management plans (continued)

Benefit of introducing the option	If this option is progressed in the NSW Murray 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 Murray–Lower Darling 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	**Murray–Lower Darling Long Term Water Plan:** www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/murray-lower-darling **Natural Resources Commission's water management plan audits:** www.nrc.nsw.gov.au/wsp-audits **Review process for NSW 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/about **Reconnecting River Country Program:** www.industry.nsw.gov.au/water/plans-programs/sdlam/reconnecting-river-country-program

Option 17. 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 NSW Murray region. This option could identify the need for: • further research into 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 • addressing blue-green algal blooms in storages such as Hume Dam by investigating a range of mitigation options, tested with the aid of a hydrodynamic computer model of the storage • additional sampling and testing for algal toxins, and identification of more cost-effective methods for testing (e.g. rapid single-use kits) and risk assessment (e.g. a risk matrix incorporating toxin presence/concentration) • baseline groundwater quality monitoring • changes to the groundwater quality management framework 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 • amendments to the NSW water sharing plans and existing policies and strategies to actively manage water quality issues and incidents in regions (e.g. consider introducing water quality allowances in valleys that currently do not have this provision, which should be considered in the context of addressing the underlying 'source' of pollution first) • additional infrastructure to improve water quality monitoring and improve the early warning network (e.g. with water quality monitors and loggers) • reviewing the availability and use of decision-making tools to address water quality events, including the Blackwater Risk Assessment Tool (see 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 NSW towns, domestic and stock uses, and water-based recreation. Extended dry periods followed by floods can lead to high turbidity and nutrient loads, and periodically result in large-scale hypoxic blackwater events, mainly in the Mid- to Lower Murray River and Edward/Kolety–Wakool Rivers. These can lead to widespread events with very low dissolved oxygen levels, and fish deaths. • Parts of the NSW Murray region are also prone to blooms of potentially toxic cyanobacteria and algae. This can impact recreation around the river such as swimming, fishing and local tourism, in addition to water treatment concerns and ecological problems such as low dissolved oxygen. Poor water quality can also render water treatment plant intake water unsuitable or excessively expensive to treat. • 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.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it 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.

Option 17. Investigate water quality improvement measures (continued)

Considerations	This option would require collaboration between the NSW Government, 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 NSW Murray region • dissolved oxygen monitoring in NSW • water quality incident management plans • the scope of WaterNSW's monthly water quality sampling • management of the Extreme Events Policy and the Murray incident response guides. The review of this information would need to be considered in the context of the new climate modelling and may lead to amendments of the NSW water sharing plans. The review would also need to be considered in line with any proposed changes to the *Australian Drinking Water Guidelines*. This option would also need to consider the recently commenced Murray–Darling Basin Authority's water quality study in the Murray River. This new study will focus on analysing the data to detect longer-term trends that impact water quality, which was last analysed in detail in 2013. Inter-jurisdictional water quality issues would also need to be explored with other state governments and the Australian Government, where relevant.
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 priorities	
Further information	**Murray–Darling Basin Authority's River Murray Water Quality Monitoring Program:** www.mdba.gov.au/water-management/river-operations/water-quality/monitoring **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 **WaterNSW 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 **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

Option 18. Manage groundwater salinity

Source: Department of Planning and Environment—Water

Description	To address groundwater salinity challenges in the NSW Murray 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 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	If this option is progressed in the NSW Murray region, it 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 required to carry out tasks involving reviewing legislation and auditing the bore network (asset is owned by WaterNSW) • coordination with relevant activities in Option 17: 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 Alluvium Water Resource Plan Groundwater resource description:** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/murray-alluvium **Murray–Darling Basin Authority's salinity information:** www.mdba.gov.au/issues-murray-darling-basin/salinity

Option 19. 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 NSW Murray region to ensure sediment compaction does not occur in the future, reducing risks to groundwater storage and long-term bore yields. In particular this 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	• 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. • Inland alluvial groundwater systems in the NSW Murray region have been identified as medium risk for sediment compaction because the aquifers consist of fine-grained, compressible sediments and there is significant decline in groundwater levels. A long-term monitoring program is needed to help ensure sediment compaction does not occur in the future. • 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 NSW Murray 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	**Murray Alluvium Water Resource Plan—Risk Assessment for the Murray Alluvium Water Resource Plan Area (GW8):** www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/murray-alluvium **CSIRO Research Publications Repository: Interpreting C-band InSAR ground deformation data for large-scale groundwater management in Australia:** publications.csiro.au/publications

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 20. 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 NSW Murray 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 several 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.
Existing problem or issue	• Several NSW towns are reliant on unregulated river sources (e.g. Bombala and Tumbarumba), or are reliant on a single water source 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 NSW Murray region under future climate change.
Benefit of introducing the option	If this option is progressed in the NSW Murray 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 water resources, such as groundwater and rivers, 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 20. 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—Exploring sewage recycling in a regional inland city:** waterrecyclinginvestment.com/resources-and-outputs/case-studies **Ballina–Lennox Head Recycled Water Master Plan:** www.ballinawater.com.au/general-information/urban-water-cycle/recycled-water-overview.html **PUB's NEWater Project (Singapore):** www.pub.gov.sg/watersupply/fournationaltaps/newater **South-east Queensland's 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

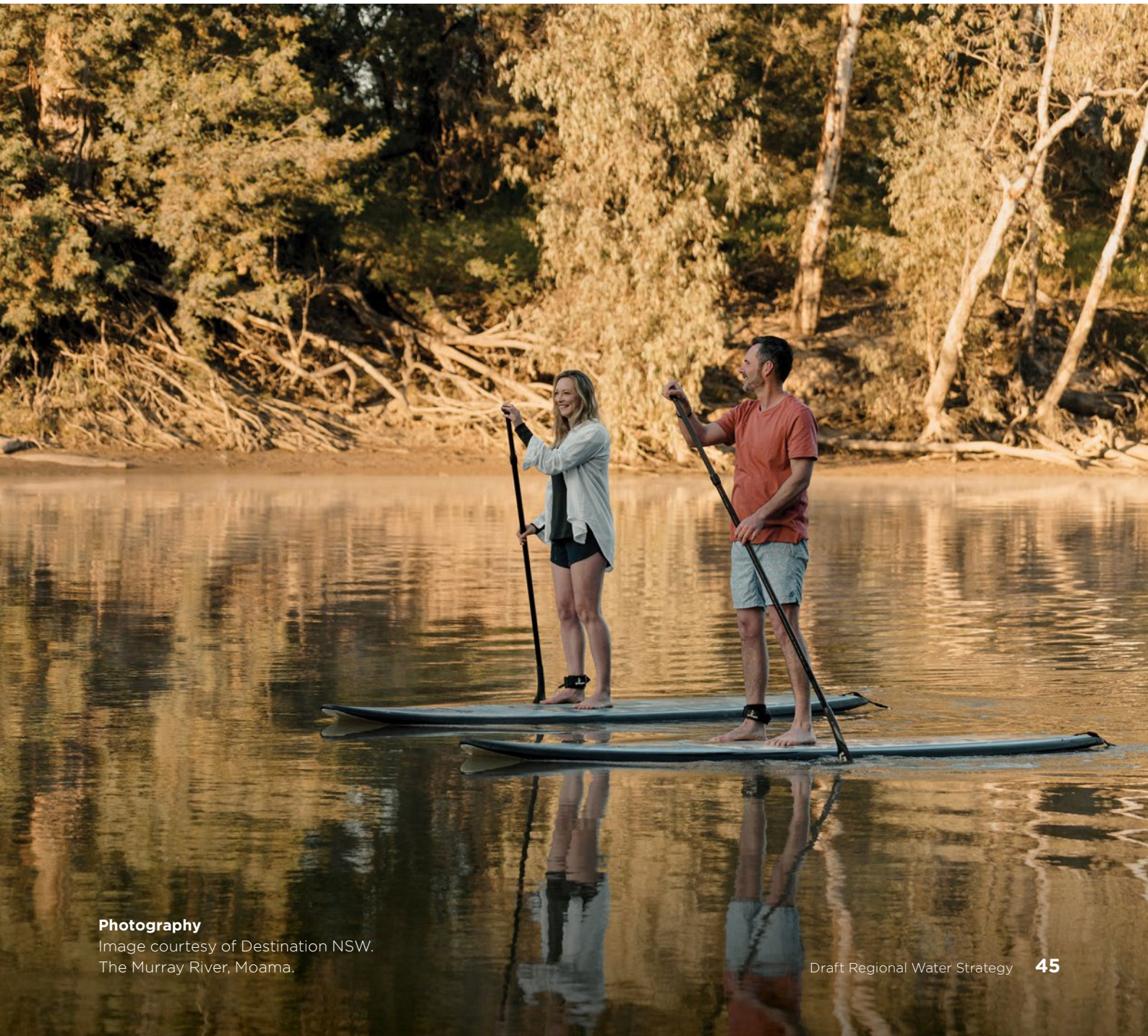
Option 21. Managed aquifer recharge investigations and policy

Source: Department of Planning and Environment—Water

Description	This option would investigate opportunities to undertake managed aquifer recharge in the NSW Murray region, including investigating the recharge capacity of sites 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 NSW Murray region; for example, high and concentrated groundwater extraction in the Lower Murray groundwater source. • There is a high rate of water loss by evaporation in existing surface water storages.
Benefit of introducing the option	If this option is progressed in the NSW Murray 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 security of regional communities and groundwater dependent industries in the NSW Murray 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 Lower Murray Alluvium (Shallow) irrigation areas if managed aquifer recharge is used • 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.

Option 21. Managed aquifer recharge investigations and policy (continued)

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 Destination NSW.
The Murray River, Moama.

Option 22. Secure and reliable access to groundwater for towns

Source: Department of Planning and Environment—Water

Description	This option would provide a strategic review of current and potential groundwater use by towns across the NSW Murray region to improve understanding of the regional need, challenges and opportunities for towns to access groundwater. This option would identify: • NSW 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 NSW 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 on other users of providing access to groundwater in fully allocated groundwater sources, such as potentially reduced available water determinations and declining groundwater levels. This option would not replace the need for NSW 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	• There are a few NSW towns that currently rely on groundwater for town water supply in the NSW Murray region. Many towns have increasing populations, which places additional pressure on current water supply capacity. • Increased climate variability and climate change is likely to reduce surface water security and reliability for towns and industries.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • increase the security, diversity and resilience of NSW town water supplies • ensure groundwater sources are shared fairly and sustainably between towns and other users.

Option 22. Secure and reliable access to groundwater for towns (continued)

Considerations	This option requires consideration of the roles and responsibilities of state and local governments in ensuring secure access to NSW town water supplies. The level of risk to security and reliability for specific NSW 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 understanding the access to reasonable quality groundwater for NSW 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 NSW Murray to obtain licences on the open market.
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—Upper and Lower Murray groundwater sources:** **www.industry.nsw.gov.au/water/science/groundwater/document-library**

Photography
Image courtesy of Destination NSW.
Edward River, Deniliquin.

Option 23. Maintain water-related amenity in the NSW Murray 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 NSW Murray region during droughts or extended dry periods. This would apply to both surface water and groundwater sources. The option would include: • considering the issues of maintaining water-related amenity in the NSW Murray region during droughts • reviewing current approaches, mechanisms and strategies of NSW local councils to maintain water-related amenity during dry times • assessing any projects or initiatives underway to address existing issues with maintaining water-related amenity • assessing and supporting relevant actions under the Riverina–Murray, Far West 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 NSW local councils and local water utilities based on the utilities' integrated water cycle management strategies (if developed) and agreed service levels. 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 this option is progressed in the NSW Murray 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 for 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 23. Maintain water-related amenity in the NSW Murray 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 NSW Murray 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 people's 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 • existing projects within the region with similar objectives such as the Deniliquin Lagoons Community Restoration Project.
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	**Deniliquin Lagoons Community Restoration Project:** www.lgnsw.org.au/Public/Policy/Environment/Case-Studies/Public/Policy/Case-Studies.aspx?hkey=ea3f79e0-75ff-4237-9624-4e0dda6affea **Integrated water cycle management for utilities:** www.industry.nsw.gov.au/water/water-utilities/best-practice-mgmt/iwcm **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 **Far West Regional Plan 2036:** www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/Far-West/Far-West-Regional-Plan-2036

Option 24. Investigate inter-regional connections

Source: Department of Planning and Environment—Water

Description	This option would investigate the construction of inter-regional pipeline connections between the NSW Murray region and neighbouring regions. Potential inter-regional connections could include: • 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 a single water source and have high to very high water security risk. • Several NSW towns experience intermittent water quality issues. • Significant growth is projected in the Federation, Albury, Berrigan and Murray River local council areas. • There is a risk to future water availability due to climate change.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • provide towns with access to more than one water source • improve 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: • outcomes of integrated water cycle management planning • 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 NSW town water supply, informed by regional water strategy modelling • operating costs such as pumping • a review of not-fully-allocated groundwater sources under the NSW Groundwater Strategy • any interstate issues and concerns.
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	**National Water Grid Authority—NSW Connections package:** **www.nationalwatergrid.gov.au/program/new-south-wales-connections-package**

Option 25. 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 NSW 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 NSW towns and industry • investigate innovative solutions for the management of brine created during treatment of saline waters.
Existing problem or issue	• Increased climate variability and climate change is likely to reduce water security and reliability for NSW towns and industries. • Increasing demand and changing water needs are due to population growth and expanding or new industries. • Balance water needs between different NSW 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 NSW Murray 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: • 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

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 26. 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 NSW Murray region, such as Walla Walla 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 values. 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.

Option 26. Improve protection of groundwater dependent ecosystems (continued)

Benefit of introducing the option	If this option is progressed in the NSW Murray 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.
Regional water strategy objectives	
Further information	**Groundwater dependent ecosystems:** www.industry.nsw.gov.au/water/science/groundwater/ecosystems **Murray–Lower Darling Long-Term Water Plan Part A: Murray–Lower Darling catchment:** www.environment.nsw.gov.au/research-and-publications/publications-search/murray-lower-darling-long-term-water-plan-part-a-catchment

Option 27. Address cold water pollution in the Hume Dam

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

Description	This option would involve a program of works and collaboration with the Australian Government including the Murray–Darling Basin Authority, and with other states through the Complementary Measures Program to address cold water pollution in Hume Dam to: • identify temperature suppression mitigation targets • investigate impediments to addressing cold water pollution and identify solutions, including data gaps/lack of monitoring and lack of funding • review cold water pollution guidelines and set a revised strategic direction to investigate infrastructure options and operational protocols to manage it • review lessons learnt from cold water pollution trials to date and investigate any new research, technology or innovation. As Lake Hume is a shared storage of the Murray River system, the exact scope and project governance arrangements would need to be mutually agreed by all relevant state and federal parties.
Existing problem or issue	• The impact of cold water pollution on native fish and river health is well documented and is acknowledged to impact the lifecycles of native fish in four ways: it reduces body growth and condition; it changes the range and distribution of species; it reduces the opportunity for effective reproduction; and it reduces recruitment success. The occurrence of cold water pollution is widespread in NSW. In the Murray River Valley, the Hume and Khancoban dams have cold water pollution impacts downstream of 196 km and 130 km respectively. • 2004 NSW Cold Water Pollution Strategy ranked the Hume and Khancoban dams second- and seventh-highest, respectively, of all dams across the Murray–Darling Basin likely to cause severe cold water pollution. • Hume Dam thermally stratifies from summer to spring, resulting in a large temperature differences between surface and bottom waters. Existing dam outlets are deep, fixed-level structures that draw cold water from deep levels of the pondage. • The dimensions of Lake Hume, high volume of releases and outlet arrangements pose challenges to developing mitigation solutions. • A 2018 study (see Further information) based on observed data over a five-year period found that the impacts of Khancoban Dam's pondage were minimal and that cold-water releases stem from periods of high electricity generation.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • improve water quality and catchment health outcomes by reducing cold water pollution arising from reservoir stratification • provide a range of ecological benefits for much of the aquatic flora and fauna in the reaches affected by cold water pollution • provide an opportunity to pilot new technologies and operational protocols • 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 • existing temperature metrics against best-practice frameworks for managing impacts on aquatic fauna • the extent and magnitude of cold water pollution effects from storages in the region • 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 • other water-storage related challenges where integrated solutions may be required, such as blue-green algae management • the needs and requirements of other states and the Australian Government.

Option 27. Address cold water pollution in the Hume Dam (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 • **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

Photography
Image courtesy of iStock.
Hume Dam, Albury.

Option 28. Remediate fish passage

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

Description	This option would address barriers to fish passage that disrupt native fish life cycles, including migration. The installation and operation of in-stream barriers to fish passage, such as dams, weirs and regulators, is a major contributor to the decline of native fish species. In-stream barriers and structures are listed as a key threatening process under the *Fisheries Management Act 1994*. A strategic program of fish passage improvement is needed to address barriers within the Murray River catchment. Within the NSW Murray region, fish passage works are proposed at **13 priority sites:** **Three high-priority structures** at Lake Victoria have been identified for fish passage assessment and remediation: • Lake Victoria Control Regulator • Lake Victoria Outlet Regulator • Lake Victoria Inlet Regulator (note that this is included under an existing commitment—the SDLAM project 'Sustainable Diversion Limit Offsets in the Lower Murray: Locks 8 and 9 Project'). Recent monitoring has also identified that the fishways installed at **Lock 11 (Mildura**) and **Stevens Weir** are not performing to design specifications. A new fishway is required at Lock 11 to replace the existing Denil fishway, and providing improved attraction flows to the Stevens Weir vertical slot is required. Modification to weir pool operation has also impacted fishway operation at **Locks 6–10**, and **Lock 15**. The existing fishways at these six sites requires assessment and refurbishment to complement and support weir pool manipulation activities while maintaining effective fish passage. Finally, the fishways at Lock 15 (Denil), **Torrumbarry (Vertical Slot)**, and **Yarrawonga Weirs (Lock)** were some of the first modern fishways constructed in Australia over 20 years ago. Works are required to bring these fishways up to contemporary design standards, and complement the aim of the Sea to Hume Fishways Program to achieve effective fish passage along the Murray River. Fish passage remediation will involve fishway construction or improvement at the identified priority weirs. Remediating existing weir barriers will improve recruitment, distribution, growth and survival for native and threatened fish species. If a fishway site forms part of an existing Joint Venture River Murray Operations asset, or is proposed to be a new asset, consideration of the cost implications will be required by Basin Governments and the Murray-Darling Basin Authority.
Existing problem or issue	Numerous structures in the Murray River are significant barriers to native fish, reducing the ability of fish to migrate (for breeding, food and shelter) and to avoid predation and unfavourable conditions (such as blackwater events). Some of these weirs are being remediated under current SDLAM projects; however, another four remain a high priority: • There is no fish passage on the Rufus River, which receives releases from Lake Victoria. Lake Victoria is a high-priority recruitment zone in the mid-Murray system. Improved connectivity with the Murray River and Lower Darling via the Rufus River and Frenchmans Creek would significantly improve native fish populations in the region and increase resilience. The proposed Frenchmans Creek SDLAM Project will provide fish passage in Frenchmans Creek, which delivers water from the Murray River to Lake Victoria; however it does not address fish passage in the Rufus River. • The Murray fishway at Lock 11 (Mildura) has been identified as insufficient. Urgent assessment is required to determine whether it can be fixed or should be rebuilt. The barrier is a significant bottleneck to fish migration in the Sea to Hume Program, which gives native fish access to 2,225 km of the Murray River. • The entrance to the fishway on Stevens Weir is only 300 mm wide and discharges about 20 ML/day of flow. Compared to the comparatively high flows discharged across the width of Stevens Weir, flows through the fishway are minimal, so it is very difficult for fish to find the entrance. To overcome this issue, installation of an overshot gate and channel that discharges high flows adjacent to the fishway is needed to attract fish to the fishway entrance.

Option 28. Remediate fish passage (continued)

Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • assist in improved forward capital planning and investment in the state's water security assets, while simultaneously alleviating the financial pressure on water industry participants and weir asset owners who have existing and future legislative obligations to address fish passage under the *Fisheries Management Act 1994* • maximise Australian Government investments in fish passage under the Basin plan • improve fish access to mainstem rivers and off-channel habitat • mitigate the impacts of future fish kills by allowing fish to move away from environmentally stressful conditions • improve native fish numbers in connected catchments to threatened and recreationally important species such as Murray cod, golden perch and silver perch • improve the health and wellbeing of the NSW community, including for recreational fishers in the NSW Murray region • benefit Aboriginal communities that hold cultural links to rivers for food and sharing of culture, regional economies that benefit directly from recreational fishing and nature-based tourism, and intrinsic and bequest values held by the broader community.
Considerations	This option would need to consider: • suitable operational arrangements to secure hydrologic connectivity between connected river reaches to ensure passage through fishways • if a fishway site (new or existing) forms part of an existing Joint Venture River Murray asset, considerations of the cost implications will be required by Basin governments and the Murray-Darling Basin Authority • ongoing operation and maintenance responsibilities, such as desilting and debris clearing to ensure continued functionality • identification and understanding of potential co-benefits of fishways for Aboriginal communities • monitoring and evaluation mechanisms after completion to determine if they are effective or need to be improved • life cycle asset management requirements, including funding • identification and understanding of potential co-benefits of fishways for Aboriginal communities.
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	**Barriers to fish passage:** www.dpi.nsw.gov.au/fishing/habitat/threats/barriers **Instream structures—Key threatening process:** www.dpi.nsw.gov.au/fishing/threatened-species/what-current/key-threatening-processes/instream-structures **Reducing the impact of weirs on aquatic habitat—New South Wales Detailed Weir Review:** www.dpi.nsw.gov.au/fishing/habitat/your-catchment/murray **Murray–Darling Basin Authority's Native Fish Recovery Strategy:** www.mdba.gov.au/publications/governance/native-fish-recovery-strategy **Department of Primary Industries 2008, The assessment and prioritisation of barriers to fish passage in the Murray catchment. Report to the Murray Catchment Management Authority. Department of Primary Industries (Conservation Action Unity), Albury.**

Option 29. Implement fish-friendly water extraction

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

Description	This option would seek to install screens on NSW gravity diversions and pumps, considering the optimal approach velocity for improved juvenile fish survival. Rollout and participation by NSW water users would likely be through a voluntary expression of interest process. Traditional screens used to protect pumping equipment and infrastructure do not perform as well as modern screening technology. Current protection guidelines state that screens with 2 mm mesh size and an approach velocity of 0.1 m/sec are required to protect native fish. In 2013, research by the Department of Regional NSW Fisheries found that well-designed and well-installed screens can reduce fish deaths by up to 90%.
Existing problem or issue	• Large losses of fish occur at gravity-fed water diversions. These fish either end up impinged on trash racks, in irrigation channels, or in storage dams, where conditions are unsuitable for survival. • Pumped diversions (capacity 35 ML to 150 ML/day) can result in fish loss from rivers of 3.5 to 887 native fish per ML diverted (see Boys et. al. 2021 in Further information) based on studies in the Murray–Darling Basin. This includes native fish species like Murray cod, golden perch, silver perch and freshwater catfish. • Most fish passing the pumps are injured by de-scaling, decapitation or exophthalmia (a type of eye injury). • There are in excess of 4,500 water pumps in NSW that operate for an average of three months a year.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • prevent entrainment of adults, larvae and eggs, thereby reducing fish mortality and supporting population growth • save pump owners money as a result of reduced costs for fuel and electricity, filters and maintenance • improve water delivery and extraction efficiency through reduced debris blockages • deliver ecological outcomes without requiring additional water allocations.
Considerations	This option would need to consider: • the costs and benefits of screening, including environmental benefits, water delivery efficiency and long-term social and financial implications to water licence holders, noting that cost may be an impediment to implementation • how screening can be better integrated with water and environmental management • where investment should be prioritised • how screening programs could be funded • lessons learnt from existing projects such as previous funding programs and pilot projects for fish-screen installation by Local Land Services in the Lower Darling River • the recommendations of the NSW Government department's guide and design specifications for fish protection screens in Australia (see Further information). Diversion screens have been used successfully for decades overseas (e.g. in western USA, Europe and New Zealand). A recent project to showcase modern screens in the Murrumbidgee region includes Narrandera Fisheries Centre with a 4 ML/day centrifugal pump including 2 mm wedge wire rotating, brushed cylinder screen mounted on a pontoon that can be floated for screen inspection (see Boys et. al. 2021 in Further information).

Option 29. Implement fish-friendly water extraction (continued)

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	**Fish Screens Australia:** fishscreens.org.au/science/ **Boys, C. A., Rayner T.S., Baumgartner L.J., Doyle K.E. 2021, *Native fish losses due to water extraction in Australian rivers: Evidence, impacts and a solution in modern fish—and farm-friendly screens*, Ecological Management and Restoration, Vol. 22, Issue 2, May:** onlinelibrary.wiley.com/doi/10.1111/emr.12483?af=R **Fish Screening Guidelines for water diversions in the Murray–Darling Basin:** finterest.com.au/fish-screening-guidelines-for-water-diversions-in-the-murray-darling-basin/ **Northern Basin Toolkit, including NSW Fish for the Future:** www.agriculture.gov.au/water/mdb/basin-plan/northern-basin-toolkit **Local Land Services NSW—Fish friendly screen installation in the Darling River video:** www.youtube.com/watch?v=Ny-1Rh50NRA&t=1s **Design specifications for fish-protection screens in Australia:** www.dpi.nsw.gov.au/fishing/habitat/rehabilitating/fish-friendly-programs/fish-friendly-farms **The practical guide to modern fish-protection screening in Australia:** www.dpi.nsw.gov.au/fishing/habitat/rehabilitating/fish-friendly-programs/fish-friendly-farms

Photography
Image courtesy of Department of Primary Industries.
Blackfish, native to the Murray River.

Option 30. Improve flows to important ecological sites

Source: Department of Planning and Environment—Environment, Energy and Science; and Murray Irrigation Limited

Description	This option would consist of several projects that aim to restore important ecological flows and connectivity between floodplains and the Murray, Edward-Kolety and Wakool rivers. These projects include: • **Upgrade Werai Forest regulators:** Replace the existing Niemur River, Reed Beds Creek, Tumudgery Creek and Moonya Lagoon inlet regulators on the Edward River (downstream of Stevens Weir) with new structures that have automated lay flat gates, flow meters and lower sills, to remove significant barriers to native fish passage, and improve flow into the Niemur River, Tumudgery Creek and Werai Forest (a Ramsar site and Indigenous Protected Area). • **Merran, Waddy and St Helena creeks restoration (including Lake Tooim connection):** Upgrading the water infrastructure to provide greater environmental water management options for this system and allow the 370 ha Lake Tooim to be managed as a golden perch nursery. • **Upgrade Millewa Forest regulators:** Upgrade and automate the regulators within Millewa Forest to improve operational efficiency and fish passage. These upgrades will lower the commence-to-flow threshold into anabranch creeks within the forest, which are key recruitment sites for native fish. Upgrades should include: – House Creek upgrade – Pinch Gut replacement – Mary Ada upgrade – Nine Panel and Nestrons replacement – Swifts and Bunnydigger replacement – Little Edwards replacement. • **Floodplain creeks restoration Program:** Restore flow into a number of different creek systems and wetlands using upgraded Murray Irrigation infrastructure. Potential creeks include, but are not limited to: – Jimaringle–Cockran–Gwynnes – Buccaneit–Cunninyeuk – Yarrein and Murrain–Yarrein – Noorong, Lanker and Wyam – Tuppal – ephemeral wetlands on private property.
Existing problem or issue	• Changes in flow regimes and land uses (including land clearing) have led to a decline in condition of important ecological sites, including wetlands. • Existing infrastructure has operational limitations, which means the delivery of environmental flows into the forest and fish passage is limited. • Barriers and associated flow management rules within a highly regulated system constrain effective environmental water delivery. • Golden perch recruitment is extremely challenging in the Mid-Murray River, as most off-river nurseries are disconnected from major creeks and rivers. • The Millewa Forest regulators are manually operated, pose a risk to juvenile or small-bodied fish and are barriers to large-bodied fish like Murray cod, trout cod and golden perch. • Many of the ephemeral creeks in the Murray irrigation area have low-level crossings (e.g. culverts) that are easily overtopped with small flows causing access issues for landholders and barriers to fish movement.

Option 30. Improve flows to important ecological sites (continued)

Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • complement existing government commitments such as the SDLAM program • improve ecological outcomes for waterbird colonies, threatened species and native fish populations; improve native fish passage and secure critical refuge and breeding habitats • provide productivity and food web benefits to waterways, improve wildlife corridors between these river systems and connect remnant vegetation communities in highly modified landscapes • improve the efficiency and effectiveness of environmental water create water quality improvements.
Considerations	This option would need to consider: • collaboration and compatibility with other NSW Government programs (e.g. including existing SDLAM projects) to ensure alignment and efficient outcomes • engagement and collaboration with landholders • appropriate water delivery regimes to maximise benefits and avoid hazards (such as hypoxic blackwater), and appropriate pest species management • regulatory and policy constraints, including the use of existing infrastructure to deliver environmental water • 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 • an accountability assessment of basin salinity management of the revised environmental water delivery practices.
NSW Water Strategy priorities	**Priority 2:** Recognise First Nations/Aboriginal 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	**Water for the environment—Murray and Lower Darling:** www.environment.nsw.gov.au/topics/water/water-for-the-environment/murray-and-lower-darling

Option 31. Develop a river and catchment recovery program for the NSW Murray 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 upper 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.
Benefit of introducing the option	If this option is progressed in the NSW Murray 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 31. Develop a river and catchment recovery program for the NSW Murray 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 Murray • 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 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 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 3.4:** 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	**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 **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 runoff to help protect waterways:** news.griffith.edu.au/2020/09/14/understanding-nutrient-runoff-to-help-protect-waterways/

Option 32. 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 Murray–Lower Darling Long-Term Water Plan under long term climate change projections. Specific aspects that could be reviewed include: • effectiveness of water set aside for environmental water allowances and access rules for environmental water allowances during extreme events • effectiveness of the Barmah–Millewa Allowance, the Barmah–Millewa Overdraw, the Murray Additional Allowance and spills of environmental allowance provisions • effectiveness of rules protecting NSW planned environmental water during extreme events. In addition, the review could also investigate: • 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 NSW 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.
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. • Current NSW water sharing plans (in regulated rivers) do not specify the priority of access for environmental water allowances when supply capability is insufficient to satisfy all water requirements in sections of the river.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • assist in meeting the environmental watering requirements as specified in the Murray–Lower Darling 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 all places 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 32. Review environmental water arrangements (continued)

Considerations	This option would need to consider: • past recommendations of the Natural Resources Commission's review of NSW water sharing plans for meeting environmental outcomes in the NSW Murray region • any interaction with the prerequisite policy measures in the NSW Murray region • the environmental watering requirements of the Murray–Lower Darling Long-Term Water Plan • legislative and policy constraints that would arise if the review suggests future changes to NSW water sharing plans to better meet environmental outcomes, including those outlined in the Basin Plan • any impacts on existing NSW entitlement holders in the NSW Murray 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 • potentially expanding the scope to include Snowy environmental flow 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	**NSW controlled allocations:** www.industry.nsw.gov.au/water/allocations-availability/controlled **Water sharing plans in the Murray and South Coast regions:** www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/status/murray-region www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/status/south-coast-region **Murray–Lower Darling Long-Term Water Plan:** www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/murray-lower-darling **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 33. Re-establish threatened fish species through habitat restoration and conservation restocking

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

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 NSW Murray region. Some species are locally extinct; therefore, a reintroduction program would be required: • Hume–Yarrawonga reach: flat-headed galaxias (critically endangered), locally extinct • Yarrawonga–Tocumal: trout cod • Torrumbarry–Barham: purple spotted gudgeons (endangered), locally extinct • Far south-west NSW (Lower Murray, Frenchmans Creek/Lake Victoria floodplains): Murray cod, golden perch recruitment, silver perch recruitment, freshwater catfish, Murray hardyhead, southern pygmy perch, pouched lamprey • Murray–Murrumbidgee junction floodplain: Murray cod, trout cod, golden perch, freshwater catfish • Edward/Kolety-Wakool region: Murray cod, trout cod, golden perch, silver perch, freshwater catfish • Millewa Forest: Murray cod, trout cod, golden perch recruitment, silver perch recruitment, freshwater catfish • Coppabella Creek: olive perchlet (endangered), locally extinct; southern pygmy perch (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 NSW Murray 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. • There are erosion and bank stability issues along the outside bends at Tocumwal and Barmah chokes (Murray) and the Edward River offtake to Moulamein township (Edward). • Reduced fish abundance impacts Aboriginal cultural connection to Country and 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.

Option 33. Re-establish threatened fish species through habitat restoration and conservation restocking (continued)

Benefit of introducing the option	If this option is progressed in the NSW Murray region, a range of environmental and social benefits could be achieved 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. This option also enhances long-term water deliverability for consumptive and environmental use through areas of flow constraints such as the Bamah Choke, Tocumwal and Edward River offtake to Moulamein.
Considerations	This option would need to consider: • any interaction with existing government commitments such as the SDLAM program • any interaction with a Murray–Darling Basin Authority riparian works program for the reach Yarrawonga to Torrumbarry. Existing riparian programs cover Hume to Yarrawonga and upper Murray River • 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 31: Develop a river and catchment recovery program for the NSW Murray 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 Aboriginal 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 34. Better understand the economic value of ecosystem services of riverine environmental assets

Source: Department of Planning and Environment—Water, and Department of Planning and Environment—Environment, Energy and Science

Description	This option would seek to improve the valuation of ecosystem services in the NSW Murray River to provide a more coherent, consistent and comparable set of information regarding the environmental, social and economic benefits provided by ecosystem services of riverine environmental assets. Through the compilation of information, records and statistics from both market-based and non-market-based valuations, a more expanded valuation framework can be established that will: • support NSW government policy, planning and investment decisions affecting the environment • strengthen the ability of the NSW Government, local governments, businesses and community to recognise the benefits of protecting and investment in the environment. Acknowledging past work to value ecosystem services of riverine environmental assets in the NSW Murray, the option would: • undertake a literature review to take stock of information/data already available and learn from other applicable investigations into the value of services provided by other environmental assets • define the spatial extent and condition of the reach of river to form part of the assessment • identify the ecosystem services provided and the beneficiaries of those services such as local communities or industries; for example, through water filtration, flood attenuation, recreational opportunities, carbon sequestration, pollination services • determine the economic value of those services. Part of this option would also seek to develop a framework to develop this approach in other NSW catchments to ensure a consistent approach across NSW.
Existing problem or issue	• The value and benefits provided by ecosystem services of riverine environmental assets are often inadequately captured by traditional measures such as economic assessments. • The valuation of ecosystem services of riverine environment is fragmented, with no consistent approach applied across the catchment (or across the state). • There is limited capability to assess the status of natural resources (extent and conditions), their attributes and the impacts of human interventions (including from new infrastructure proposals) for better policy and decision-making to sustain the long-term health of these ecosystems.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • an economic understanding of the value of the Murray River environmental assets and their ecosystem services in the NSW Murray region to beneficiaries • more consistent, coherent and comparable information to inform decision-making in terms of understanding the potential impact of proposed policies, programs or infrastructure on the asset • improved understanding to determine the actual value/benefits of delivered environmental water or implemented complementary measure projects • a transferable method to value riverine ecosystem services in other valleys across NSW.

Option 34. Better understand the economic value of ecosystem services of riverine environmental assets (continued)

Considerations	This option would need to consider: • consultation with local, national and international experts to resolve many conceptual and technical issues • the additional benefits that could be provided by a new valuation approach and how it could be applied across NSW • a wide range of expertise to compile relevant information, data and statistics—dependent on literature review • how the work in the NSW Murray could be applied state-wide, and link with a national approach to environmental-economic accounting (see Further information) • inter-jurisdictional cooperation and collaboration to collate and align work with other Basin governments.
NSW Water Strategy priority	**Priority 5:** Support economic growth and resilient industries within a capped system • **Action 5.2:** Invest in R&D and new technologies to lift water productivity in NSW industries (see 5.2a: Better capturing and quantifying the contribution of water to economic outcomes at the state and regional level, including the economic value of natural systems, in order to better understand and measure water productivity).
Regional water strategy objectives	
Further information	**Economics and the environment | State of the Environment 2015:** www.epa.nsw.gov.au/about-us/publications-and-reports/state-of-the-environment/state-of-the-environment-2015/02-economics **Environmental-Economic Accounting:** eea.environment.gov.au/ **Environmental Economic Accounting: A common national approach—Strategy and Action Plan:** eea.environment.gov.au/about/national-strategy-and-action-plan **Victorian Government's Accounting for the Environment:** www.environment.vic.gov.au/accounting-for-the-environment **Experimental ecosystem accounting project in the Gunbower-Koondrook-Perricoota Forest Icon Site:** eea.environment.gov.au/media/163 **Environmental-economic accounting for the Mitchell River:** www.nespnorthern.edu.au/projects/nesp/environmental-economic-accounting/

Limits to water availability in times of a changing climate

Water needs across the NSW Murray 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 35. 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 NSW Murray 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 NSW town water supplies. • **Growth in NSW 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 35. Better understand water use with data collection and analytics (continued)

Benefit of introducing the option	If this option is progressed in the NSW Murray 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 NSW Murray region, including river operations, implementation of NSW water sharing plans/water resource plans • identify existing or emerging risks and help manage these risks as they arise • proactively manage future water security risks to NSW towns due to growth in the NSW Murray region (e.g. 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 NSW Murray region • better plan and manage the system during normal and extreme events and 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, the Australian Geoscience Data Cube) 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 NSW water sharing plans, for the Natural Resources Access Regulator, and for 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 36. 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 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 NSW Murray region to guide future management decisions by the NSW Government. • Increased climate variability poses new risks to NSW towns, communities and industries in the NSW Murray 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 NSW Murray region, 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 governments.

Option 36. Improve the understanding of groundwater sources and processes, risks and impacts (continued)

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

Photography
Image courtesy of Destination NSW.
Murray River, Moama.

Option 37. 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 NSW Murray region (both primary and secondary)—including those reliant on NSW town water supply systems. This study would make use of the new climate data and updated modelling developed for the Murray Regional Water Strategy. In addition, the study would consider recent and projected industry changes in the NSW Murray 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 this option is progressed in the NSW Murray region, it would: • provide insight 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 on regional NSW communities • provide information on the types of industries or crops suited to the region in a more variable and drier future • help future NSW 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. ABARES, 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 Industry—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.*

Option 37. Undertake a water dependent industry resilience study (continued)

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.
Regional water strategy objectives	
Further information	**Right to Farm Policy:** www.dpi.nsw.gov.au/agriculture/lup/right-to-farm-policy **Future Ready Regions:** www.nsw.gov.au/regional-nsw/future-ready-regions **Farm Business Resilience Program:** droughthub.nsw.gov.au/fbrp **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 iStock.
Murray River, Tocumwal.

Option 38. 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 NSW Murray 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 and to manage their risks to future water availability • NSW water allocation processes (process, inputs, assumptions)—to better understand the water management framework and its underlying assumptions • water delivery risk—to better understand the water delivery risks for NSW water users below the Barmah Choke • 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 science and 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 • 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 in a variety of ways including summaries and papers 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. • In the Murray River, there is an increasing risk of delivery shortfall.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would: • assist all NSW 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 recommendations 15 and 23 of the Australian Competition and Consumer Commission's *Murray–Darling Basin water markets inquiry*.

Option 38. 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 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 **WaterNSW WaterInsights portal:** waterinsights.waternsw.com.au **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 39. Investigate water availability in the NSW Murray 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 NSW Murray 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 NSW 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 this option is progressed in the NSW Murray region, it would: • provide transparency and evidence on whether there is systemic underuse in southern NSW regions • provide evidence on possible causes of any underuse and an opportunity to encourage water use up to, but not exceeding, the sustainable diversion limit • maximise the efficient use of all available (allocated) water in the NSW Murray 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 NSW Murray 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 Murray 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 40. 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 NSW town water supplies: – supporting 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 (e.g. including trials of new water efficient technologies) – investigating increased use of recycled water or stormwater by industry, within or near NSW towns, in the NSW Murray 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 receive funding under the Australian Government's Off-Farm Efficiency Grants 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 NSW 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 this option is progressed in the NSW Murray 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 contribute 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 40. 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 Grants Program • strategic opportunities within and across the region to implement trials, including collaboration between 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 NSW 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-information-pack www.wsaa.asn.au/publication/water-efficiency-report-2017 **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):** 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

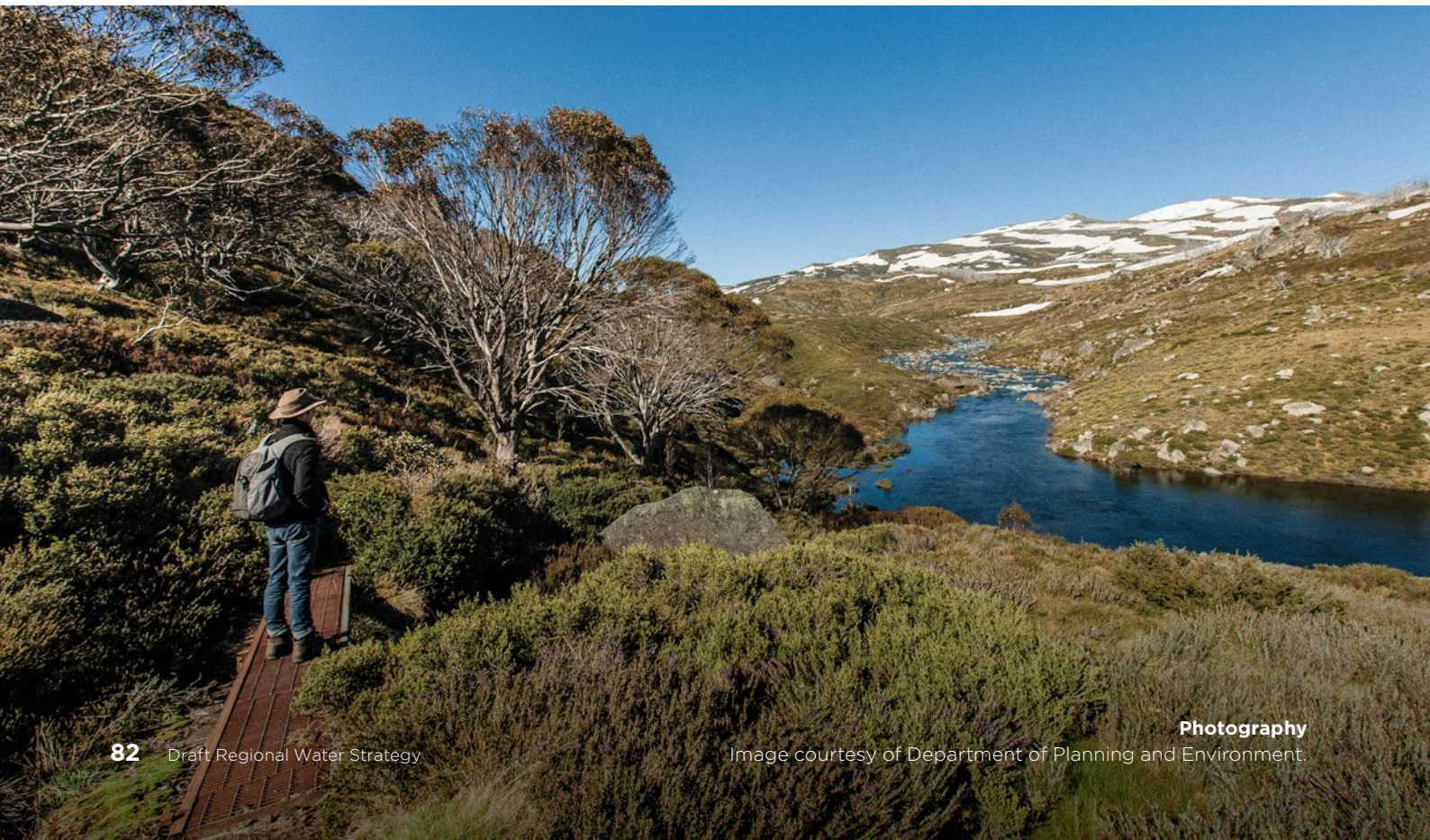
Option 41. Investigate the expansion of cloud seeding in key water supply catchments

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 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-east Australia and internationally.
Existing problem or issue	• Observed declines in water availability now. • Increased risk of lower water availability under future climate change scenarios.
Benefit of introducing the option	If this option is progressed in the NSW Murray region, it would 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.

Option 41. Investigate the expansion of cloud seeding in key water supply catchments (continued)

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	
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.semanticscholar.org/paper/Case-studies-of-orographic-precipitation-in-the-and-Chubb-Morrison/76929556c1eb92822ed7818763f760babf9b23f3 **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/configurable/content/journals$002fbams$002f100$002f8$002fbams-d-18-0160.1.xml?t:ac=journals%24002fbams%24002f100%24002f8%24002fbams-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 Planning and Environment.

Option 42. 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) 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 NSW 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 this option is progressed in the NSW Murray 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 • 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

Option 43. 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 carryover 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 sources.
Existing problem or issue	• There are differences between 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 this option is progressed in the NSW Murray 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 NSW Murray 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.

Option 43. 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 Murray Regional Water Strategy, including councils' ability to trade without compromising their future growth aspirations • stakeholder 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 (e.g. growth in permanent plantings at the end of the system) – capacity constraints and related issues with managing delivery risks in the NSW Murray 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 **Water Reform—Transparency in the NSW water market:** www.industry.nsw.gov.au/water/licensing-trade/trade/have-your-say **WaterNSW Review of the Murrumbidgee inter-valley transfer (IVT) application and assessment approach—Issues and options paper for public consultation:** www.waternsw.com.au

Option 44. 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 (i.e. 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, including opportunities for private investment • 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 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 dam catchments such as the Snowy Mountains and Victorian Alps, as they have occurred periodically in recent times, they can have significant impacts on dam inflows. One estimate (see Hill et al., 2008 in Further information) puts the impact of the 2003 bushfires at a maximum reduction of 859 GL/year on average for the Murray River, downstream of Albury. • 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 NSW Murray 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.

Option 44. Consider hydrological processes in bushfire management (continued)

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.
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):** 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

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