Draft Regional Water Strategy

Lachlan:
Shortlisted Actions – Consultation Paper

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Cover image Image courtesy of iStock. Wyangala Dam, Wyangala NSW.

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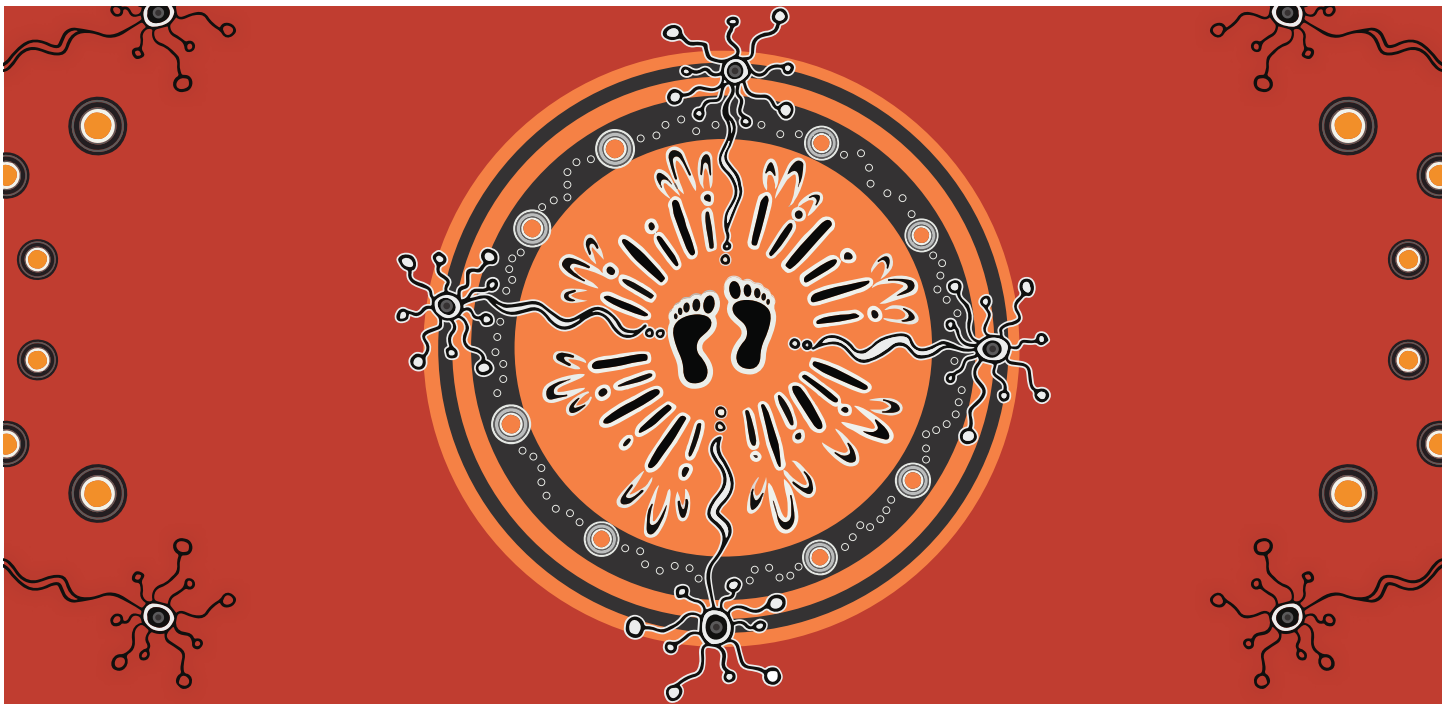

Acknowledging First Nations people

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

Today, they practice the oldest living culture on earth.

The NSW Government acknowledges the First Nations People/Traditional Owners from the Lachlan region as having an intrinsic connection with the lands and waters of the Lachlan Regional Water Strategy area. The landscape and its waters provide the First Nations people with essential links to their history and help them to maintain and practice their traditional culture and lifestyle.

We recognise the Traditional Owners were the first managers of Country and by incorporating their culture and knowledge into management of water in the region is a significant step for closing the gap.

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

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

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

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

Artwork courtesy of Nikita Ridgeway.

Minister's foreword

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

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

When it comes to managing water in NSW my view is healthy rivers, healthy farms and healthy communities. Not one or the other.

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

The Lachlan is home to 100,000 people and thriving regional towns of Cowra, Parkes, Forbes and Young, which drive the region's $6.73 billion economy. The region is located within the traditional lands of the Nari Nari, Ngiyampaa, Wiradjuri, Barkandji, Maljangapa and Yita Yita people.

Water drives local businesses, supports towns and ensures a healthy local environment, which in the Lachlan includes the Lachlan and Belubula river catchments.

Our state is no stranger to extremes; we have always had to manage our water resources through prolonged floods and droughts. In the face of an increasingly variable climate future, we must prepare for even longer and more severe wet and dry periods.

We need to start a conversation now with the community on how to support and structure the future economic growth of the region. This strategy is the start of that conversation.

Working closely with the community, we are now making decisions around future investments that will set up the region for the future.

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

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

This strategy, alongside 11 other regional and 2 metropolitan strategies across the state has been developed using the best and latest scientific evidence to ensure we can understand and mitigate risk even in the most extreme climatic circumstances.

We engaged leading academics to undertake historic climate-informed rainfall and evaporation modelling. This climate modelling is based on a deliberately conservative scenario that is intended to 'pressure test' the effectiveness of the strategy in a worst-case scenario. These climate scenarios will not necessarily eventuate, but they give us an idea of the possible climate risks and allow us to begin planning to mitigate these risks should they arise.

The Lachlan Regional Water Strategy will put forward the best mix of solutions to address these challenges and support environment, social and economic outcomes. After widespread community consultation, we have shortlisted proposed actions to take a holistic approach to land and water management, ensure water resources are used sustainably and fairly, and prepare for a more variable climate.

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

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

There is no 'one size fits all' policy to manage water in our regions. I encourage all members of the community and stakeholders in the Lachlan to get involved and contribute to the strategy. Water is for everyone, and we are ensuring our water management policies support the future of the Lachlan and all of NSW.

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

Contents

Image courtesy of Destination NSW. Lachlan River, Condobolin.

Snapshot

The Lachlan region

100,000
population

90,000
km² area

Aboriginal Nations:
Nari Nari, Ngiyampaa, Wiradjuri, Barkandji, Maljangapa and Yita Yita

Key regional centres include:
Cowra, Forbes, Parkes and Young

Smaller regional centres include:
Blayney, Booligal, Boorowa, Gunning, Canowindra, Condobolin, Crookwell, Euabalong, Gunning, Hillston, Ivanhoe, Lake Cargelligo, Oxley, Temora and West Wyalong

Main surface water sources:
The regulated Lachlan and Belubula rivers plus a number of unregulated rivers and creeks

Council areas:
Upper Lachlan Shire Council, Temora Shire Council, Blayney Shire Council, Cowra Shire Council, Cabonne Shire Council, Bland Shire Council, Forbes Shire Council, Parkes Shire Council, Weddin Shire Council, Lachlan Shire Council, Cobar Shire Council, Carrathool Shire Council, Central Darling Shire Council, Hay Shire Council, Balranald Shire Councils and Hilltops Council

Main groundwater sources:
Upper Lachlan Alluvium groundwater source, lower Lachlan Alluvium groundwater source, Belubula valley groundwater source, lower Murrumbidgee Deep groundwater source, Orange Basalt and Young Granite

Major water storages:
Wyangala Dam with a storage capacity of 1,217 GL and Carcoar Dam with a storage capacity of 35.8 GL as well as 2 re-regulating storages: Lake Brewster and Lake Cargelligo

Water for the environment:
Approximately 19% of licences in the regulated Lachlan River, or 127 GL of licenced water entitlements are managed by state and federal environmental water holders. The majority of these licences are general security licences

The Water Sharing Plan for the Lachlan regulated river also includes an environmental water allowance, a water quality allowance and daily environmental releases (also referred to as translucent flows)

Key environmental assets:
The region supports several nationally important wetlands including Lake Cowal, the Booligal wetlands and the Great Cumbung Swamp and the region provides habitat for rare, endangered and threatened animal and plant species

Gross Regional Product (2020–21): **$6.73 billion**

Engine industries: agriculture, mining, manufacturing

Figure 1. Map of the Lachlan region

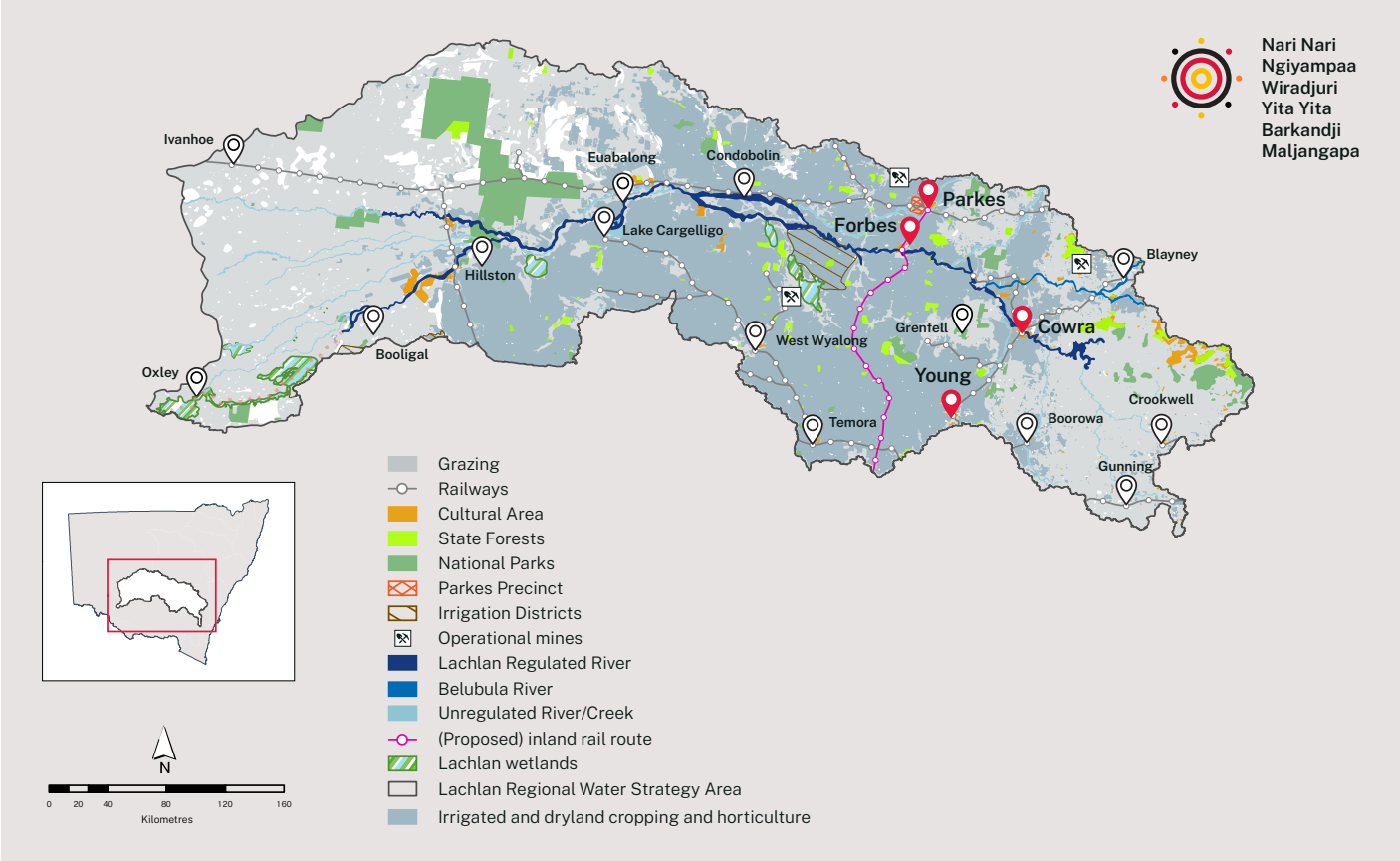

Image courtesy of Destination NSW. Bellevue Hill Lookout, Cowra.

What is the purpose of this consultation paper?

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Image courtesy of Destination NSW. Windmill, Booligal.

The NSW Government is developing 12 regional water strategies that bring together the best and latest climate evidence with a wide range of tools and solutions to plan and manage each region's water needs over the next 20 to 40 years.

The first draft of the Lachlan Regional Water Strategy, including a long list of options, was released in September 2020.[1]

Since public consultation on the draft strategy, we have taken on board what we heard. We have undertaken additional analyses to prioritise the key challenges in the region that need to be tackled first and have shortlisted actions to help meet these challenges. The process we went through is described in the Options assessment process: Overview.[2] This consultation paper presents the outcomes of this work, which is summarised in Figure 2.

No decisions have been made on the shortlist of proposed actions. This consultation paper seeks your views on what the best actions are to set the Lachlan region up for the future before a final strategy and implementation plan are developed.

You can find additional background information in Lachlan region: Draft Regional Water Strategy: What we heard.[3]

Other regional water challenges described in the Draft Lachlan Regional Water Strategy are important and will be revisited during future reviews of the final strategy, planned to be every 3 to 4 years.

Image courtesy of Destination NSW. Hughie Cameron Park, Hillston.

1. The *Draft Lachlan Regional Water Strategy and long list of options* can be viewed at: water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/lachlan-regional-water-strategy
2. Available for download at www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/identifying-and-assessing
3. The Department of Planning and Environment, *Draft Lachlan Regional Water Strategy* available at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/lachlan-regional-water-strategy

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

Vision

Support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous region.

Objectives

- Deliver and manage water for local communities
- Recognise and protect Aboriginal water rights, interests and access to water
- Enable economic prosperity
- Protect and enhance the environment
- Affordability

Regional challenges to meet our vision and objectives

- Managing water resources during more extreme events for people, industry, and the environment
- Improving water quality
- Addressing barriers to Aboriginal water rights
- Sustaining the health and resilience of the region's water dependent ecosystems
- Supporting economic growth and diversification

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Priority 1	Priority 2	Priority 3	Priority 4
Build resilience to climate extremes	Ensure best use of existing water for the environment	Support economic prosperity in a capped system	Improve our knowledge of water resources
Page 58	Page 76	Page 92	Page 102
Action 1.1–1.7	Action 2.1–2.5	Action 3.1–3.5	Action 4.1–4.3

Why we are developing regional water strategies

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

In addition to understanding and managing future pressures, there are opportunities to consider the role water resources will play in growing our region, improving liveability and making sure each region remains a great place to live, work, play and visit. The NSW Government's strategic investments in special activation precincts, regional job precincts, renewable energy zones, critical minerals hubs and actions identified through regional economic development strategies are critical to realising this vision. However, all these activities rely on access to water.

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

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

Image courtesy of Destination NSW. Landscape, Cowra.

How do regional water strategies fit with other water strategies?

The NSW Water Strategy, together with the 12 regional water strategies, and 2 metropolitan water strategies that underpin it, will form the strategic planning framework for water management in NSW. The NSW Water Strategy was developed in parallel with the draft regional water strategies. The NSW Water Strategy guides the strategic, state-level actions that we need to take, while the regional water strategies will prioritise how those state-wide actions – as well as other region-specific, place-based solutions – should be staged and implemented in each region (Figure 3).

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

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

The NSW Water Strategy and the Lachlan Regional Water Strategy also complement other whole-of-government strategies, including the 20-Year Economic Vision for Regional NSW and accompanying Future Ready Regions Strategy, and the updated State Infrastructure Strategy 2022–2042.

The Lachlan Regional Water Strategy also seeks to align its actions and recommendations with the goals and directions set out in relevant regional plans,[4] support the growth and development enabled through the Inland Rail Project and Fast Rail Network Strategy, as well as the Parkes Special Activation Precinct and the Central West and Orana Renewable Energy Zone.

The strategy will be cognisant of further developments resulting from existing government commitments to develop water-related infrastructure business cases in the Lachlan and other NSW Government initiatives that are under development, like the review of the Regional Economic Development Strategies, the Housing 2041 – NSW Housing Strategy and the NSW Electricity Strategy.

Providing a coordinated approach to support the range of transformational NSW Government policies that have recently been introduced, we will be able to proactively build resilience in regional communities. The aspiration is to adopt a place-based framework that is flexible and adaptive to changing circumstances and enable government and regional communities to work together to ensure the Lachlan is a great place to 'live, work, and visit'.

4. The Lachlan Regional Water Strategy area covers the Central West and Orana Regional Plan, the Far West Regional Plan, the Riverina-Murray Regional Plan and the South-East and Tablelands Regional Plan

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

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

We need to plan for multiple possible futures

The Lachlan Regional Water Strategy is not being prepared in isolation. Existing government commitments are underway in the region that aim to improve water resource resilience, drive future economic prosperity and enhance liveability. There are 2 major projects for which business cases are currently being developed:

- **The Wyangala Dam Wall raising Project**[5] – Water Infrastructure NSW is leading the development of a final business case[6] to augment the existing Wyangala Dam to deliver improved water security, drought resilience and flood attenuation benefits for the Lachlan valley. The development of the final business case and the environmental impact statement[7] are currently underway
- **The Belubula Water Security Project**[8] – Water Infrastructure NSW is leading the development of a business case that assesses a range of potential options to improve the efficiency and resilience of water management in the Belubula valley. This business case will assess 2 interrelated pieces of infrastructure: a pipeline linking the Central Tablelands Water owned Lake Rowlands and the Water NSW owned Carcoar Dam, and the augmentation of Lake Rowlands.[9]

The Lachlan Regional Water Strategy will be developed in parallel with these major infrastructure business cases. The hydrologic, economic and environmental assessments for the business cases will be more detailed and subject to stringent requirements via the Infrastructure NSW gateway process.[10] To avoid inconsistencies with the high-level assessments of the Lachlan Regional Water Strategy, we have not undertaken any further hydrologic modelling or any economic or environmental assessments for these projects.

We are aware that several options on the original Lachlan Regional Water Strategy long list are directly affected by the outcomes of the final business cases – particularly the Wyangala Dam Wall raising project (see breakout box under proposed action 3.5).[11] For these options, the Lachlan Regional Water Strategy has undertaken some high-level hydrologic modelling (where feasible) to understand whether these options have merit to progress for further detailed assessment. Where any of these options show merit, the strategy recommends that those infrastructure options be revisited once the final business cases are complete.

5. In the original *Draft Lachlan Regional Water Strategy*, this project was listed under 'Existing government commitment 2'. For further information, please see Department of Planning and Environment, Water Infrastructure, water.dpie.nsw.gov.au/water-infrastructure-nsw/dam-projects/wyangala-dam
6. Work has commenced on a new $5.1 million Wyangala Water Treatment Plant to deliver up to 800,000 litres/day of drinking water.
7. pp.planningportal.nsw.gov.au/major-projects/projects/wyangala-dam-wall-raising
8. In the original *Draft Lachlan Regional Water Strategy*, this project was listed under 'Existing government commitment 1 and 3'. For further information, please see Department of Planning and Environment, *Belubula Water Security Project*, water.dpie.nsw.gov.au/water-infrastructure-nsw/regional-projects/belubula-water-security-project
9. Central Tablelands Water, Lake Rowlands, www.ctw.nsw.gov.au/your-water/lake-rowlands/
10. NSW Treasury, *Gateway – Investor Assurance,* treasury.nsw.gov.au/finance-resource/gateway-investor-assurance
11. These options include the mid-Lachlan and lower Lachlan efficiency measure options (original options 26 and 27), the lower Lachlan weir Project (original option 39).

Regional water strategies are backed by new climate data

To improve our strategic water planning, new ground-breaking climate datasets have been developed for the Regional Water Strategy Program. These datasets provide us with a more comprehensive understanding of the climate variability in the Lachlan region beyond the recorded historical data.

To support the development of the Lachlan Regional Water Strategy, we are using the recorded dataset as well as 2 plausible climate scenarios to test their respective implications for regional water resources:

- **historical data:** data from rainfall and evaporation records collected by Australian government meteorological records over the past 130 years
- **long-term historical past climate:** 10,000 years of stochastic-generated climate data developed using paleoclimatic information from The University of Adelaide, Australia
- **dry future climate:** Applying the NSW and Australian Regional Climate Modelling (NARCliM) climate projections to define a dry climate change scenario for 2060–79 compared to the baseline period of 1990–2009.

The dry future climate change scenario[12] is the SRES A2 which represents a high carbon emissions scenario, and thus results in higher projected climate change impacts on the region.[13] This is not a forecast of expected climate change, but it is one of many possible future outcomes.

While this climate change scenario may not occur, it helps us to undertake strategic water planning and highlight key water challenges we may need to focus on in the future. It also helps us to understand how different options may respond to climate change.

Combined, these 3 datasets provide us with a range of plausible climate futures, that cover a range of wet and dry sequences. For further details about the new climate data and modelling, please refer to www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/climate-data-and-modelling.

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

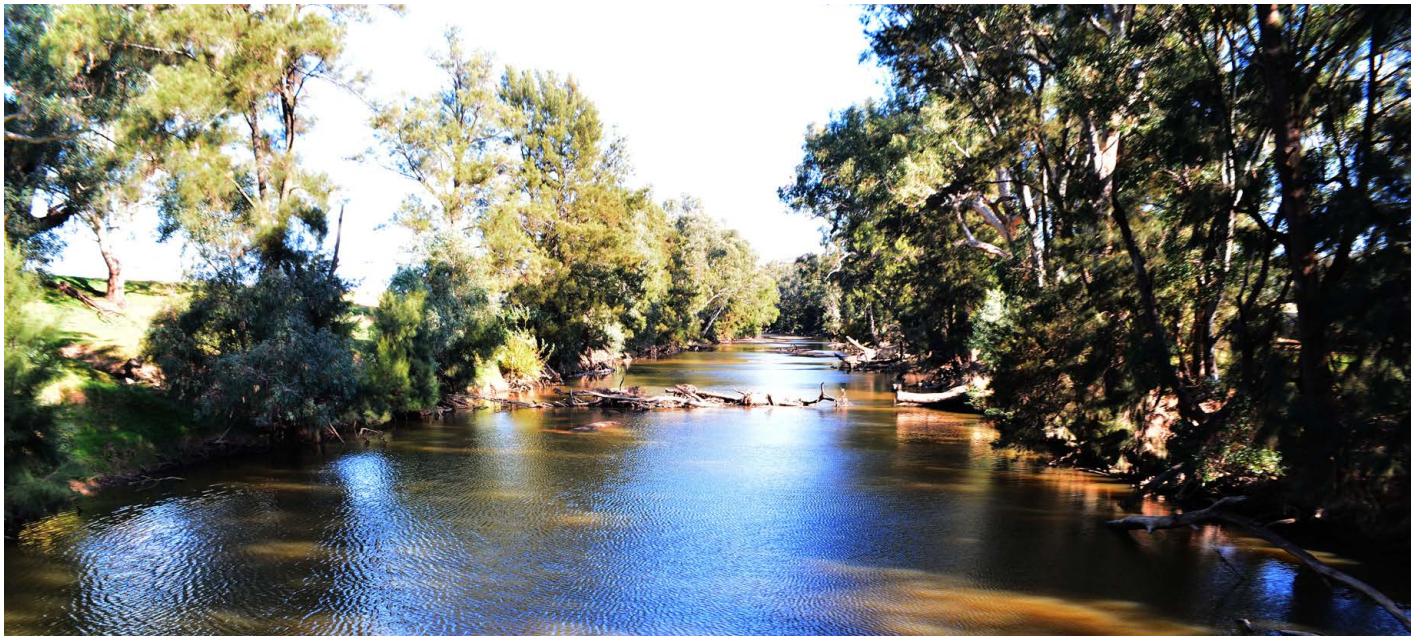


Image courtesy of iStock. Lachlan River, Reids Flat.

12. The scenario uses the regionally downscaled factors from the NARCliM 1.0 Project to adjust the long-term past climate scenario rainfall and evapotranspiration data. Further information on NARCliM 1.0 Project is available on the NSW Government, AdaptNSW website: www.climatechange.environment.nsw.gov.au/climate-projections-used-adaptnsw
13. The SRES A2 assumes a 2C warming over the regional water strategy planning horizon.

What the future climate could look like in the Lachlan region

We don't know for certain what the Lachlan region's future climate will be like. It may be similar to what we have experienced in the past or it may be more variable than we have seen in our lifetimes. Our analysis of different climate scenarios tells us that there could be hotter and longer droughts, higher evaporation rates, and more unpredictable rainfall events and variable river flows.

We need to plan for these uncertainties and continue to refine our understanding of the water-related risks in the Lachlan region to ensure people, the environment and industries can live and thrive in the future.

Changing rainfall patterns

Changing rainfall patterns with potential decreases in **critical winter/spring** rainfall and **increases in summer/autumn** rainfall.

Potential less average annual rainfall.

More extreme events

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

Higher evaporation

Potential increase in evapotranspiration by up to

5%

by 2070

compared to levels between 1990 and 2009.

Changes in river flows

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

Lower inflows into Wyangala and Carcoar dams

Average annual inflows into the regions' main storages **could decline and storage levels could be consistently lower** under future dry climate projections.

We want to hear from you

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

We are seeking your feedback on:

- the key regional water-related challenges
- the 4 priorities and proposed actions
- the focus questions under each proposed action.

The feedback we receive from you will help us finalise the Lachlan Regional Water Strategy and implementation plan.

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

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

Benefits and impacts of actions on Aboriginal people and communities

Aboriginal communities across NSW have told us that they need specific information on how the shortlisted actions will affect them.

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

At this stage of the regional water strategies process, we are identifying and recording the types of questions that Aboriginal communities are likely to have about each of the proposed actions. We are also working out what information communities will need to make informed decisions about how specific actions will affect them.

Once we have undertaken the detailed analysis required to progress preferred actions, we will share that information with Aboriginal communities and seek their feedback on how these actions may impact them. That evidence may help us to refine a preferred action or identify risks in progressing with an action.

What we have heard so far

2

Image courtesy of iStock. Wyangala, NSW.

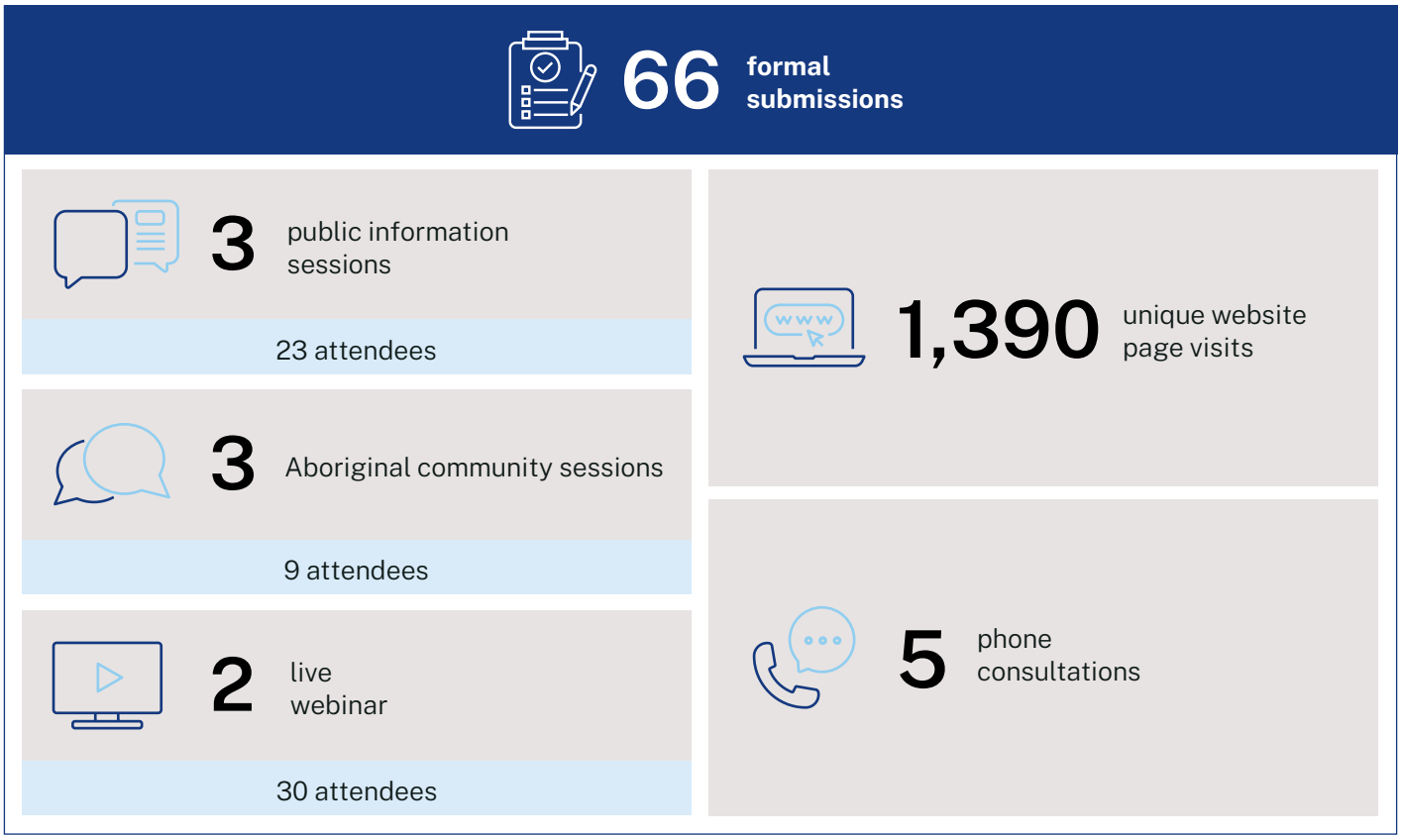
We sought input on the Draft Lachlan Regional Water Strategy and long list of options from September to December 2020 (Figure 4). The What We Heard Report[14] for the draft strategy summarises the key issues we heard during the first round of public exhibition. It highlights how the feedback we received during this period has informed the next steps in the development of the Lachlan Regional Water Strategy.

There was general support for the development of the Lachlan Regional Water Strategy, but some stakeholders suggested that insufficient consultation had been undertaken in developing the draft strategy.

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

Stakeholders encouraged the department to continue progressing the development of the NSW Water Strategy and regional water strategies. Since then, the NSW Water Strategy has been finalised and released for public consultation.

Figure 4. Stakeholder engagement during the first public exhibition period



14. Department of Planning and Environment, *Draft Lachlan Regional Water Strategy What We Heard Report*, available via: water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/lachlan-regional-water-strategy

During consultation we heard views on a range of water-related issues

Climate and modelling

- There was support for the strategy's long-term vision and its consideration of future climate risks.
- The development of new climate datasets and updated modelling was welcomed, but there were mixed views on how it should be used.
- Further research is needed to better understand how the region's future climate will affect groundwater sources.
- Stakeholders were supportive of demand management initiatives and progressing projects that could enhance water use efficiency.

Environment and ecosystem health

- Protecting and maintaining healthy rivers, groundwater sources and ecosystems was important for many stakeholders.
- Stakeholders suggested that more options are needed to address downstream environmental needs.
- There was broad support for options that improve river system connectivity, water quality, and options that support important wetlands and species across the catchment.
- Improving aquatic ecosystem health through improved land management and removal of ineffective or non-essential water-related infrastructure was considered important.

New and existing water infrastructure

- There were mixed views about the construction of new water-related infrastructure, or augmentation of existing infrastructure. We heard that new or augmented water infrastructure could:
  - provide greater economic, social and water security benefits for the region
  - be a threat to the environment, cultural heritage and groundwater sources.
- There was strong opposition to the augmentation of the Lake Cargelligo system due to the impact on the environment, communities and economic prosperity. The options associated with augmenting Lake Cargelligo have not been carried forward in the strategy.
- There was strong opposition to the mid- and lower-Lachlan efficiency measures due to the impact on the environment and individual landholders.
  - It was recognised that our ability to model the mid-Lachlan efficiency measure option is limited so a decision on this option has been deferred until we have improved our hydrological modelling capabilities to assess the potential benefits and costs of this option. Future consideration of these options will also require a more detailed environmental and social impact assessment.
  - Preliminary hydrological and economic assessments of the lower Lachlan efficiency measure option suggested this option had limited merit and was therefore not carried forward in the strategy.

Aboriginal people's water rights and connection to Country and waterways

- There was broad support for improving the recognition of Aboriginal people's water rights, interests, and access to water and Country.
- Many stakeholders think that local Aboriginal people have a valuable role to play in long-term water management and emphasised the importance of involving Aboriginal people in the development of the strategy and its implementation.
- All options aimed at delivering Aboriginal water rights received support from Aboriginal groups and other stakeholders.
- Stakeholders think that additional actions and better consultation are needed to meet the needs and aspirations of Aboriginal people in the region and to achieve tangible outcomes.

Town water security and water-related amenity

- There was strong support to provide long-term water security for regional towns and communities and ensure that towns have access to more than one water source ('multi-source' approach).
- Stakeholders stressed that the affordability of safe, secure and reliable water sources was important to ensure regional communities continue to thrive.
- Some stakeholders saw the need to preserve water-related amenity during dry times to support the health and wellbeing of regional communities. Stakeholders also saw the need for regular advice from government to inform local drought management planning.
- Some stakeholders think there is a need for a governance framework for the development and implementation of the regional water strategy.

Water entitlement reliability and risk management

- There is a need to better understand climate risks in the region in order to develop appropriate risk mitigation strategies and help industries prepare for future climate change.
- Existing industries have adapted to the region's variable climate, but actions are needed to attract new industries and capitalise on existing government investments in the region.
- Some stakeholders are concerned about the impact of future climate change on the reliability of their water entitlements.

Groundwater

- There was support for more research and improved knowledge to better understand the relationship between surface water and groundwater.
- Stakeholders thought that our understanding of climate impacts on groundwater sources should be enhanced.
- Stakeholders were concerned about an over-reliance on groundwater, especially in times of droughts.
- Stakeholders wanted to see more transparency around groundwater management.

Where should we focus first?

3

Image courtesy of Amanda Ind. Condobolin, NSW.

To achieve our vision of the Lachlan region, we need to support the delivery of healthy, reliable and resilient water resources that will sustain a liveable and prosperous region.

The Lachlan region lies at the geographic heart of NSW and includes stunning natural landscapes that change from mountainous terrain in the east to flat alluvial plains in the west. The region is home to many vibrant towns and communities, productive agricultural and mining industries, important ecosystems and nationally important and culturally significant wetlands, including the Lake Cowal/Wilbertroy wetlands, Booligal wetlands and the Great Cumbung Swamp.

The region is located within the traditional lands of the Nari Nari, Ngiyampaa, Wiradjuri, Barkandji, Maljangapa and Yita Yita Nations. These Nations have been caretakers of the Lachlan region for over 60,000 years.

The Lachlan region has access to surface water and good quality groundwater for towns, recreational use, cultural and environmental needs, and industry. Due to the region's highly variable climate, groundwater is an important water source for the region.

As experienced over the last 2 decades, severe droughts can be followed by significant rainfall events and flooding. These extreme events pose challenges for the region, its water resources and all water users. Like other regions across Australia, the Lachlan region will likely face a more variable and changing climate in the future. We need to prepare now for the transition to a scenario where we may have more variable and potentially less water available. We also need to set actions in motion to make smarter decisions about our water use and management armed with better knowledge and information to protect our most critical water needs.

The Lachlan Regional Water Strategy provides an opportunity to develop a long-term strategic plan so that communities, the environment and industries can be better prepared for a future changing climate. This will help keep the Lachlan an attractive place to live, work and visit.

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

- **Managing water resources during more extreme events for people, industry, and the environment.**
- **Improving water quality.**
- **Addressing barriers to Aboriginal water rights.**
- **Sustaining the health and resilience of the region's water dependent ecosystems.**
- **Supporting economic growth and diversification.**

Addressing these will help us meet the vision and objectives we have set for the regional water strategies.

Image courtesy of Destination NSW. The Grecian Rotunda, Victoria Park, Forbes.

Challenge: Managing water resources during more extreme events for people, industry, and the environment

Water management in the Lachlan is challenging due to the region's variable climate and the extensive, low-gradient river system, which is subject to high system losses. Future climate change is predicted to bring more extreme events, warmer temperatures and higher evaporation which will stress the system and give it less time to recover. This will also likely bring more variable river flows, impact groundwater recharge and influence water supplies to all water users, including towns and communities, industries and environmental water holders.

Less reliable water supplies for towns reliant on the regulated river system

During public consultation we heard about the importance that town water plays in supporting businesses and thereby the economy and prosperity of the region, as well as for the smaller towns, villages and rural residences that these centres support during droughts.

Our new climate datasets and updated modelling suggest that the region's major centres – including Cowra, Forbes and Parkes – have a reasonably secure surface water supply and a relatively low likelihood of surface water supply shortfalls[15] based on our long-term historical past climate records. Under a dry future climate scenario, our modelling indicates that the risk of surface water supply shortfall for towns and communities could increase notably[16] (Table 1).[17]

From a town water perspective, this possible future surface water supply shortfall risk needs to be monitored, in conjunction with any risks to groundwater sources.

15. In the context of the regional water strategy program, a shortfall is defined as conditions where surface water supplied is less than a water utilities' unrestricted demand.
16. The Regional Water Strategies only assesses shortfall risks to surface water supplies and does not factor in other water supply sources that towns may have access to, except in the case of Parkes. It needs to be noted that all major regional centres in the Lachlan region have access to surface water and groundwater.
17. See Attachment 1.1 for further information

Table 1. Town water surface water supply shortfall assessment

Town/Supply	Average annual shortfall (ML)	Average annual demand (ML)	Shortfall as a % of demand
Historical data			
Cowra	13.5	2,889.9	0.5
Forbes	63.5	2,238.6	2.8
Parkes	39.5	4,147.4	1.0
Condobolin	25.5	954.9	2.7
Lake Cargelligo	1.3	400.8	0.3
Long-term historical past climate			
Cowra	31.0	2,893.5	1.1
Forbes	76.8	2,257.1	3.4
Parkes	40.0	4,166.3	1.0
Condobolin	31.0	953.8	3.3
Lake Cargelligo	3.3	400.8	0.8
Dry future climate			
Cowra	422.5	2,955.1	14.3
Forbes	398.0	2,376.4	16.7
Parkes	72.3	4,288.6	1.7
Condobolin	159.5	989.7	16.1
Lake Cargelligo	52.8	400.8	13.2

Source: Department of Planning and Environment 2022

Aside from the regional water strategy surface water supply shortfall analysis, we know that towns reliant on the regulated Lachlan River can face town water security risks during severe and prolonged droughts, as conveyance water[18] requirements and transmission losses[19] along the regulated Lachlan River can become so large that it can be difficult to maintain flows along the entire length of the river system. In order to minimise losses and conserve water for essential needs closer to Wyangala Dam, management decisions can be taken in these extreme situations that may result in ceasing to supply water along the entire length of the regulated river system.[20]

18. Conveyance water is water required to operate regulated rivers and utility supply networks to enable the delivery of water
19. Transmission losses – water, from an accounting perspective, that is considered lost through surface water seeping into the ground or evaporation
20. During the Millennium Drought, flows along the regulated Lachlan River were cut off at Lake Cargelligo

In response to the region's variable climate and past extreme events, most towns and communities in the region have pursued access to more than one water source, including groundwater. It will be important that this 'multi-source' approach to town water supply is supported and strengthened at a local level. To do so, we need to better understand the impact of climate change on groundwater sources so we can ensure towns are able to access groundwater in case surface water is not available.[21] In addition, we need to evaluate the merit of expanding water reuse and recycling initiatives as well as assess the benefits for redundancy options like pipeline linkages that extend beyond local government areas and which can be called upon as drought severity increases.[22]

To further enhance town water security in the Lachlan region, we have proposed action 1.5 which seeks to support groundwater use for towns and communities, as well as proposed action 1.7, which seeks to further investigate the need to expand the regional water supply grid.

Work across local government areas

There are existing town water supply linkages in the Lachlan region that extend across local government boundaries and neighbouring catchments (Figure 5).

Water sourced from the Murrumbidgee catchment supplies the townships of Temora, West Wyalong and Young via the Goldenfields Water network. Also, Murrumbidgee Irrigation Limited supplies the small town of Goolgowi which is located in the Lachlan Regional Water Strategy area.

In the Macquarie-Castlereagh catchment, Tottenham is reliant on water sourced from the Lachlan River whilst Orange is connected to the Central Tablelands Water network via an emergency pipeline. Cobar on the other hand is located within the Lachlan catchment but draws water from the Macquarie-Castlereagh region.

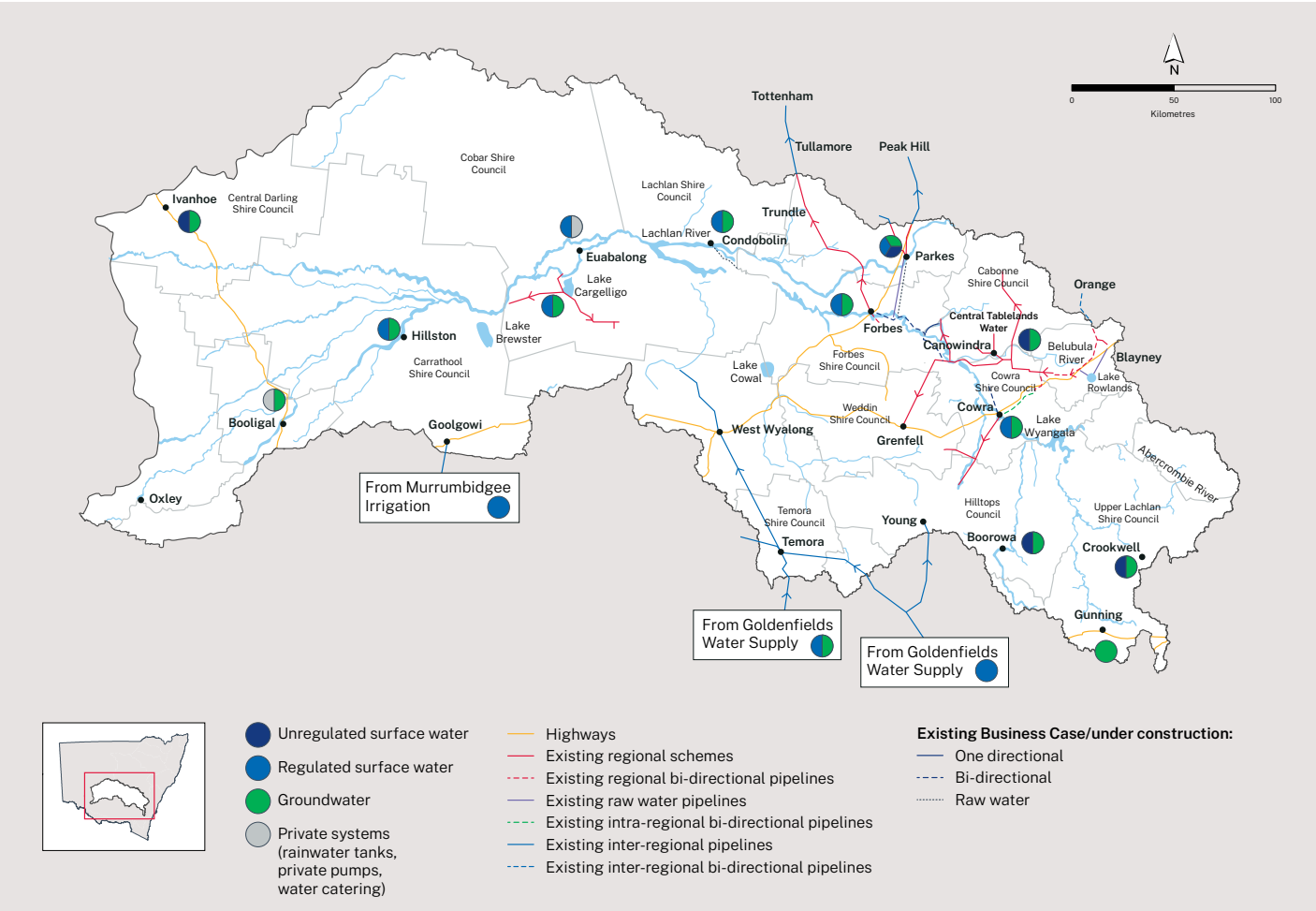
Local water utilities are constantly exploring new ways to better service their communities. In the Lachlan:

- there is a business case for a pipeline from Forbes' water treatment plant to Parkes' pump station to Gooloogong bores. This would expand the existing Central Tablelands Water network linking Parkes and Forbes to the Central Tablelands Water Supply network
- Cabonne Council, Central Tablelands Water and Orange City Council have established a working party to develop a sub-regional town water strategy. This sub-regional town water strategy is considering several pipeline connections between the Lachlan and Macquarie-Castlereagh regional water strategy areas to improve urban water security
- Central Tablelands Water is working with the Department of Planning and Environment (Water Infrastructure NSW) on the Belubula Water Security Project
- Lachlan Shire Council is progressing a Sewerage Scheme Upgrade and Hilltops Council is progressing the Boorowa Drought Security Project
- over the last 5 years, work was completed for a pipeline connecting Gooloogong and Grenfell to transfer potable water from Carcoar Water Treatment Plant to Grenfell. In addition, a pipeline between Orange Water Treatment Plant and Carcoar Water Treatment Plant was completed to enable the transfer of potable water in both directions
- a pipeline between Billimari and Cowra is currently under construction and Lachlan Shire Council is progressing work to connect a set of groundwater bores to the Condobolin's water supply system.

In order to provide ongoing support to local councils in the Lachlan region and to ensure there is an effective dialogue around water management during extreme events, we have proposed action 1.1, which seeks to establish an enduring governance framework.

21. Most major towns in the Lachlan have groundwater licences. See Attachment 1.1 for further information.
22. We have completed a preliminary assessment of direct connection to the region's major storage Wyangala dam, to access dead water storage during extreme drought emergencies. Results from the assessment are available in Attachment 1.2.

Figure 5. Existing town water pipeline network in the Lachlan region



Greater water supply risk for communities reliant on unregulated rivers and streams

Several smaller towns in the Lachlan and Belubula catchments are reliant on unregulated rivers and streams for their water supply, as are many rural properties who require water for domestic and stock needs.

- In the upper Lachlan catchment above Wyangala Dam, Boorowa, Crookwell and Gunning rely on unregulated rivers and streams – for example the Boorowa River and Hovells Creek, the Lachlan River above Reids Flat, and the Crookwell River and the Abercrombie River above Wyangala Dam.
- In the Belubula catchment, Central Tablelands Water[23] captures water in Lake Rowlands from Coombing Creek, an unregulated tributary of the Belubula River.
- In the lower Lachlan, Ivanhoe relies on an unregulated effluent creek that receives replenishment flows from the Lachlan regulated river system.

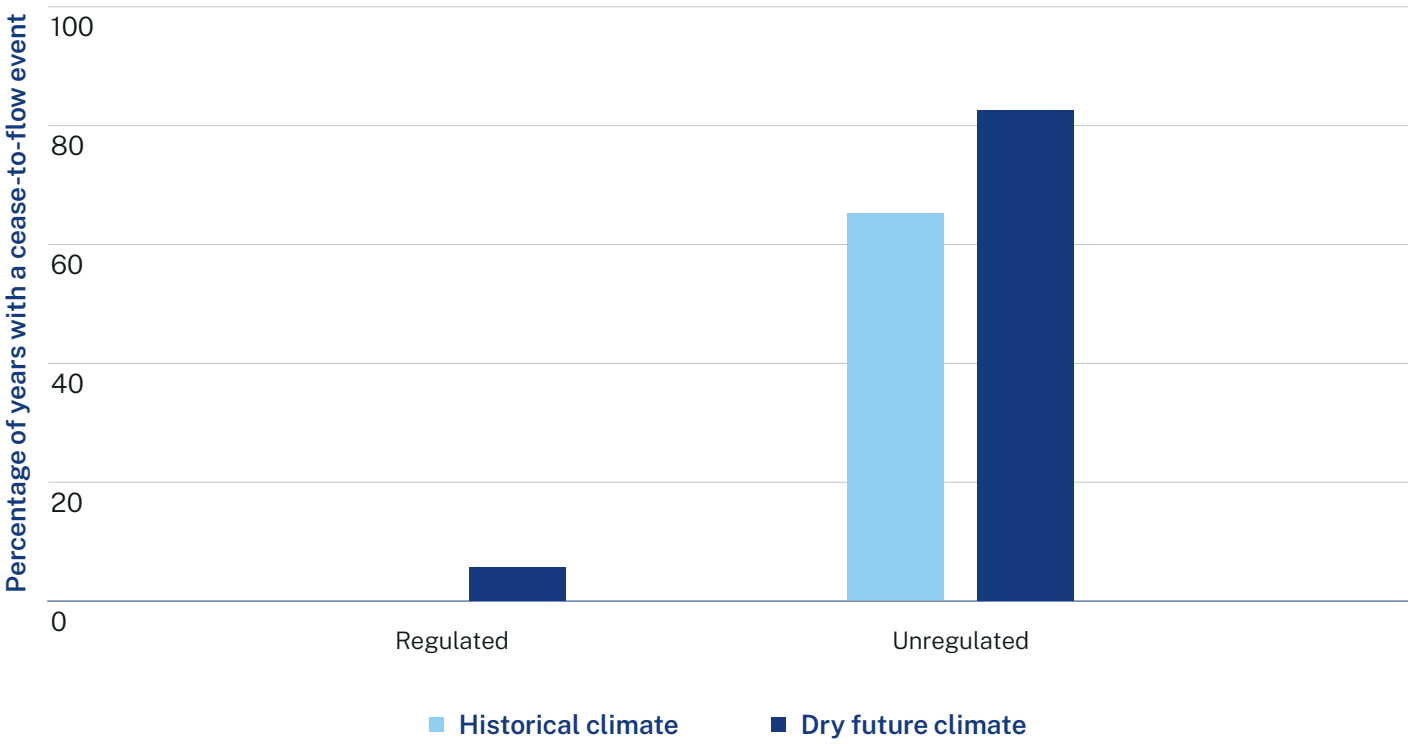
Although our capacity to utilise the new climate datasets to assess water security risks for towns and communities reliant on unregulated water sources in the Lachlan region is limited, our preliminary work suggests that these towns could be more at risk in the future due to more variable river flows and more frequent cease-to-flow events under a dry future climate change scenario.

Figure 6 outlines our preliminary modelling results for the upper Lachlan (at Boorowa Prossers Crossing) which indicates that there could be more years with cease-to-flow events in unregulated streams under a dry climate change scenario. Further modelling needs to be undertaken to verify the magnitude and frequency of flow changes at other locations along unregulated streams in the Lachlan region.

Despite the potential changes in flows and the greater likelihood of cease-to-flow events, it is important to recognise that many towns and communities that rely on these unregulated rivers and steams often have access to alternative water supplies, including groundwater, or off-stream storages that would help mitigate risks to town water supplies.

23. Central Tablelands Water supplies 14 towns and villages in Blayney, Cabonne and Weddin Council areas through an extensive water supply pipeline network that spans beyond the Belubula catchment

Figure 6. Possible impacts of climate change on cease-to-flow events in the Lachlan region



Source: Department of Planning and Environment, 2022

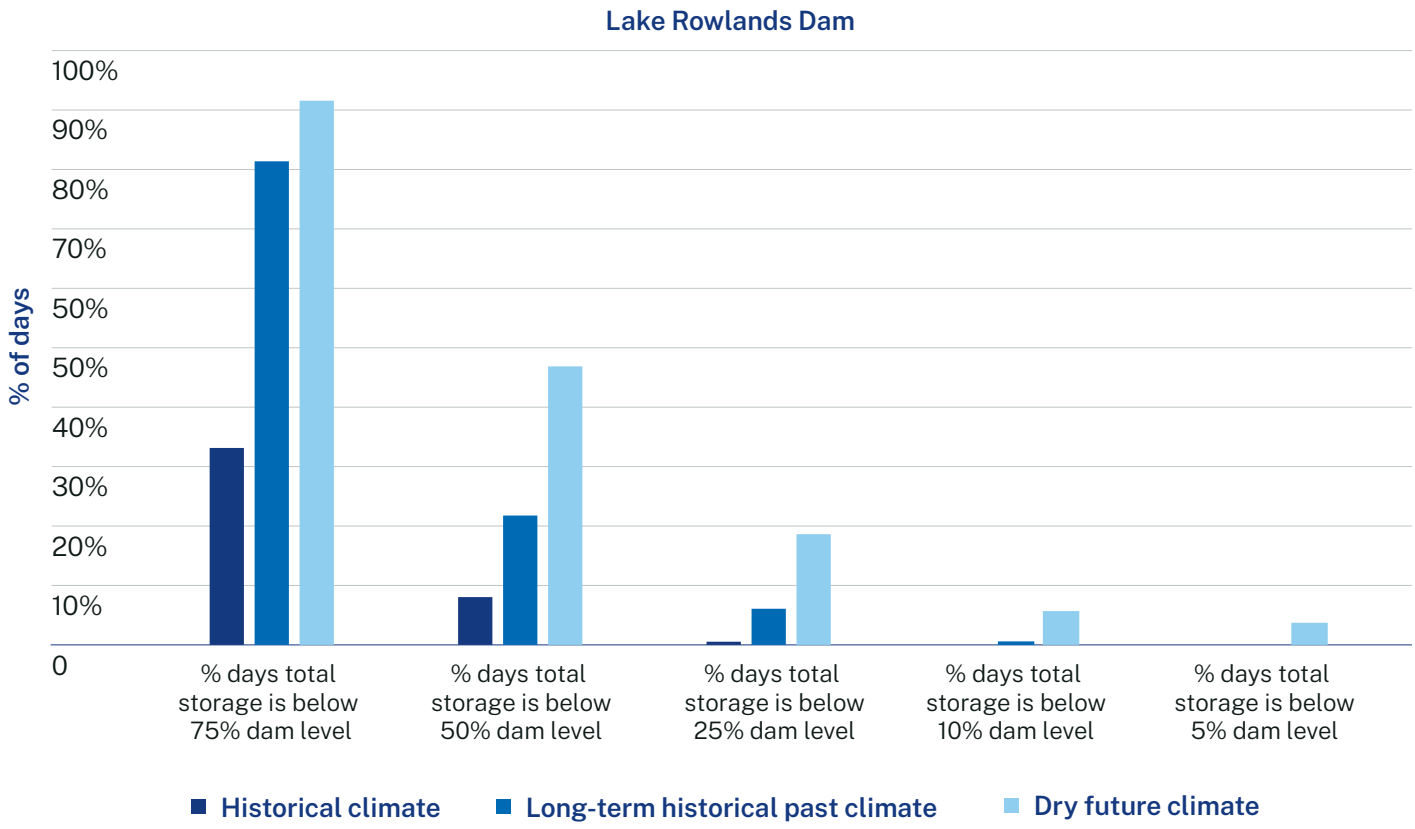
To better understand the water-related risks to towns and communities reliant on unregulated rivers and creeks, we have included proposed action 1.6 to investigate water security for small and remote communities.

Image courtesy of Kevin Roche. Lachlan River.

In the Belubula catchment, Central Tablelands Water is working with Water Infrastructure NSW to develop the Belubula Water Security Project,[24] which also includes further detailed investigations into Central Tablelands Water future town water security risks.

For the regional water strategies, we have undertaken some preliminary investigations. Our modelling suggests that towns and communities reliant on Central Tablelands Water are more likely to experience surface water supply shortfalls under all climate scenarios than towns reliant on the regulated Lachlan River (see Attachment 1.1). In particular, water security risks increase significantly under a dry future climate scenario. This is also reflected in our analysis of Lake Rowlands storage level,[25] which could be lower more frequently under a dry climate change scenario (Figure 7).[26]

Figure 7. Percentage of time Lake Rowlands storage level is below certain storage levels



Source: Department of Planning and Environment, 2022

Note: Long-term historical climate refers to climate information derived from the paleo-stochastic modelling

Note: We understand that when the Central Tablelands Water owned and operated Lake Rowlands drops below 20% capacity, deep water recovery measures need to be initiated which requires a floating pontoon and pump-set to access the volume of storage below the 20% capacity level. This is an untested emergency drought contingency measure.

24. The project seeks to improve the efficiency and resilience of water management in the Belubula valley.
25. Lake Rowlands is owned and operated by Central Tablelands Water
26. The Central Tablelands Water supply is supplemented by groundwater, mainly from the Gooloogong bores, which supplement supply to the western end of the system. Current access to groundwater is insufficient to meet Central Tablelands Water demand.

Groundwater could become less reliable

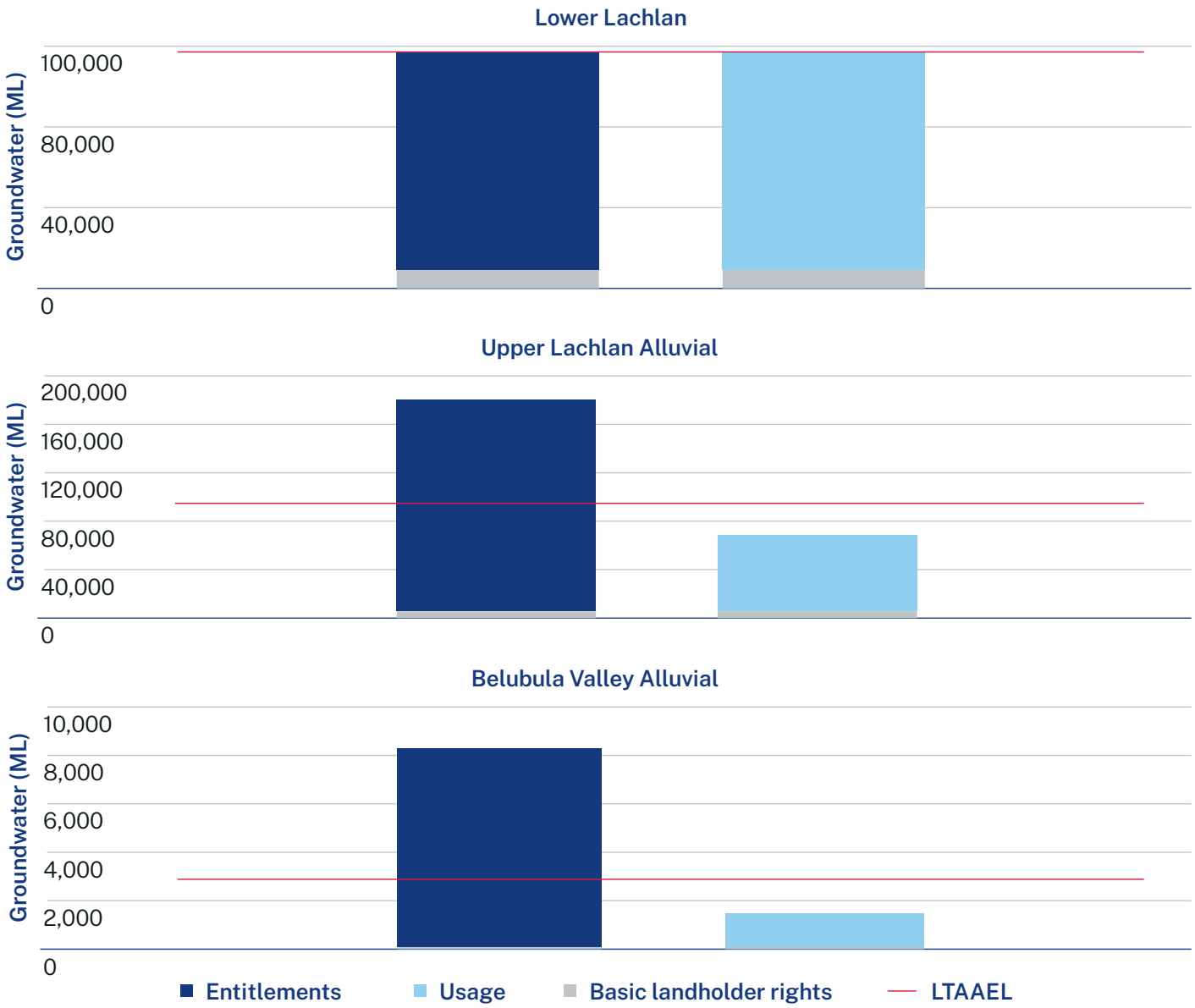
Most regional centres in the Lachlan region have access to groundwater.[27]

In contrast to the lower Lachlan groundwater source, which was part of the NSW's Achieving Sustainable Groundwater Entitlement Program, the upper Lachlan Alluvial and the Belubula Valley Alluvial continue to have a very high entitlement level compared to the Water Sharing Plan extraction limit (Figure 8).

This will create some challenges as groundwater use by existing entitlement holders could increase under a drier future climate, which could see groundwater use get closer to the extraction limit and potentially trigger actions such as reduced annual allocations. Also, a drying climate may make groundwater less reliable, as the amount of water seeping into the ground and replenishing groundwater could decrease while also pushing up groundwater demands as surface water becomes scarcer.

While town water supply licences have a higher level of priority than other groundwater licences under the *Water Management Act 2000*, decreases in the reliability of groundwater will potentially affect all classes of water access licences. Councils in particular will require more information on anticipated future demands and how groundwater is managed in the region.

Figure 8. Volume of groundwater for long-term average annual extraction limits (LTAAELs), basic landholder rights (BLR), total share component and average annual metered use from 2015 to 2020 for groundwater sources in the Lachlan region



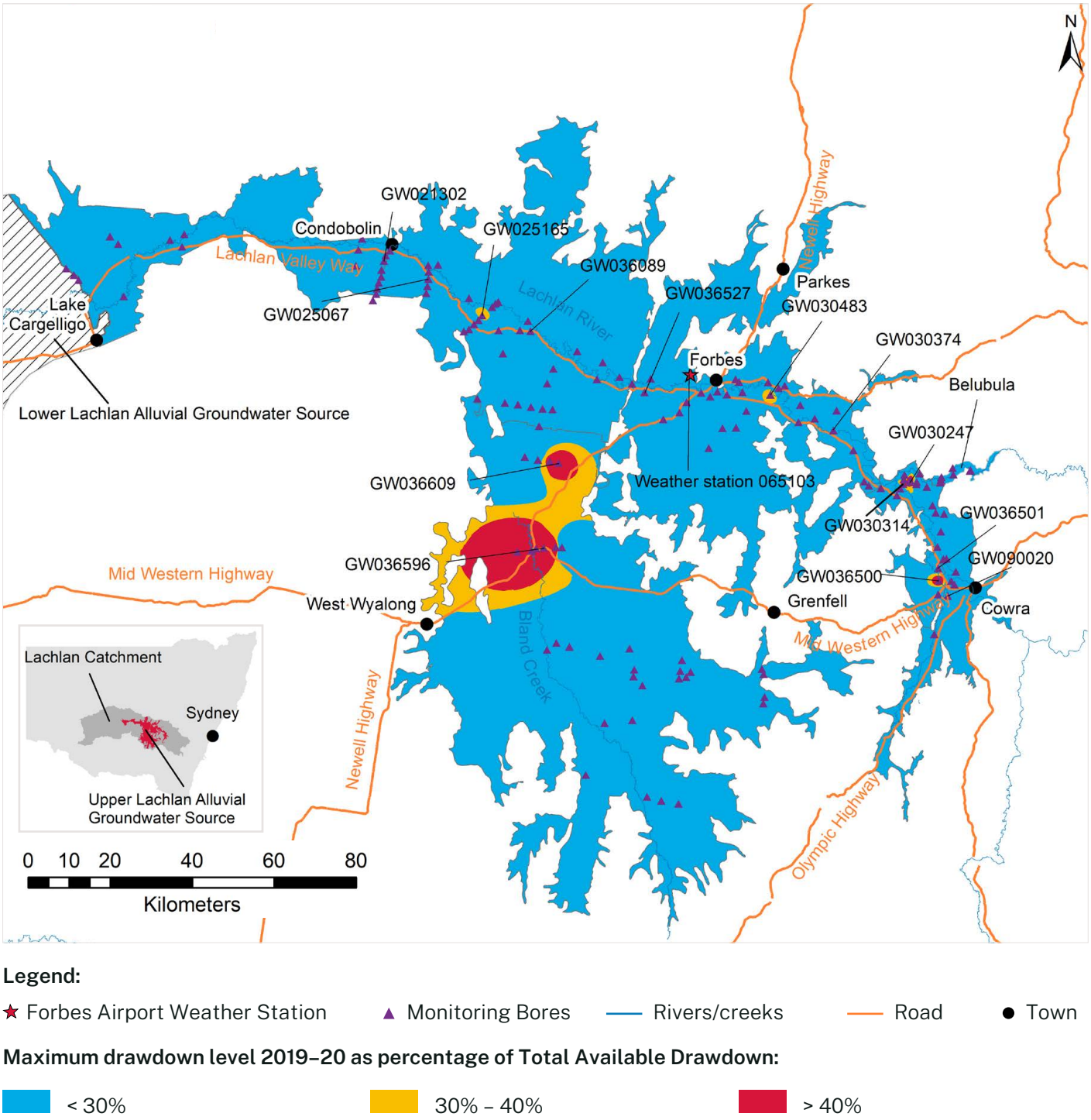
Source: Department of planning and Environment, 2022

Note: Other sources where entitlements are about the same or less than the long-term average annual extraction limits LTAAEL include: Young Granite, Lower Murrumbidgee Deep, Lower Murrumbidgee Shallow, Lachlan Fold Belt MDB, Kanmantoo Belt MDB, and the Orange Belt.

27. Cowra, Forbes, Parkes and Condobolin have access to the Upper Lachlan Groundwater Source. Hillston has access to the Lower Lachlan groundwater source.

Even though groundwater use in the upper Lachlan Alluvial and Belubula Valley Alluvial has been below the Water Sharing Plan extraction limits over the period 2015–2020, high and more concentrated use in certain years has led to a decline in groundwater levels in some areas (Figure 9).[28]

Figure 9. Maximum drawdown level during the pumping season of 2019–2020 as a percentage of total available drawdown in the Upper Lachlan Groundwater Source



Legend:

★ Forbes Airport Weather Station ▲ Monitoring Bores — Rivers/creeks — Road ● Town

Maximum drawdown level 2019–20 as percentage of Total Available Drawdown:

< 30% 30% – 40% > 40%

Note: The change in groundwater levels is expressed as a percentage of the total available drawdown (TAD) which is calculated based on the physical characterises of the groundwater system. In the Upper Lachlan Alluvial Groundwater Source, the maximum drawdown level during the pumping season should not exceed 40% of the total available drawdown.[29]

28. A temporary water restriction order has been imposed on the Upper Lachlan Alluvial Zone 1 Management Zone of the Upper Lachlan Alluvium Groundwater Source on 1 July 2021. This order has been put in place to protect groundwater levels and associated impacts on access for critical needs and groundwater dependent ecosystems. The order is set to end on 30 June 2024. Further information are available on the Department of Planning and Environment website: www.industry.nsw.gov.au/water/allocations-availability/temporary-water-restrictions/upper-lachlan-alluvial-gw-mgmt-zone-1-2021
29. Department of Planning and Environment, *Upper Lachlan Alluvial Groundwater Source – 2021 Groundwater Level Review* (December 2021), www.industry.nsw.gov.au/water/allocations-availability/managing-decline-in-groundwater-levels

Access to groundwater will become increasingly important in the context of diminishing surface water availability under a drier climate. Also, climate change and reduced surface water availability could impact groundwater recharge, which may be an issue for all groundwater users and the environment. Greater demand on groundwater sources associated with growth in population, housing and employment, may also pose a risk to future water security for towns, communities and other users reliant on these sources[30] in the Lachlan region.

The NSW Government is developing a state-wide Groundwater Strategy. In addition, we have included proposed action 4.1 to improve the understanding and management of groundwater resources in the Lachlan region so that these sources can be protected for all users and the environment.

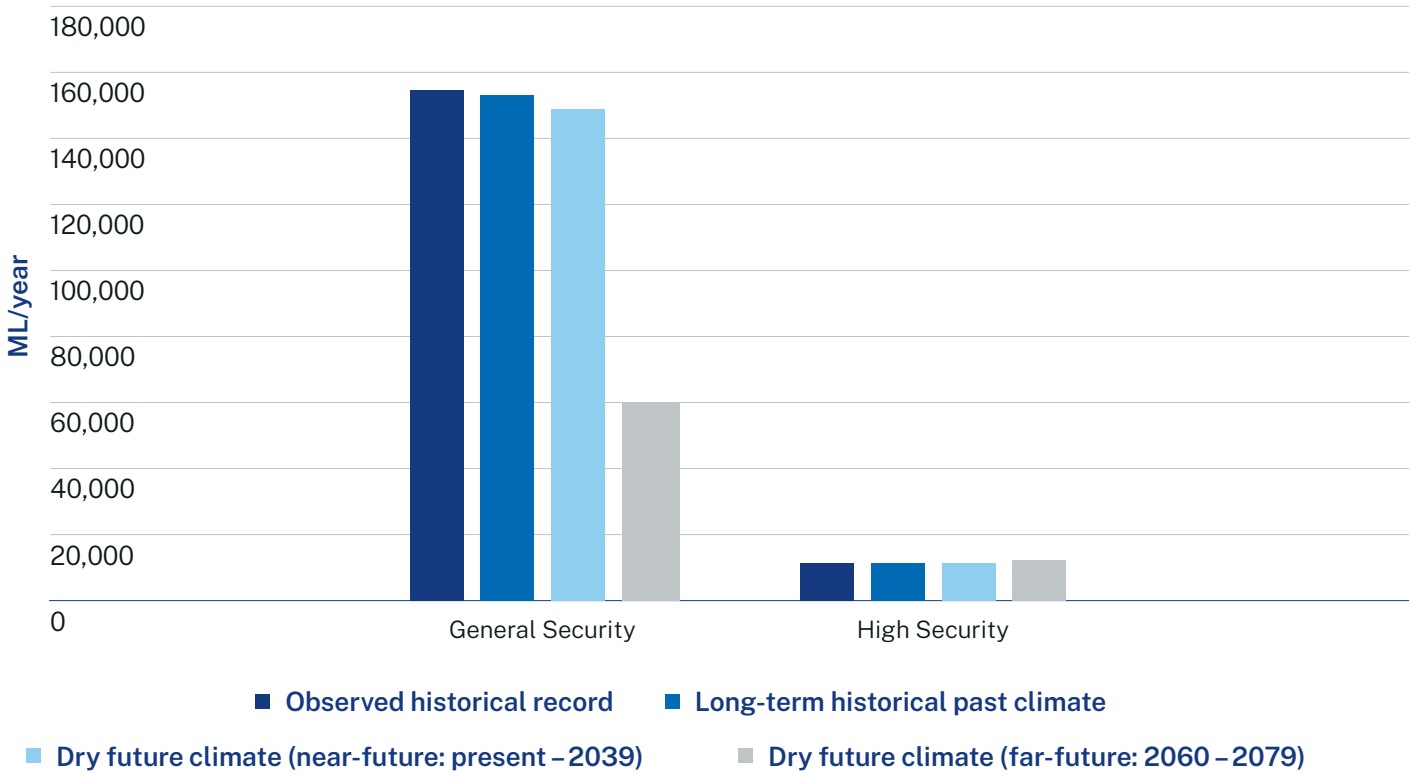
Supporting general security water access licence holders

The region's key industries and the environmental water managers rely predominately (but not exclusively) on general security water access licences to meet their water needs.

General security water access licences make up 89% of all surface water access licences in the Lachlan Regulated River Water Source and 83% in the Belubula Regulated River Water Source. These licences have a lower reliability than high security water access licences or local water utilities licences. During drought periods, general security water access licences frequently received zero or low water allocations.[31]

A variable climate and future climate change could increase the frequency and severity of extreme events and cause even greater variability in water availability to general security water access licence holders. This creates uncertainties for businesses and could impact the region's economy and the health of water dependent ecosystems. We have used our new climate datasets and updated modelling to better understand the impact of water being available to general security water access licence holders at the start of the water year (Figure 10).

Figure 10. Impact on general security water access licence holders under an 'average 122-year period' under different climate scenarios



Source: Department of Planning and Environment, 2020

30. The construction of new bores could also be a challenge for towns and communities in the Lachlan region. All new groundwater bores will be assessed against the impact on the groundwater source, the broader environment and other existing users. In broad terms, the operation of a new groundwater bore cannot result in 'greater harm' than any other water supply works approval and a new bore would need to be located in areas where water level declines are not an issue. As such, new bores may need to be located further away from existing borefields, which adds to the challenge (and additional costs) of connecting them to the town water supply system.
31. In addition, access restrictions have previously been applied to water accounts to protect water for critical needs.

In addition, we have further investigated the potential implications on future annual allocation for general security water access licence holders under different climate scenarios (see Attachment 1.3). The potential implications for general security water access licence holders need to be an ongoing focus for the Lachlan Regional Water Strategy to ensure industries and the environment can be affectively supported under a dry future climate scenario.

Water account rules provide industries with flexibility to meet their water needs

The Water Sharing Plan for the Lachlan Regulated River Water Source has some unique features that assist general security water access licence holders to meet their water needs despite the variable water supply:

- the ability to 'carry-over' allocations between years
- the provision of a 200% account limit[32]
- the potential access to other water sources, including groundwater or town water supply systems or water trade.

Despite the 200% account limit, water use is managed by way of a 'use limit', which cannot exceed 100% of the licenced entitlement in any year, regardless of how much water is held in accounts.[33] As general security entitlements are last in the hierarchy of the allocation framework, the 200% account limit allows these entitlement holders to manage their water needs over multiple years.

We have undertaken some preliminary investigations into changing the take limit to 1.1 ML/unit share to better understand whether it could provide greater flexibility to general security entitlement holders to access water in their accounts (see Attachment 1.3).

In the Belubula catchment, the water accounting rules are slightly different. The Water Sharing Plan for the Belubula Regulated River Water Source provides general security water access licence holders with a 130% account limit. Those general security water access licence holders can carry over unused water allocations up to a maximum account limit of 130%.

It could become increasingly difficult to meet environmental water requirements

The amount of licensed water and environmental water allowance that is available for use varies year by year depending on the available water determinations and how much water the environmental managers have decided to carry over from previous years. This variability is considered as part of the annual planning process and long-term strategic planning by the environmental agencies.

During dry periods, less water is available for all water users, including the environment and, in some instances, this limits the opportunities to protect critical environmental needs at the extremities of the system. In particular, it is often challenging to meet the environmental water requirements as specified by the Long-Term Water Plan[34] during extreme drought periods. Also, we may see frequent reductions – or cessation – of replenishment flows to the many effluent creeks in the lower Lachlan during these times, which impact stock and domestic users, and which can also affect environmental and Aboriginal people's cultural assets.

32. General Security accounts are split between a 'take' sub-account to hold water that can be used with a water year and a 'hold' sub-account' that enables general security entitlement holders to park water that can be used in future years. The take account cannot be more than 100% of the licenced entitlement unless take water from another licence is transferred during year. Although there is no direct limit to the volume of water that can be transferred into a general security account in any one year, the account balance cannot exceed 200% of the licenced entitlement at any time.
33. If Wyangala Dam, Lake Cargelligo, and Lake Brewster are all at full capacity, any water held in (spillable) sub-accounts is at risk of spill (both physical spills and airspace operations will result in account resets).
34. This is why the environmental water managers take a long-term strategic view of the portfolio and often rely on wet unregulated flows to build resilience into the system. The strategies deployed by the environmental water managers in the Lachlan are sophisticated and adapted to the natural boom and bust cycle of the system.

Preparing for future floods

Floods feature in the history of the Lachlan region,[35] and the intensity of heavy flood producing rainfall events could increase under climate change.[36] Given the flat landscape, many areas of the Lachlan region are subject to flood risk – either directly through road closure and damages to infrastructure or indirectly through water quality contamination. The economic costs of flooding can directly impact businesses and industries in the Lachlan region via crop losses, infrastructure losses or loss in production, or indirectly due to road closures or the need to stop operation. However, regular flooding is critical to supporting significant cultural assets on floodplains, riverine and floodplain environments, ecosystem functions, such as colonial waterbird breeding and increased connectivity, and recharging groundwater systems.

The management of large rainfall events and floods is an ongoing challenge for the Lachlan region.[37] Based on the 2014 Catchment Needs Assessment,[38] which supported the development of the 2018 NSW State Infrastructure Strategy, the Lachlan was identified as a catchment that had limited ability to capture high flow events through the region's major headwater storage. Tributary flows downstream of the region's major headwater storages are also often a major contributor to flooding in the region.

There are existing floodplain management plans in the Lachlan region[39] that identify a floodway network to convey floodwaters away from properties and infrastructure, while also supporting the floodplain environment.[40] A review of the 3 floodplain management plans in the Lachlan region has been completed and further work is underway to improve floodplain management in the catchment.

We have proposed action 4.2 to support the update of the southern inland floodplain management plans and audit the infrastructure within the Great Cumbung Swamp and Booligal wetlands.

Regional Water Strategy modelling and flood analysis

NSW's hydrological models have been developed to understand long-term inflows into rivers and extractions from rivers. Although the hydrologic modelling undertaken for the regional water strategies provides some information on the possible changes to the frequencies of floods, the models are not specifically designed for flood analysis, as hydraulic flood models require a detailed understanding of the shape of the floodplain and work on shorter timesteps than the hydrologic models.[41] The regional water strategies have deliberately modelled a dry climate change scenario to stress-test the system. Under a wetter climate change scenario, the projections could look different and would need to be investigated further.

35. Over the last 122 years of observed records, the Lachlan region has experienced several major floods, notably in 1952, 1990, 2012 and 2016. Extensive rainfall across NSW in 2021 has also led to minor to moderate flood levels in the Lachlan.
36. This may not translate to increased runoff and larger floods, due to the likelihood of drier soils and catchment conditions
37. There are several regional centres in the Lachlan region which are at risk of flooding during major rainfall events, including Forbes.
38. State Infrastructure Strategy 2018 accessed at www.infrastructure.nsw.gov.au/media/1096/inf_j14_871_sis_report_ch06_web.pdf This analysis was based on the capacity of major dams to provide flood mitigations in the last 100 years with current asset conditions.
39. Three separate floodplain management plans have been developed for 3 zones within the region: Gooloogong to Jemalong Gap, between Jemalong Gap and Condobolin floodplain, and between Lake Brewster and Whealbah (Hillston).
40. The Natural Resources Commission audited the implementation of floodplain management plans for the Lachlan, Murrumbidgee and Murray and the results are available at www.nrc.nsw.gov.au/wsp-audits
41. The development of hydraulic models will be important for progressing the work on new floodplain management plans in the Lachlan region.

2022 NSW Flood Inquiry

In responses to the widespread floods in 2021 and 2022, the NSW Government commissioned an independent expert inquiry into the preparation for, causes of, response to and recovery from the 2022 flood events in NSW.[42] The final inquiry report was published in August 2022 and included 28 recommendations. The NSW Government supported all 28 recommendations, either in full or in principle.

Several of the report's recommendations and the NSW Government's response are of relevance for the Lachlan Regional Water Strategy, including (but not limited to):

- The NSW Government supports (in principle) building more accurate and complete data for flood threat identification, warning and modelling system (recommendation 1)
- The NSW Government supports (in principle) building on its existing initiatives around climate and weather research to identify opportunities to build and align disaster research and technology development (recommendation 2)
- The NSW Government supports (in principle) strengthening the delivery of evidence based, targeted education campaigns aimed at building disaster resilience (recommendation 14)
- The NSW Government supports (in principle) further essential service infrastructure development above the flood planning level, where appropriate. Consideration will be given to how to encourage private sector essential infrastructure developers take the same approach (recommendation 28).

Image courtesy of Amanda Ind. Hillston, NSW.

42. NSW Government 2022, NSW Flood Inquiry, www.nsw.gov.au/nsw-government/projects-and-initiatives/floodinquiry

Challenge: Improving water quality

Poor water quality has a direct impact on the health, wellbeing and resilience of all water users and is a prevalent risk in the Lachlan region.

Ecological health is reliant on good water quality

A variety of water quality problems exist in the Lachlan region, which can lead to poor ecological health. Dissolved oxygen can be depleted during hypoxic black water events and harmful algal blooms – often caused by excessive nutrients – can lead to the death of aquatic plants and animals. Unseasonal temperatures can also directly contribute to fish deaths and high turbidity can reduce the light penetrating of the water column and stress benthic plants. Salinity (both dryland and instream) can impact on vegetation leading to erosion and high turbidity as well as increase salt loads beyond the tolerance level of some native plants and animals. Existing water infrastructure can also cause cold water pollution impacts which can reduce the range and abundance of native fish.

In the Lachlan the key water quality problems include:

- high turbidity linked to sediment transfer from areas including Hovells Creek, upper Lachlan River, Back Creek and Bland Creek and the slopes surrounding the Boorowa River.[43] In addition to land use changes, invasive species like carp can contribute to increased turbidity.[44] Sediment transfer from bank slumping and increasingly eroded areas has caused a build-up of sediment in creek, riverbeds,[45] crossings and drains[46] in some parts of the catchment including 150 km sediment slug between Wyangala and Forbes[47]
- excessive nutrients – nitrogen and phosphorous – linked to sediment transfer and polluted runoff from agricultural fertilisers and waste. Excessive nutrients in waterways can lead to harmful algal blooms.[48] Land clearing and access by stock to waterways can also lead to degradation of riparian zones, increasing riverbank erosion, sediment transport and nutrient input. These impacts affect ecological health by reducing the ability of the landscape to filter pollutants from overland runoff and decrease water quality
- harmful algal blooms occurring in Wyangala and Carcoar dams and in Lake Cargelligo and Lake Brewster, with potentially toxic cyanobacteria numbers reaching the red alert level for recreational use[49] and requiring significant cost to treat at water treatment plants. Potentially toxic cyanobacterial blooms can also quarantine water in storages such as Lake Brewster making it unavailable for consumptive or environmental use. However, mitigation measures can be effective, including circulating water through the Brewster system and filtering via the outflow wetlands
- blackwater events occur naturally in all river systems when organic matter on the floodplain is washed into the river during floods. A reduction in magnitude and timing of floodplain inundations and overbank events in the Lachlan region can lead to a prolonged build-up of organic matter on the floodplain. When there is eventually an overbank flow this organic load can cause hypoxic blackwater events that are more likely to lead to sustained low dissolved oxygen, changes to pH and sometimes result in localised death of aquatic organisms[50]

43. Department of Planning, Industry and Environment, *Lachlan Long Term Water Plan Part A*
44. Koehn, J.D 2004, Carp (Cyprinus carpio) as a powerful invader in Australian waterways, *Freshwater Biology* 57: pp 882-894.
45. Lachlan Council has recently cleared a 3-meter-deep sand slug from the low-level road crossing across the Lachlan River at Bevandale, above Wyangala.
46. In 2019 the Hilltops Council spent weeks removing many truckloads of sand, silt and organic debris from creek crossings and table drains along the Hovells Creek valley.
47. Identified by NSW Fisheries for Central Tablelands Local Lands Services in 2020
48. WaterNSW, Algae Prevention and Control, accessed at www.waternsw.com.au/water-quality/algae/prevention-and-control
49. WaterNSW, Algae Alerts, accessed at www.waternsw.com.au/water-quality/algae
50. www.waterquality.gov.au/issues/blackwater-events

- dryland salinity and instream salt loads are an issue in the Lachlan region.[51] For example, the mid Lachlan, the upper Lachlan and Belubula rivers contribute significantly to salinity[52] and should be a target for land management intervention, particularly grazing and soil rehabilitation. Alluvial aquifers adjoining the rivers in these areas need to be managed in association with the rivers; as groundwater salinity levels may affect ecosystems, town water supplies and productive users.

We have proposed action 2.1 which aims to improve long-term water quality by addressing salinity and erosion in the upper Lachlan and Belubula catchments.

Good water quality supports reliable and affordable drinking water

Local water utilities are required to treat water to a minimum standard for drinking, based on the water quality targets in the Australian Drinking Water Guidelines 2011. The occurrence of severe water quality events in the catchment can result in significant treatment costs to local water utilities in order meet these targets.

Despite past investments, some water treatment infrastructure in the Lachlan region may be unable to cope with future water quality incidents. Also, many Aboriginal communities live in more remote locations in the Lachlan region, and some do not have access to a secure potable drinking water supply.[53] With a possible drier future climate and increased pressure on existing water sources, communities that are at a significant distance from the regulated river will face extra costs in obtaining and maintaining supply security.

In order to provide ongoing support to local councils in the Lachlan region and ensure there is an effective dialogue on key water management issues concerning local governments, we have proposed action 1.1.

Impacts of mines on water quality

During the first public exhibition of the Draft Lachlan Regional Water Strategy, we heard concerns about potential water quality impacts from existing and proposed mining operations.

Mining proposals are subject to the NSW Development Assessment process. Under the *Environmental Planning & Assessment Act 1979,* development that is important to the State for economic, environmental or social reasons can be classified as a State significant development or State significant infrastructure. This development requires the approval of the Minister for Planning or Independent Planning Commission before it may proceed.

Mining operations are regulated in NSW[54] to ensure minimum impacts to land, waterways and aquifers. For example, new and expanding mines are required to have surface water management plans and groundwater management plans for the construction and operation phases and these are developed in collaboration with the Department of Planning and Environment.

In the Belubula catchment, new water quality monitoring sites have recently been added to existing sites to give a better understanding of the mine area and provide an early warning mechanism should any water quality issues emerge.[55]

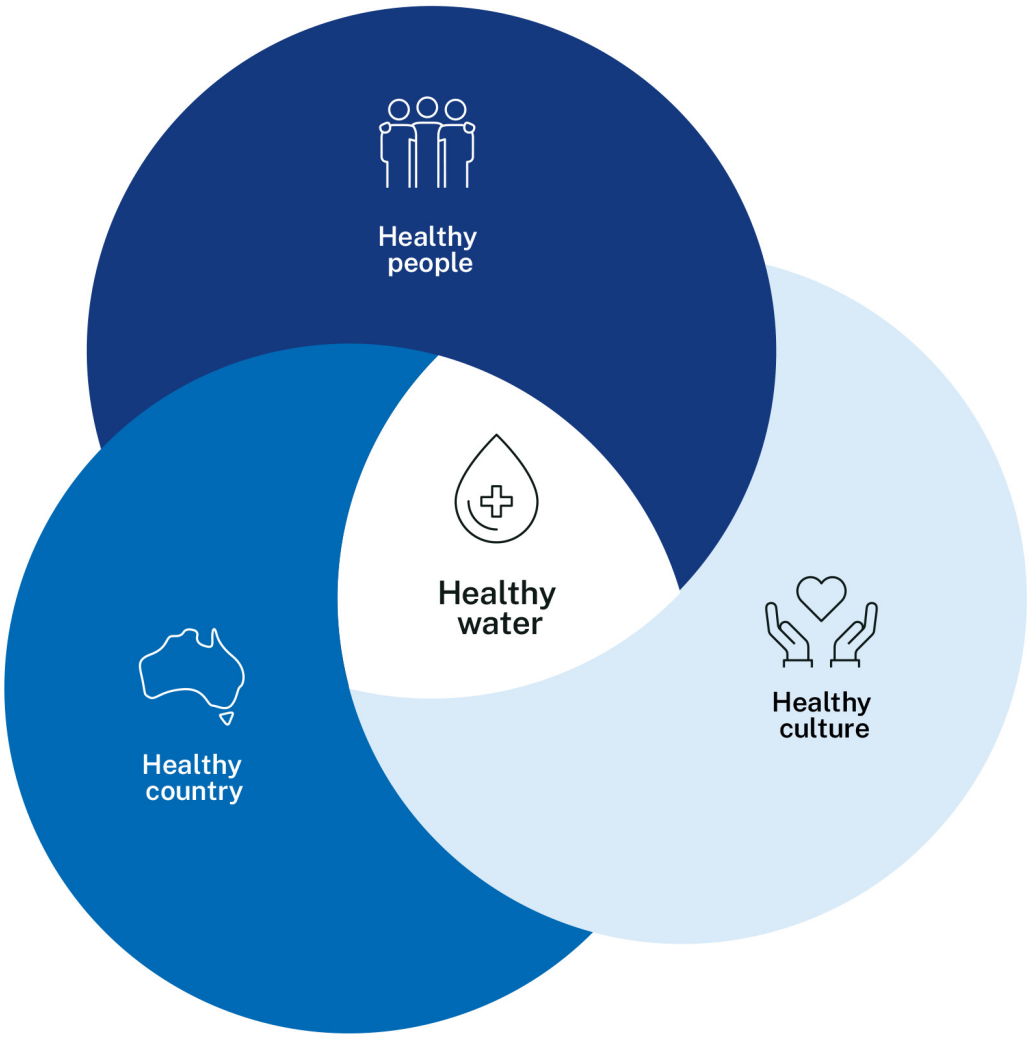
Acknowledging that mining can have serious impact on water sources and water quality if sites are not properly designed and managed, it will be important to plan and work together with the industry to develop appropriate risk management plans to address future extreme events associated with climate change.[56]

51. There is high electrical conductivity from the mid Lachlan catchments of Hovells Creek, Boorowa River, Crowther Creek, Waugoola Creek and Mandagery Creek. The upper Lachlan has significant sediment delivery in addition to salinity. The Belubula River system also delivers high salinity from a very small part of the landscape.
52. Despite a water quality allowance codified in the Water Sharing Plan for the Lachlan regulated river, salinity in the parts of the Lachlan region – such as Forbes and Cowra – can often be very high.
53. The Department of Planning and Environment is seeking to address these risks through the Aboriginal Communities Water and Sewerage Program, learn more at www.industry.nsw.gov.au/water/plans-programs/infrastructure-programs/aboriginal-communities
54. Department of Regional NSW, *Mining, Exploration and Geoscience Compliance and Reporting*, at www.regional.nsw.gov.au/meg/exploring-and-mining/compliance-and-reporting
55. mcphillamysgold.com/the-project/fact-sheets/
56. www.australianmining.com.au/features/implications-of-climate-change-on-mine-water-quality/

Healthy waterways are critical for connection to Country

Aboriginal people rely on the good water quality of waterways for their health, wellbeing and continued practice of cultural traditions (Figure 11).

Figure 11. Australian Aboriginal people's view of the relationship between water, environment, culture and people



Source: Adapted from Moggridge, B. 2010. Aboriginal Water Knowledge & Connections, in: *Water and its Interdependencies in the Australian Economy*, 22 to 23 June 2010, Australian Academy of Technological Sciences and Engineering, Sydney

If important cultural sites dry up or are impacted by ongoing poor water quality, the traditional story or the meaning of a particular cultural site can be severely impacted or lost forever.

Over the last 200 years and with increased development around Lachlan waterways, there has been a decline in water quality at many sites. Of the 11 monitoring sites along the length of the Lachlan catchment, 8 are rated as fair or poor, and recent water quality data indicates that turbidity and nutrient levels are often too high and risk exceeding water quality targets.[57]

We have proposed action 2.2 to protect and rehabilitate riparian vegetation and instream habitats, which seeks to improve water quality in the regulated Lachlan River over the long-term and could assist in better protecting important cultural sites in the region.

57. Department Planning, Industry and Environment 2020, Water quality technical report for the Lachlan surface water resource plan area (SW10).

Challenge: Addressing barriers to Aboriginal water rights

'If the water is healthy, Country is healthy. If Country is healthy then the People and Culture will be healthy.'

Increasing Aboriginal representation in water management decisions

In the past, water management decisions in the Lachlan region have not been comprehensively informed by Aboriginal people's history, knowledge and experiences, which are based on many thousands of years of living on Country. Although Aboriginal people's knowledge is increasingly being recognised as an essential element of water management, there are still limited opportunities for Aboriginal people to participate in water decision-making or to undertake co-management activities.

Involving Aboriginal people more closely in the decision-making process around water management could enrich and improve our water-management decisions and in turn provide employment and economic advancement opportunities for Aboriginal people, including youth. Genuine involvement based on the principles of free, prior, and informed consent is essential to incorporate traditional knowledge and expertise into strategic water planning, whilst respecting the rights of Aboriginal people.

We have proposed action 1.3, which would support existing and new Aboriginal groups to develop an Aboriginal Water Advisory Committee in the Lachlan region and we have also proposed action 3.4, which seeks to support business development and employment opportunities for Aboriginal people in the Lachlan region, such as river rangers and cultural water officers.

Image courtesy of Destination NSW. Aboriginal murals painted by indigenous artist Kym Freeman, Cowra.

Improving Aboriginal access to water and Country

Access to waterways is critical to provide a purpose and pathway for young people. Waterways are used for the passing on of traditional knowledge through storytelling on Country and provide a space for healing, as well as for food, medicine and teaching.

Noting the importance of access to water and country, there are opportunities to build on existing community lead programs such as 'Down the track'. This program organises yearly Aboriginal youth camps on Robinson Crusoe Island at Lake Cargelligo and focuses on teaching about the environment including bird surveys, water quality and fish. Programs like these provide young Aboriginal people opportunities to explore different pathways around water and water management that exist in the local community.

We have included proposed action 1.4, which seeks to support Aboriginal organisations and communities to develop more tailored projects for their communities related to water and access to Country.

Reducing barriers to Aboriginal water ownership

Aboriginal people have raised concerns that water management in NSW is largely seen as an allocation problem between agriculture, towns and the environment. This allocation distribution overlooks the interest, perspectives, knowledge and rights of Aboriginal people and their cultural obligation to Country.[58]

While there are ways of accessing water for cultural purposes, we heard from Aboriginal people that the current provisions in the *Water Management Act 2000* are not meeting their spiritual, cultural, social and economic needs. For example, Aboriginal people can apply for individual Aboriginal cultural water access licences, but these licences can only be used for a limited range of purpose and not economic gain.[59]

The licensing framework and costs associated with purchasing water on the market create significant barriers for Aboriginal people to buy and own water entitlements. Associated costs of also purchasing and maintaining water related infrastructure, like pumps and pipes, makes it prohibitively expensive. Ownership of water entitlements by Aboriginal people or communities remains small, despite government commitments to set aside funding to help Aboriginal communities to invest in water entitlements.

This lack of ownership provides a significant obstacle to Aboriginal people having a voice in water management decisions and advancing the economic and social needs of Aboriginal people.

To address the lack of ownership of water entitlements and the complexity of applying for Aboriginal cultural water licences, the NSW Government is progressing the Aboriginal Water Strategy.

58. Jackson, S., Woods, R. and Hooper, F 2021, Empowering First Nations in the governance and management of the Murray–Darling Basin, In Murray–Darling Basin, Australia, pp. 313-338, Elsevier.
59. Licenses may be granted for personal, domestic or communal Aboriginal cultural activities conducted by an Aboriginal person or community; including drinking, food preparation, washing, manufacturing traditional artefacts, watering domestic gardens, cultural teaching, hunting, fishing, gathering and for recreational, cultural and ceremonial purposes.

Challenge: Sustaining the health and resilience of the region's water dependent ecosystems

The river system, floodplains, swamps, aquifers and wetlands in the Lachlan provide habitat for many aquatic species, including birds and native fish. The lower Lachlan floodplain is home to 8 nationally important wetlands, which feature areas of valuable river red gum forest and woodlands, blackbox woodland and lignum. Our challenge is to sustain the health and resilience of these natural assets and ecosystems now and into the future.

Minimising the impacts of altered flows will be critical to protect and enhance water dependent ecosystems

Water infrastructure, river regulation and water extraction have influenced flow variability, water quality and the distribution of water throughout the catchment. For example, headwater and re-regulating storages[60] have resulted in a decline in medium and high flow frequencies and low flow patterns have become more common due to releases for consumptive use and end of system target flows (as shown in Figure 12).[61]

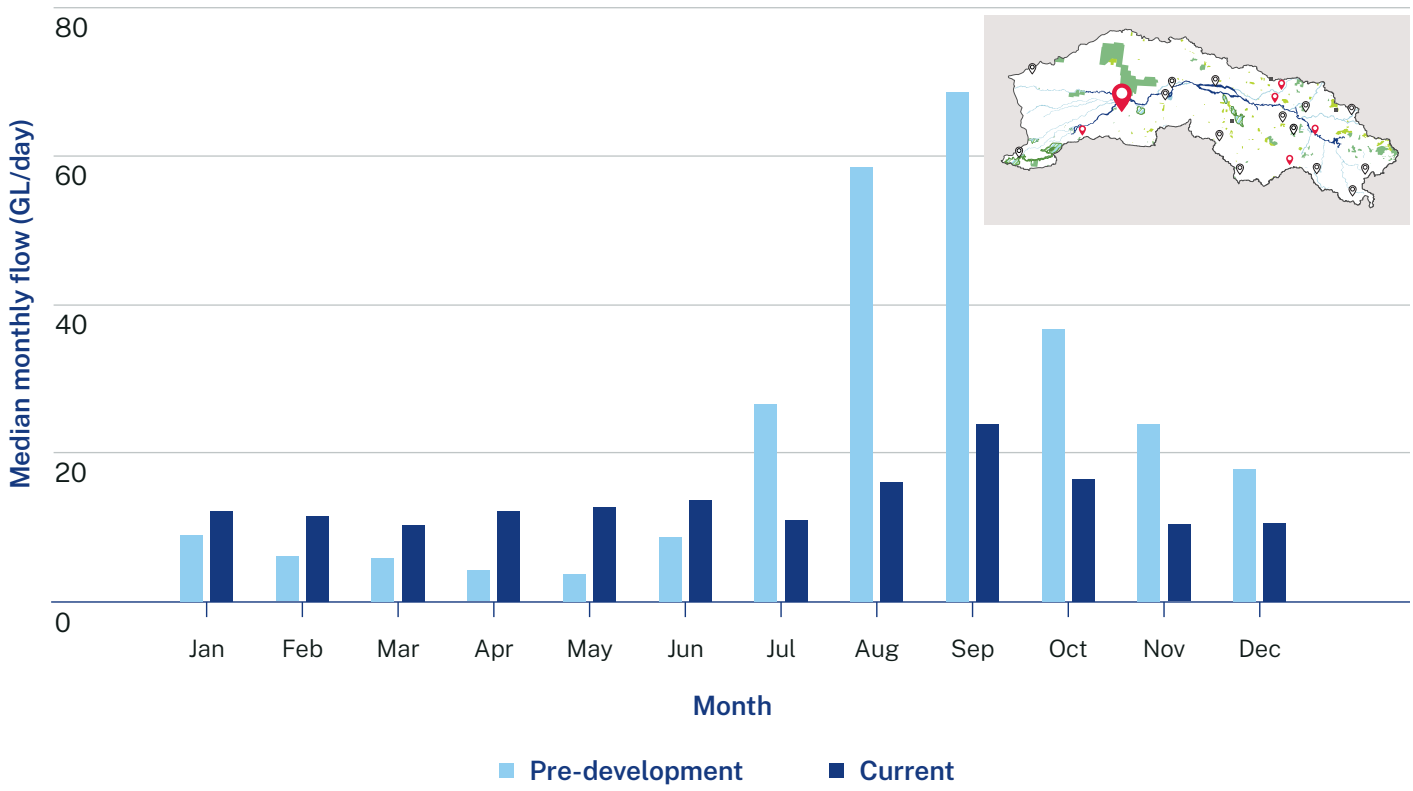
In addition, modelling comparing pre-development and current conditions, suggest that there has been a sizable loss in the natural flow variability, reduced inundation of wetlands[62] and decreased flows at Booligal (Figure 13). While these findings are based on modelled datasets, it suggests that more could be done to improve lateral connecting flows to meet the environmental water requirements – as outlined in the Lachlan Long Term Water Plan – without the intention to return to pre-development conditions.

Improving lateral connectivity would support water quality, system-scale productivity and drought refugia[63] and facilitate the movement of aquatic fauna from stressed state to more moderate conditions.

We have proposed action 2.3 to upgrade and automate existing public re-regulating structures in the mid- and lower Lachlan to build functional resilience of critical ecosystems

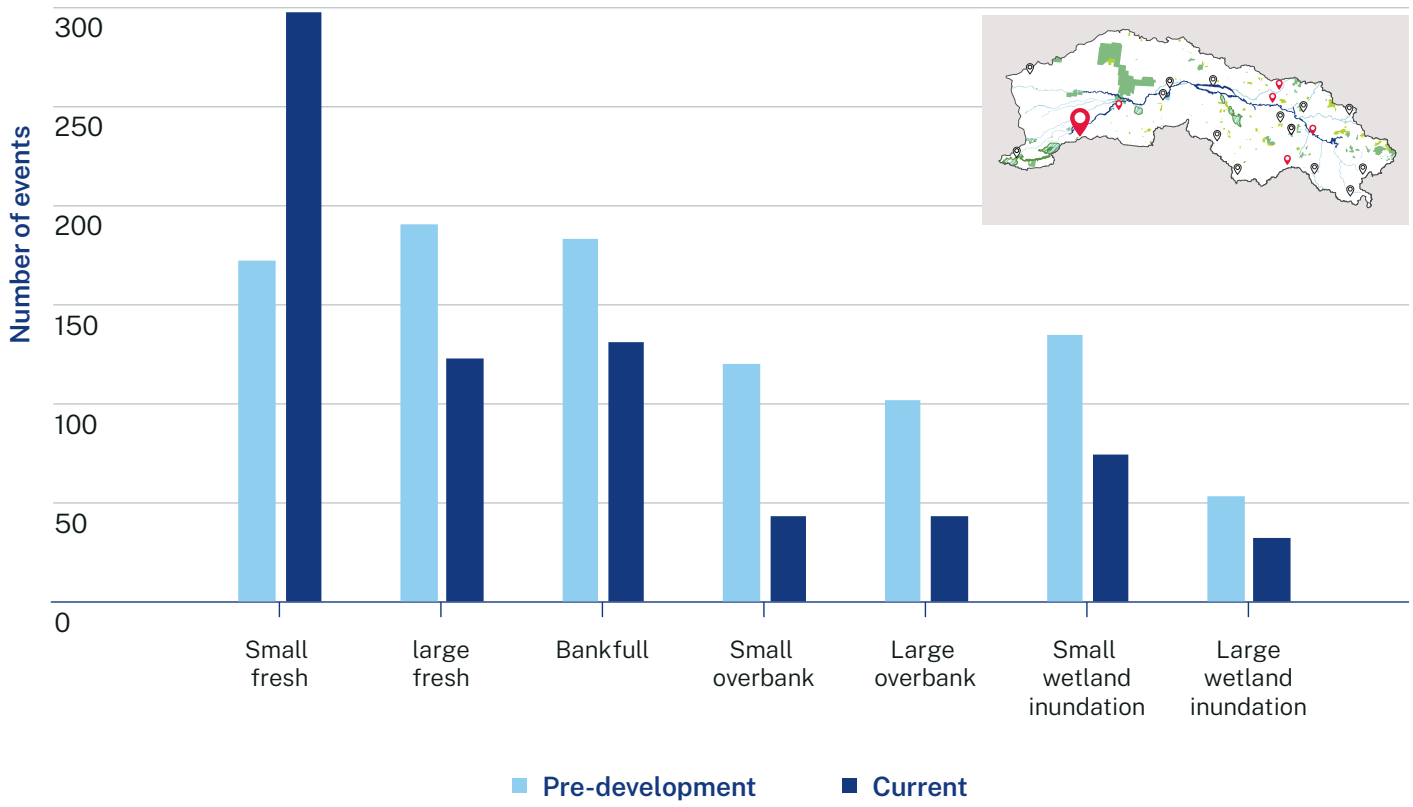
60. Including the main storages of Wyangala Dam and Carcoar Dam, as well as Lake Rowlands and the re-regulating storages – e.g. Lake Brewster and Lake Cargelligo – and several weirs and regulators. Larger flows can also be subject to re-regulation at Lake Brewster and to a lesser extent at Lake Cargelligo.
61. *Lachlan Long Term Water Plan*, and Hillman and Brierley, 2002
62. Wetland inundations at the Booligal gauge (412005) is defined at a flow rate above 650 ML/day for longer than 30 days (small) and a flow rate above 1,200 ML/day for longer than 60 days (large) as outlined in the *Lachlan Long Term Water Plan*.
63. Drought refugia is habitats or environmental factors that give spatial and temporal resistance and resilience to biotic communities impacted by drought.

Figure 12. Modelled median monthly flow rate at Hillston under current conditions and under 'pre-development' conditions



Source: Department of Planning and Environment, 2022

Figure 13. Modelled number of different flow events at Booligal under current conditions and under a 'pre- development' condition



Source: Department of Planning and Environment, 2022

Changes to the natural flow regime are not only impacting the environment but are also influencing Aboriginal social and cultural outcomes. Aboriginal people have called for the introduction of 'cultural flows', which are currently not explicitly provided for in the *Water Management Act 2000* or in the region's relevant water sharing plans.

The Echuca Declaration[64] describes cultural flows which could assist in returning river systems to a more natural flow regime. Under the Echuca Declaration, 'cultural flows' would encompass a broader range of water-related aspirations for Aboriginal people.

Environmental water managers have already made progress towards achieving cultural and ecological co-benefits such as delivery of water for the environment to improve the health of Booberoi Creek in partnership with the Ngiyampaa Nation. In the context of a variable and changing climate, more work[65] and partnerships like these are needed to ensure the spiritual, cultural, social and economic needs of Aboriginal people can be better met in the Lachlan region.

Flows in the Belubula system

In addition to regulated releases from storages, flow variability is introduced to the regulated Lachlan system due to the frequency of dam spilling events and contribution from downstream tributaries, such as the Mandagery, Goobang and Gunningbland creeks.

Carcoar Dam rarely spills[66] and flows into the regulated Belubula River generally occur downstream of Carcoar Dam from unregulated streams such as Coombing Creek. Unregulated flows have environmental and downstream user benefits and help to keep the natural variability of flow in the Belubula River. However, protecting unregulated flows downstream of Carcoar Dam and Lake Rowlands[67] can be challenging and existing infrastructure business cases[68] could have additional impacts on flow variability in the Belubula River, which need to be further investigated.

In addition, high groundwater connectivity in the lower reaches of the Belubula River has a significant influence on river flows and on the connectivity between the Belubula River and the Lachlan River. During the most recent drought, the Water Sharing Plan for the Belubula Regulated River Water Source 2012 was suspended in July 2019, as the end of system flow requirements in the Belubula could not be met.[69] During the development of the new Water Sharing Plan alternative rules for the end of system flows will be investigated.

The Natural Resources Commission is completing a statutory review of the Water Sharing Plan for the Belubula Regulated River Water Source 2012. This review will help identify opportunities to improve water sharing provisions and associated outcomes.

64. Under the 2007 Echuca Declaration, cultural flows are defined as 'water entitlements that are legally beneficially owned by the Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, natural, environmental, social and economic conditions of those Nations'.
65. The national cultural flows research project is working to secure a future where First Nations' water allocations are embedded within Australia's water planning and management regimes, to deliver cultural, spiritual and social benefits as well as environmental and economic benefits, to Aboriginal communities in the Murray–Darling Basin and beyond. See culturalflows.com.au/
66. In contrast to Carcoar Dam, Central Tablelands Water's owned and operated Lake Rowlands has spilled on several occasions over the recent wet period. These spills are being considered as part of the *Belubula Water Security Project*.
67. Department of Planning, Industry and Environment, *Lachlan Long Term Water Plan Part B: Lachlan planning units*
68. Department of Planning and Environment, *Belubula Water Security Project*, www.dpie.nsw.gov.au/water/water-infrastructure-nsw/regional-projects/belubula-water-security-project
69. Department of Planning and Environment, *Suspension to Water Sharing Plan for the Belubula Regulated Rivers Water Sources 2012*, www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/suspensions/expired-or-repealed/belubula-regulated-rivers; Department of Planning and Environment, *Audit of the Water Sharing Plan for the Belubula Regulated River Water Source 2012*, www.industry.nsw.gov.au/__data/assets/pdf_file/0009/289476/Belubula-Regulated-River-Water-Sources-2012.pdf

Improving the resilience of the region's nationally significant wetlands

Floodplain wetlands[70] in the Lachlan region remain in a good, although stressed, condition. They are nationally important feeding and breeding habitats for a range of water birds and other animals and support a wide range of vegetation communities. They are vulnerable to changes in natural flow regimes and prolonged dry periods. For example, the Booligal wetlands with its small isolated wetland areas of river red gums and a larger area of lignum shrubland, experienced a significant decline in conditions during the Millennium Drought. However, these assets also recovered with the help of water for the environment and by wetter conditions that followed this prolonged drought period. The most significant loss of ecological structures and functions has occurred at the lower end of these systems (e.g. Merrowie Creek below Cuba Dam, Merrimajeel Creek below Murrumbidgil and Willandra Creek.

In addition, the effect of man-made structures (dams and weirs) has reduced the number of connectivity events for some floodplain habitats[71] in the Lachlan region by up to 60%.[72] A reduction in connectivity can have serious consequences for some birds,[73] water dependent species and there are also implications for deep and shallow groundwater resources, which sustain riparian and floodplain vegetation ecosystems.

To improve the resilience of the region's significant wetlands, we have proposed action 2.3, which will seek to upgrade and automate existing public re-regulating structures in the mid- and lower Lachlan to build functional resilience of critical ecosystems. We have also proposed action 2.5, which will review and evaluate the Lake Brewster Water Efficiency Project.

Protecting the region's threatened or endangered fish

The Lachlan and Belubula waterways (including their floodplains) support a variety of native fish with several being listed as threatened or endangered in NSW. In addition to changes in the region's flow regimes, the following factors have contributed to the poor health of the native fish community in the Lachlan region.

- The presence of barriers[74] impact fish passage by preventing migration, disrupting life cycles, and reducing gene pools. Barriers also create conditions where fish populations become more susceptible to the impacts of habitat loss, water quality issues – for example, hypoxic blackwater events, invasive species, disease and predation.[75]
- A loss of aquatic habitat[76] and a reduction in access to habitat is negatively impacting native fish in the Lachlan region.[77]
- Pumps with ineffective screens result in fish and other aquatic animals being either sucked into the diversion or impinged and injured on the screen.
- Cold water pollution can reduce the range and abundance of native fish as they require a specific water temperature range for survival.[78] Cold water pollution may prevent, inhibit or delay spawning,[79] as water delivery for industry such as irrigation-users occurs during the warmer months, which coincides with spawning and migration of native fish.
- Exotic species[80] thrive in disturbed habitats compared to native fish. The presence and dominance of introduced species can have a significant impact on the health and condition of native fish populations.

To improve conditions for native fish we have included proposed action 2.4, which seeks to mitigate the impact of water infrastructure on the region's important fish stocks.

70. Examples include Booligal wetlands, Lake Brewster, Lake Cowal, Murrumbidgil Swamp and the Great Cumbung Swamp
71. Whealbah Billabong and Booligal Swamp
72. Higgisson, W., Higgisson, B., Powell, M., Driver, P., Dyer, F 2019, Impacts of water resource development on hydrological connectivity of different floodplain habitats in a highly variable system, *River Research and applications*, 36(4).
73. Such as the straw-necked ibis who are particularly sensitive to falling water levels in their colony sites and surrounding habitat, which can cause adult birds to abandon their nests. Department of Planning and Environment, *Lachlan Long Term Water Plan – Part A*, www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/lachlan
74. Such as dams, weirs and road crossings
75. Department of Industries 2006, Reducing the impact of weirs on aquatic habitat – NSW Detailed Weir Review, Report to the NSW Environmental Trust, Lachlan CMA.
76. Disturbance and deliberate removal is responsible for the loss of Large Woody Habitat, with particular impacts on nesting species such as Murray Cod.
77. Flow events of a sufficient size used to inundate woody debris of new habitat or, during low flow conditions allow connectivity between refuge pools.
78. Michie, L., Thiem, J., Facey, J., Boys, C., Crook, D., Mitrovic, S 2020, Effects of suboptimal temperatures on larval and juvenile development and otolith morphology in 3 freshwater fishes: implications for cold water pollution in rivers, *Environmental Biology of Fishes*, 103(1527 – 1540).
79. Boys, C., Miles, N., and Rayner, T 2009, *Scoping options for the ecological assessment of cold-water pollution mitigation downstream of Keepit Dam, Namoi River*, Murray–Darling Basin Authority, NSW Department of Primary Industries.
80. Such as European carp, eastern gambusia, goldfish and redfin perch

Protecting groundwater dependent ecosystems

The Lachlan region has areas of high ecological value aquatic ecosystems that also overlap in many places with groundwater dependent ecosystems. This includes the Great Cumbung Swamp, where the groundwater – surface water interactions are central to ecological health. There are also significant amounts of groundwater dependent ecosystems identified in the area around Condobolin.

During periods of drought with limited surface water availability, groundwater extractions can increase (subject to licenced entitlement holdings by water users and extraction limits), which can lead to a reduction in groundwater levels.[81] Increased and prolonged reliance on groundwater during extended dry periods – or under a future drier climate – could accentuate existing risks and put more pressure on groundwater sources and groundwater dependent ecosystems that are already under stress.

To better protect groundwater dependent ecosystems we have proposed action 4.1, which will improve the understanding and management of groundwater resources within the region.

Image courtesy of Greg Russell, Department of Primary Industries. Groundwater monitoring, NSW.

81. This is particularly important downstream of Hillston and in 2 areas above Lake Cargelligo, where we have seen groundwater levels decline

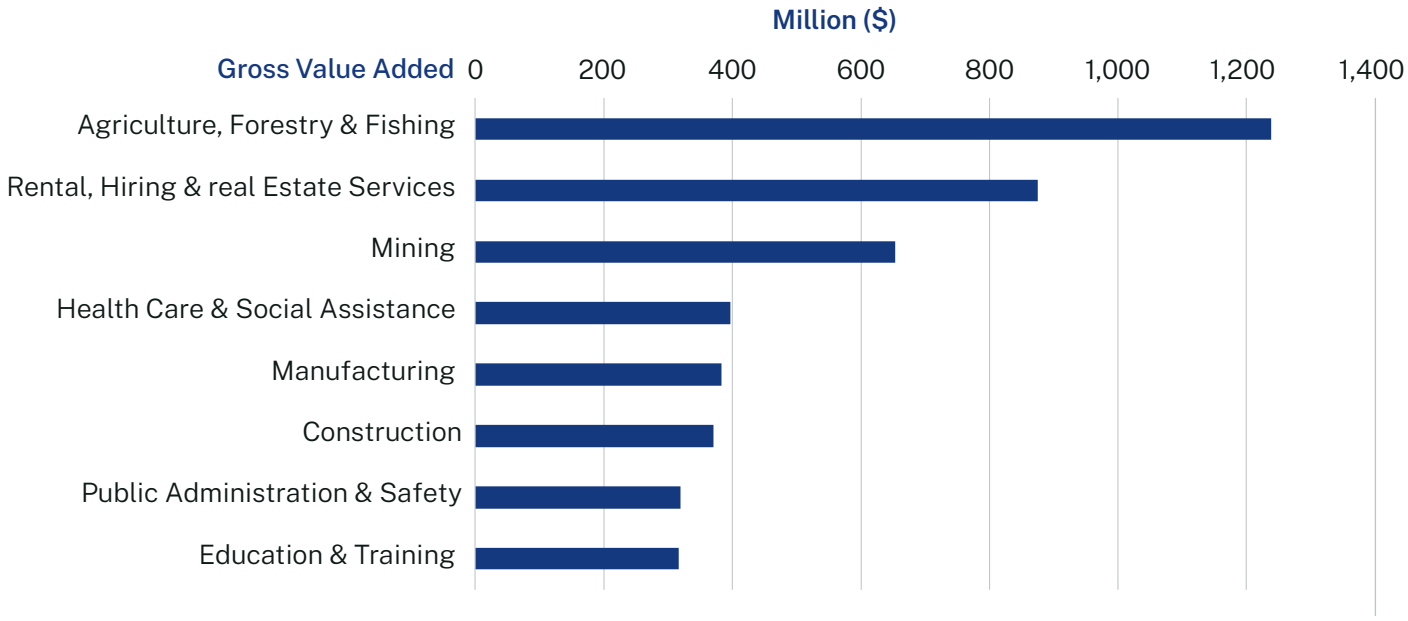
Challenge: Supporting economic growth and diversification

The industry profile in the Lachlan region is changing. Over the next 20 years, food processing and agriculture, mining and renewable energy production is expected to expand – aided in parts by upgrades to roads, transport links and government investments in the Parkes Special Activation Precinct. Our challenge is to support new and existing industries in the context of a variable and changing climate.

Improve the integration of water into regional planning

The Lachlan region has a diverse regional economy that contributed $6.73 billion to the state's gross regional product in 2020–21.[82] Most key industries rely on the region's water resources, including agriculture, mining and manufacturing (Figure 14). Tourism, including water-related recreational activities around Lake Cargelligo, are also dependent on high quality water resources and healthy waterways.

Figure 14. Gross value added for key industries in the Lachlan region

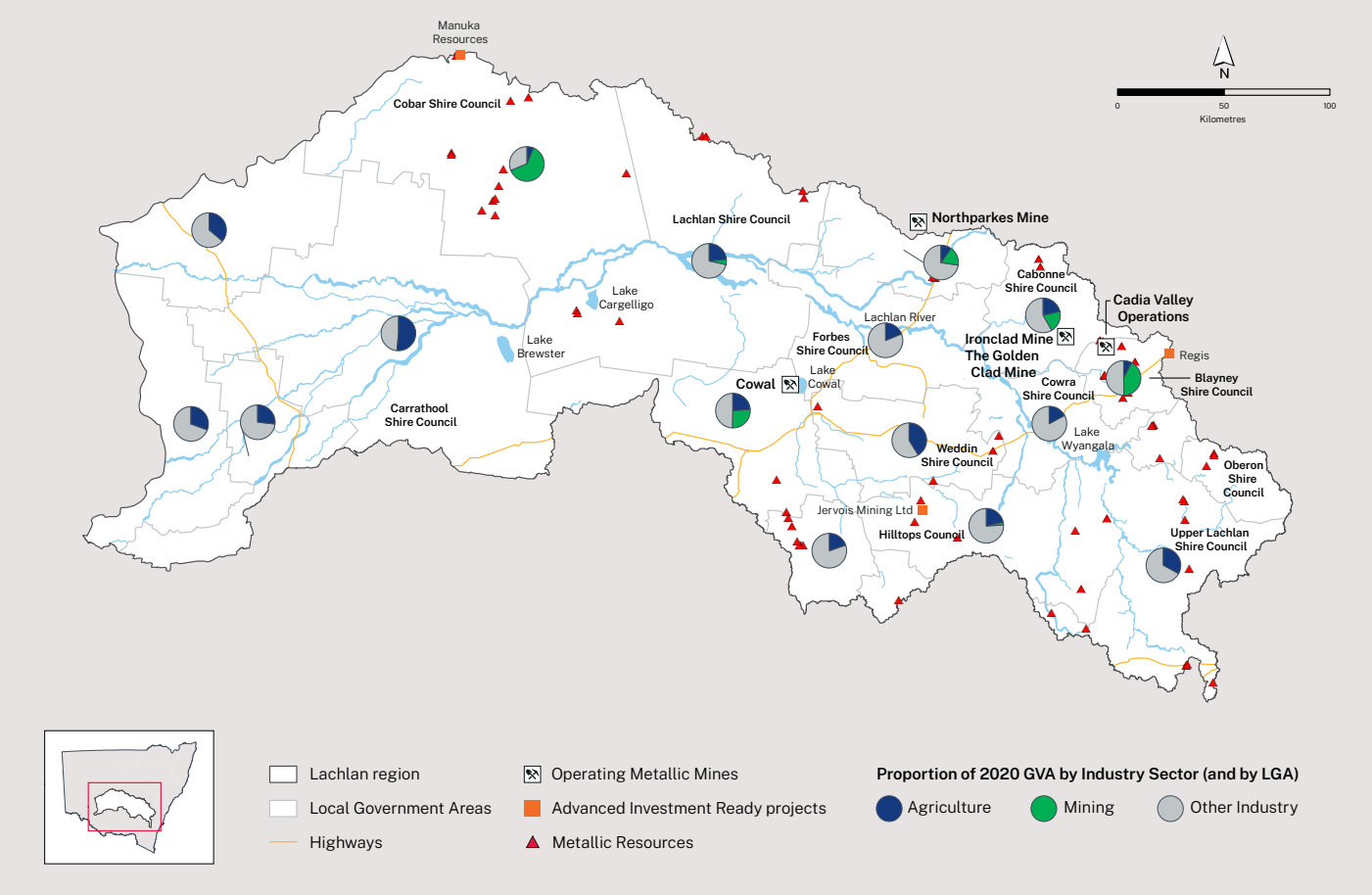


Source: Remplan Economy, Lachlan Regional Water Strategy boundaries data, 2022

82. $6.27 billion in 2020–21 as measured by gross value added, which accounts for 1% of NSWs economic output as measured by gross value added.

Attracting new high value industries and supporting economic diversification is a strong focus for the region and access to reliable water is important to realise this vision. Aside from an expected growth in agriculture, food processing and renewable energy production over the next 20 years, we are likely to see an increase in exploration and mining activity (Figure 15) due to increased global demand for extractive resources, including critical minerals.[83]

Figure 15. Industry sector contribution to the regional economy (GVA, 2020–2021), including proposed mine expansions



Sources:

1. REMPLAN Economy: Lachlan Regional Water Strategy boundaries 2022
2. Department of Regional NSW MinView 2021

The Inland Rail Project, the Parkes Special Activation Precinct, and upgrades to the Newell Highway will also enable the broader Central West region to leverage its position along nationally significant rail and road corridors, which in turn encourages further industry development and job growth. It will also likely change water-use patterns and drive greater competition for available water resources.

Regional areas are also becoming increasingly attractive places to live, with the increased ability to work remotely and access to more affordable housing. For example, the 2022 NSW Population Projections estimate significant growth in the Forbes local government area, with a 32% increase in population expected over the next 20 years.[84] In this context, regional housing will be a key focus in future years, which will also require further consideration of the implications on future water demand.

To ensure that we consider water resources earlier in future land use planning processes, we have proposed action 4.3. This action seeks to better integrate future strategic land and water planning, as well as identify any water-related gaps in the current land use planning framework.

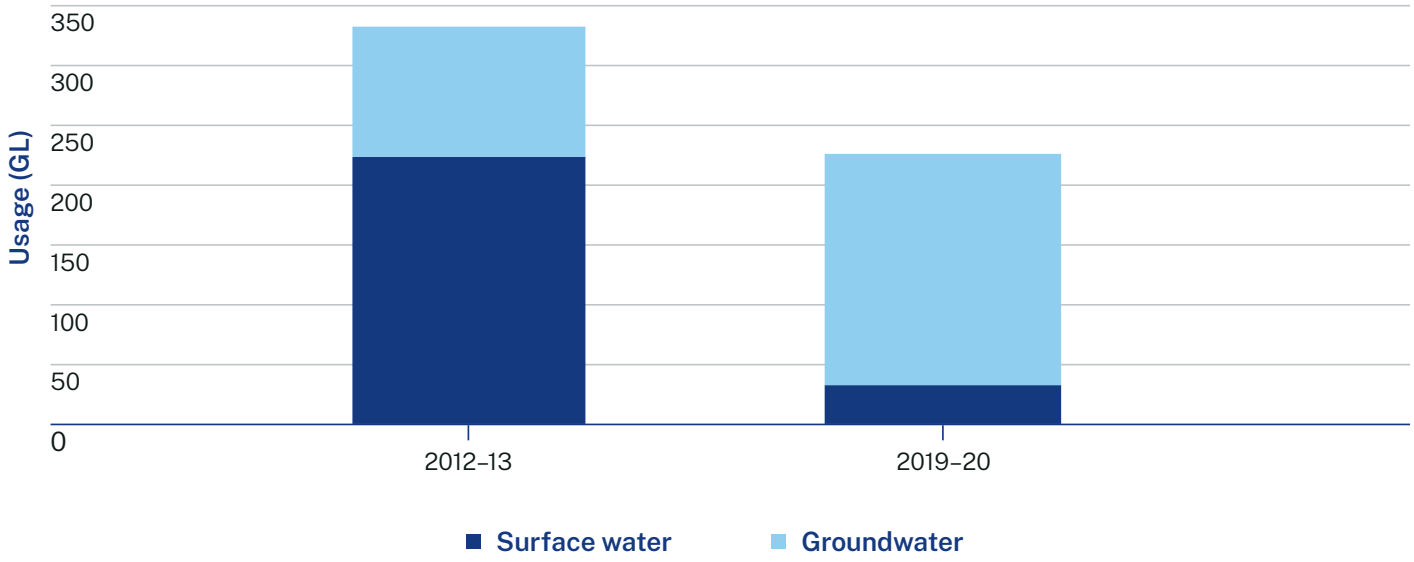
In addition, proposed action 3.3 seeks to strengthen industry resilience through a comprehensive long-term study on the impact of climate variability and climate change on future water availability to help determine its potential impacts on water-dependent industries in the region.

83. The *Critical Minerals and High-Tech Metals Strategy* outlines the NSW Government's vision to build on our existing potential and position NSW as a major global supplier and processor of critical minerals and high-tech metals well into the future. Under this strategy the NSW Government will establish a Critical Minerals Hub in the Central West of NSW, to activate benefits of collaboration across the critical minerals supply chain, leveraging our existing investments in the Central-West Orana Renewable Energy Zone and Parkes Special Activation Precinct.
84. pp.planningportal.nsw.gov.au/populations

Improve our understanding of groundwater resources

Businesses and industries that are not located close to a surface water source often rely on groundwater to meet their water needs. Although allocations to groundwater access licences have historically been high, prolonged dry conditions and reduced surface water availability could increase demand for groundwater, which in turn could push groundwater extraction closer to the Water Sharing Plan extraction limits. In instances where use exceeds these limits, further investigations would be undertaken and potential compliance actions initiated to ensure groundwater extraction remain within allowable extraction limits on average.

Figure 16. Groundwater use during high and low surface water availability years (see note)



Source: Department of Planning and Environment – Water 2022 www.industry.nsw.gov.au/water/allocations-availability/water-accounting/gpwar

Note: Groundwater combines usage in the upper and lower Lachlan Groundwater sources. Surface water use only includes use in the regulated Lachlan River.

Figure 16 shows that groundwater use can fluctuate significantly from year to year and is often linked to climate conditions and the availability of surface water. In 2012–2013, the Lachlan region experienced significant rainfall events and groundwater use was relatively low. During the most recent drought in 2018–2019, groundwater use was relatively high and contributed more to the total water use than surface water in the Lachlan region. This suggests that groundwater could become an even a more important water source during future dry conditions, as surface water availability becomes constrained, especially in the lower Lachlan region.

Under dry future climate projections this trend in greater groundwater use will become more pronounced both in terms of overall demand for groundwater, as well as the duration of sustained high groundwater use. This will increase the risk that extraction may reach and/or exceed the Water Sharing Plan extraction limits, which would trigger reduction in future allocations or restrictions to account water access.

Greater and more sustained reliance on groundwater could cause further declines in groundwater level. As observed in parts of the catchment, such declines in groundwater levels pose risks to industries (particularly to businesses with an inflexible water demand like permanent plantings)[85] and town water users who rely on this resource.

To improve our understanding and management of groundwater resources in the Lachlan, we have proposed action 4.1. This action looks to advance our scientific understanding of groundwater resources, including the connectivity between groundwater and surface water, to inform better groundwater management approaches.

85. Future growth in the number of permanent plantings in the lower Lachlan region could worsen the decline in groundwater levels.

Investigating water use behaviour in the region

All water-dependent industries need to hold water access licences (or have access to an existing town water supply system) to meet their needs. In the Lachlan and Belubula regions, both surface water resources and groundwater sources are fully allocated[86] and extraction limits guide how much water is permitted to be extracted. This means there are challenges for existing and new industries should they require additional water.[87]

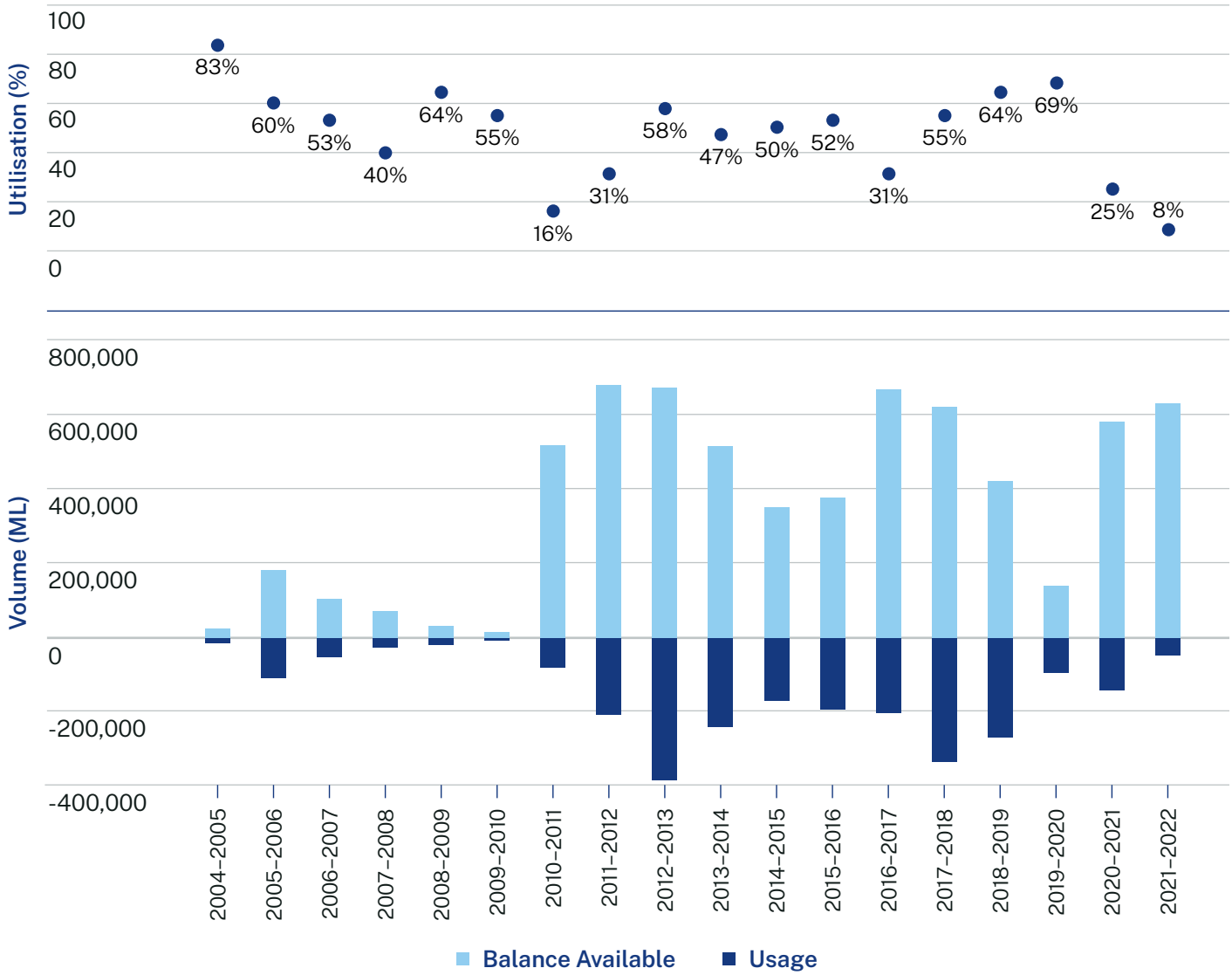
- For existing industries, a change in water needs must be met through either a more efficient or innovative use of water or through the acquisition of licences via the water market.
- For new industries reliant on water, acquisition of water access licences or an alternative water supply contract is critical. However, opportunities to set up the system efficiently at the onset and consider how to drive the productivity of existing water resources – for example through re-use and recycling schemes – could provide additional opportunities for growth.

To mitigate the implications of the regions' variable climate and the associated fluctuations in general security allocations, many general security entitlement holders have accessed the water market[88] or have adopted a conservative water-use behaviour as well as made use of the existing water accounting rules to carry over water between years. This is reflected in the account utilisation (Figure 17 and Figure 18). However, aside from a conservative water use behaviour, industry stakeholders have suggested that the existing Water Sharing Plan rules and/or other related policies are also leading to a systemic 'underuse'. This issue requires further analysis.

To better understand water use and future water demand in the Lachlan region, we have proposed action 3.2.

86. There may be an opportunity to issue new licenses in marginal groundwater sources, potentially through controlled allocations
87. To meet their different water needs, many businesses in the region hold a portfolio of surface water and groundwater entitlements and trade water on the temporary and permanent market (if required).
88. Department of Planning and Environment, *Trade dashboard*, www.industry.nsw.gov.au/water/licensing-trade/trade/dashboard

Figure 17. Account utilisation in the Lachlan Regulated River Water Source – water use relative to maximum amount available



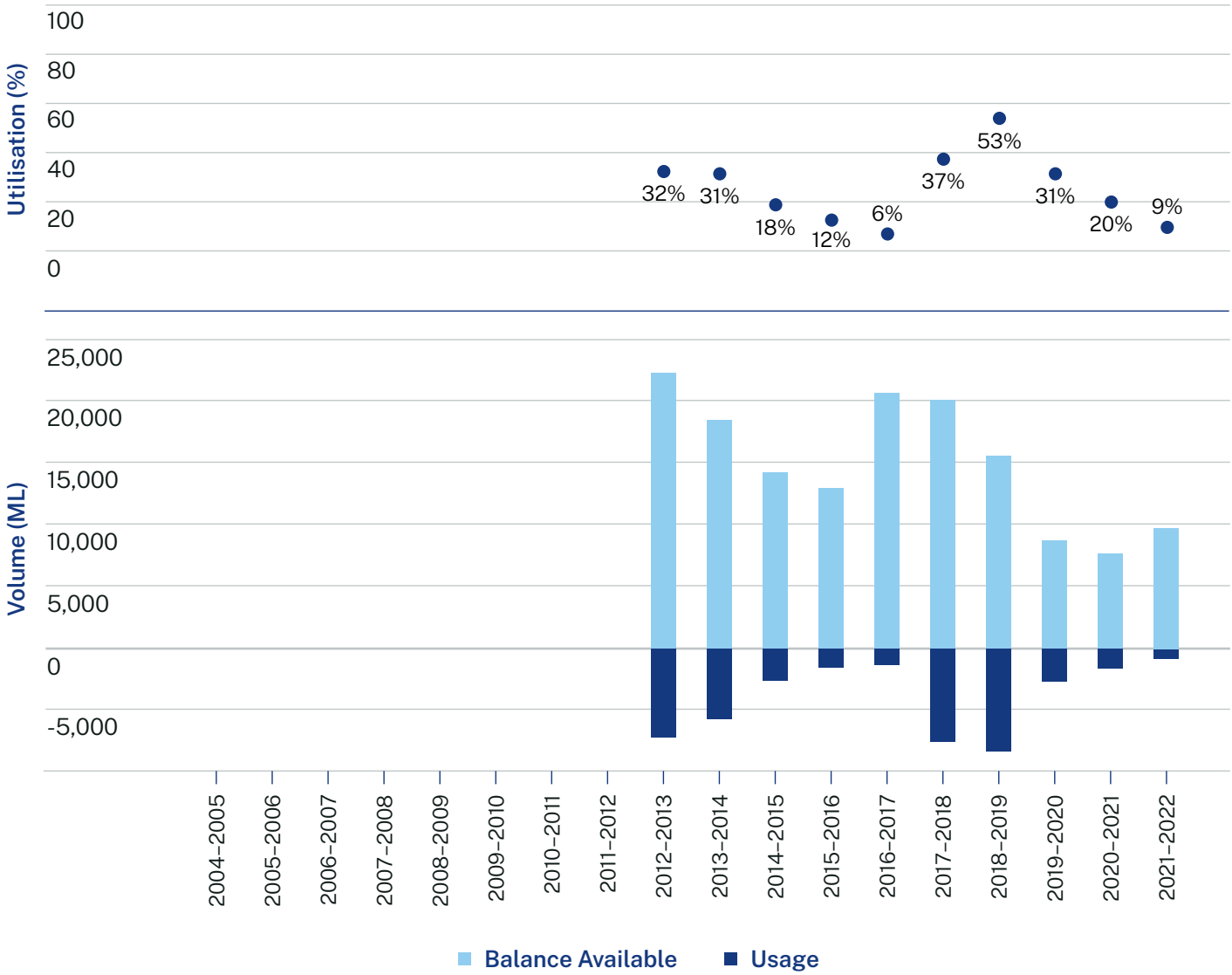
Explanatory notes

- Utilisation rate calculation is the water availability plus trade in from external water sources against account usage and trade out to external water sources.
- Utilisation rate calculation excludes Supplementary, account usage restrictions, tagged trading, annual use limits and uncontrolled flow access.

Source: Department of Planning and Environment – Water, General Purpose Water Accounting Report – NSW Lachlan and Belubula Catchments 2020-21, www.industry.nsw.gov.au/water/allocations-availability/water-accounting/gpwar

Note: Account utilisation – reflects the amount of water used from regulated supplies, relative to the maximum amount of available for use.

Figure 18. Account utilisation in the Belubula Regulated River Water Source – water use relative to maximum amount available



Explanatory notes

- Utilisation rate calculation is the water availability plus trade in from external water sources against account usage and trade out to external water sources.
- Utilisation rate calculation excludes Supplementary, account usage restrictions, tagged trading, annual use limits and uncontrolled flow access.

Source: Department of Planning and Environment – Water, General Purpose Water Accounting Report – NSW Lachlan and Belubula Catchments 2020-21, www.industry.nsw.gov.au/water/allocations-availability/water-accounting/gpwar

Note: Account utilisation – reflects the amount of water used from regulated supplies (excluding supplementary water) relative to the maximum amount of available for use.

Enhance water-related business decisions

Critical water management decisions are being made based on the last 130 years of climate records. Our new climate modelling and the last drought have demonstrated that the past is not necessarily a good indicator of the future, and the last 130 years of data could be inadequate for forecasting future water availability. There is also little published information on long-term water availability and drought risk for unregulated rivers and stream flow records for many unregulated rivers are short.

A limited understanding of future water availability and publicly available climate information can lead to poor investments, business decisions and drought security planning as well as a loss of opportunities to invest in alternative water supplies.

While the provision of climate and water availability information by government has improved in recent years, more can be done to ensure it meets the expectations of water users. The new climate data that has been published in regional water strategies is the first step in providing more information to water users on the future risks to water availability; however, tailoring of its application for industry and communities is likely to deliver the greatest benefits.

We have proposed action 3.1, which seeks to improve public access to climate information and water availability forecasts that are suitable for water users and their business planning needs in the Lachlan region.

Image courtesy of Destination NSW. Cotton field, Condobolin.

Image courtesy of Destination NSW. Streetscape, Carcoar.

Addressing the challenges

4

Image courtesy of Stef Schulte. Hillston, NSW.

To address the challenges in the Lachlan region, we have set 4 priorities and proposed actions for each priority.

The regional priorities are:

1. Build resilience to climate extremes
2. Ensure best use of existing water for the environment
3. Support economic prosperity in a capped system
4. Improve our knowledge of water resources.

These priorities and proposed actions can improve the Lachlan region's readiness to adapt to a more variable climate and support the difficult decisions we need to make to deliver healthy, reliable and resilient water resources for the region's future.

Image courtesy of iStock. Township, Forbes.

Priority 1

Build resilience to climate extremes

Actions under this priority focus on building resilience through a more holistic, inclusive and transparent approach to planning, whilst doing the groundwork to enhance water security in the region in case more extreme events materialise.

Aboriginal people have acquired a deep and intimate knowledge of landscape and water. Living in the driest inhabited continent on earth for many thousands of years, Aboriginal people have insights and experiences that could add significant value to strategic water planning and provide opportunities for Aboriginal people to have a stronger voice in water management. Genuine involvement based on the principles of free, prior and informed consent is essential to incorporate traditional knowledge and expertise into strategic water planning, whilst respecting the rights of Aboriginal people.

We have added a specific action to improve ongoing coordination and engagement with water supply authorities and local government to build on the work by the Town Water Risk Reduction Program. Relationships built between state and local government will be particularly important during future extreme events, and to carry forward the initiatives and actions shortlisted in the regional water strategy implementation plan.

In summary, the actions shortlisted under this priority will:

- build the resilience through better integrating regional and local strategic water management activities and improved coordination during extreme events
- improve our hydrological modelling capabilities, including scoping a program of works to build a new model for the upper Lachlan to investigate water security risks to towns and communities in the upper Lachlan
- support Aboriginal people to be more involved in water management, by better valuing their traditional knowledge and contributing to decision making
- improve our understanding of important groundwater sources and investigate opportunities to expand the existing regional water supply grid.

What we're already doing

The NSW Water Strategy[89] has committed to supporting resilient, prosperous and liveable cities and towns through inclusive engagement, transparency and accountability.

The NSW Government will partner with First Nations/Aboriginal People to co-design a state-wide Aboriginal Water Strategy that will identify a program of measures to deliver on Aboriginal people's water rights and interests in water management and help address the state-wide systemic issues to better enable the exercise of Aboriginal people's rights and access to water.

The NSW Government is developing a state-wide Groundwater Strategy that identifies the key risks to our groundwater resources and the associated management challenges for NSW. The strategy sets out the actions required to respond to these challenges and provide a logical framework for funding of groundwater management reform work over the next 20 years.

The Future Ready Regions Strategy[90] has committed to actions that support stronger communities and diverse regional economies and more sustainable, secure and healthy water resources.

The Department of Planning and Environment has developed region-specific information about drought management and committed to a range of region-specific actions to improve the management of future droughts.[91]

89. Department of Planning, Industry and Environment 2021, *NSW Water Strategy*, available at www.dpie.nsw.gov.au/water/plans-and-programs/nsw-water-strategy
90. Department of Regional NSW 2021, *Future Ready Regions Strategy*, available at www.nsw.gov.au/regional-nsw/future-ready-regions
91. Department of Planning, Industry and Environment 2020, Drought Recovery Guide, available at www.industry.nsw.gov.au/water/allocations-availability/droughts-floods/drought-update/previous-valleys-in-drought

Legend				
Managing water resources during more extreme events for people, industry, and the environment	Improving water quality	Addressing barriers to Aboriginal water rights	Sustaining the health and resilience of the region's water dependent ecosystems	Supporting economic growth and diversification

Table 2. Overview of proposed actions to build resilience to climate extremes

Proposed action	Summary	Challenges addressed
Action 1.1 Establish a governance framework to coordinate actions under Priority 1	Establish a governance framework and arrangements in consultation with local councils and local water utilities in the Lachlan region to support the coordination of water-related actions under Priority 1, and improve coordinated, timely decision-making during extreme events.	
Action 1.2 Upgrade the existing hydrological models for the Lachlan catchment to better represent river operations and drought contingency measures	Improve the representation of river operations and drought contingency measures in the Department's hydrological model for the Lachlan regulated river in order to investigate options to optimise system wide operations across the catchment and inform future environmental water management decisions.	
Action 1.3 Develop ongoing arrangements for participation of local Aboriginal people in water management	Support existing and new Aboriginal groups to develop an Aboriginal Water Advisory Committee in the Lachlan for involvement in water management activities and decision making.	
Action 1.4 Support place-based initiatives to deliver cultural outcomes for Aboriginal people	Support Aboriginal organisations and communities to develop tailored projects for their communities. This action would aim to move away from centralised decision-making and develop a flexible program that can be adapted and is driven by the principle of self-determination and collaboration.	
Action 1.5 Support groundwater use for towns and communities	Undertake a detailed review of how groundwater can support secure and reliable water access for towns in the Lachlan region.	

Proposed action	Summary	Challenges addressed
Action 1.6 Investigate water security for small and remote communities	Investigate the merit of building a new hydrological model for the upper Lachlan (above Wyangala Dam) and utilise the new regional water strategy climate datasets to better understand the water security risks for small towns and communities in the upper Lachlan region.	
Action 1.7 Investigate the need to further expand the regional water supply grid	Explore, in partnership with relevant local councils, the expansion of the regional water supply grid. This could include strategic upgrades to existing major distributors and work that could help link parts of the pipeline distribution network.	

Image courtesy of iStock. Crookwell Wind Farm, Southern Highlands.

Proposed action 1.1: Establish a governance framework to coordinate actions under Priority 1

Throughout the development of the Draft Lachlan Regional Water Strategy, councils and joint organisations have told us that there needs to be a continued, coordinated focus on supporting and implementing water security measures and drought preparedness for towns in the Lachlan region. We have heard this needs to be an approach that involves all level of government.

Progressing this action

This action will, in partnership with local councils and local water utilities in the Lachlan region, establish an enduring governance framework that coordinates the town water-related actions under Priority 1 of the Lachlan Regional Water Strategy.[92]

The aim of this action is to support the drought resilience of local councils by improving the coordination of water management actions and planning processes that support town water security across different levels of government.

Town Water Risk Reduction Program[93]

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

The 2-year program, which ends in December 2022, is focusing is on working together with the sector to identify the most fundamental barriers within state and local government that prevent effective and strategic risk management, and to develop and implement long-term solutions to these barriers.

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

Several pilots have been initiated through the Town Water Risk Reduction Program to trial new approaches to local water utility strategic planning. Recognising the important connection between each local water utility's strategic planning and regional water strategies, a pilot has been led by the Central NSW Joint Organisation of Councils to co-design an approach to regionally based local water utility strategic planning incorporating the Integrated Planning and Reporting framework of the *Local Government Act 1993.*

Have your say

Who should be represented in the governance framework in addition to water supply authorities and local government?

92. Consideration will be given to the capacity of local councils and local water utilities to contribute to such a governance framework.
93. Department of Planning and Environment, *Town Water Risk Reduction Program,* available via www.dpie.nsw.gov.au/water/plans-and-programs/town-water-risk-reduction-program

Stronger focus on water efficiency and demand management for towns and communities

Local water utilities play an important role in managing urban water demand and improving water use efficiency in the Lachlan region. These measures will continue to be needed into the future to support population and industry growth and we heard strong support for these measures during the first public consultation on the Draft Lachlan Regional Water Strategy.

The NSW Government is enhancing its investment in water conservation and will support councils in the region to implement the Government's new state-wide Water Efficiency Framework. Action 1.1 will provide a platform to continue the conversations with local water utilities about the new Water Efficiency Program and other innovative reuse and recycle options aimed at improving water security in regional areas. It will also enable a discussion with local water utilities on a policy and regulatory barriers to recycled water in mid-2022 which will inform the development of more workable policy and regulatory frameworks for recycled water.

New Water Efficiency Program

The NSW Government has introduced a new Water Efficiency Program and Water Efficiency Framework. This program seeks to collaborate with key stakeholders,[94] to increase the investment in water system efficiency, water conservation and demand management which can delay the timing and reduce the scale of investment in new supply infrastructure.

Regional Leakage Reduction Program

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

The Central NSW Joint Organisation is also overseeing a water loss management program in its constituent councils across the Macquarie and Lachlan catchments.

Smart Approved WaterMark – Smart Water Advise Program

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

Local Water Utility performance data

The NSW Government provides and maintains a public web-based database[95] for NSW regional water utilities to annually report their current water supply and sewerage data. Performance monitoring and benchmarking are required under the National Water Initiative and provide assurance to the NSW Government that the requirements of the *Water Management Act 2000* are being met (i.e. each local water utility is performing satisfactorily).

94. Including the Water Directorate, Local Government NSW, Water Utilities, industry leaders and communities and other government agencies
95. Department of Planning and Environment, *Water Utilities Performance Data*, www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data

Proposed action 1.2: Upgrade the existing hydrological models for the Lachlan catchment to better represent river operations and drought contingency measures

The way we operate the regulated Lachlan River has the potential to enhance environmental, water quality and social[96] outcomes or exacerbate impacts. Our water sharing plans aim to ensure water resources are protected and they also guide river operations in each of NSW's catchments.

Through the work of the regional water strategies and the development of new climate datasets, we have an opportunity to review our hydrological models to ensure existing river operations and management practices as well as drought contingency measures are accurately reflected in these planning models.

This will enable us to establish a baseline which can be used to test existing or changes to river operations under different climate scenarios and provide the underlying information base for environmental water managers in the Lachlan to inform future watering decisions.

Progressing this action

The NSW Government will use the transition of the regulated Lachlan River hydrological model to a new modelling platform[97] to improve the representation of river operations and drought contingency measures. This could assist in developing options to optimise system wide operations across the catchment.

In addition, the upgrades to the hydrological model and the new climate datasets could be used in conjunction with the Lachlan Long Term Water Plan to inform future environmental water management decisions.

Have your say

Do you see any opportunities for improving existing river operations? Who would they benefit and who would they impact?

96. Social outcomes include things like the ability to use the river for recreation – e.g. swimming or kayaking – or visual amenity based on water clarity and volume. Recreation and amenity can be affected if there is inadequate volume, unseasonal cold temperature or if the river is moving quickly and is too dangerous to swim.
97. The Department will transition the current IQQM model to a Source model

Proposed action 1.3: Develop ongoing arrangements for participation of local Aboriginal people in water management

During consultation for the Draft Lachlan Regional Water Strategy, Aboriginal people told us that consultation with their communities on water issues has been infrequent and poorly executed. Community sentiment is that government agencies often come out to 'tick a box' and after they have got what they want, they are never seen again.

We also heard from Aboriginal people that the government had to earn the trust of the community as the first step in building a strong lasting relationship with them. To address this now and build on it over the next 20 years, we need an approach that allows Aboriginal people in each local area and region to get the right people involved in decisions about water management.

Progressing this action

This action would support existing and new Aboriginal groups to develop an Aboriginal Water Advisory Committee in the Lachlan for involvement in water management activities and decision making. The success of this action will be driven by the extent to which it enables self-determination and provides an adequate level of support for the groups.

This action supports Priority Reform 1 in the Closing the Gap National Agreement – to enter formal partnerships and decision-making arrangements and develop place-based partnerships to respond to local priorities. Local Aboriginal groups in the Lachlan region could be involved in:

- developing programs and initiatives to improve cultural competency within the water sector
- developing culturally appropriate water knowledge programs
- outlining a process that the NSW Government can follow to ensure water decisions have been considered by the community
- progressing on-ground initiatives.

NSW's obligation under the Basin Plan

The NSW Government has obligations for the development of water resource plans under Chapter 10 of the Basin Plan. These plans must meet Aboriginal people's objectives and desired outcomes for managing water resources in each region.

The objectives and outcomes as stated by the Barkandji and Maljangapa, Nari Nari, Ngiyampaa, Wiradjuri and Yita Yita Nations in the Lachlan water resource plans will be the basis for further initiatives that will help to consider Aboriginal people's objectives and outcomes in water resource management.

Have your say

How can we support Aboriginal people to be more involved in water management in the Lachlan region?

Proposed action 1.4: Support place-based initiatives to deliver cultural outcomes for Aboriginal people

The Draft Lachlan Regional Water Strategy identified high-level options to improve Aboriginal people's access to water and water rights. There was a significant amount of support for these options to be progressed, but the needs of Aboriginal communities varied between different parts of the region.

The Australian Government's Closing the Gap Report and the Local and Indigenous Voice program highlighted that Aboriginal people have a desire for strong and inclusive partnerships where local communities set their own priorities and tailor services and projects to their unique situations.

This action would support Aboriginal organisations (such as those suggested in Action 1.3) and communities to build on or develop tailored projects for their communities such as the Down the Track Program in Lake Cargelligo.[98] It would aim to move away from central decision making and develop a flexible program that can be adapted and is driven by the principle of self-determination – local communities 'speaking with their voice' to make decisions about the programs needed for their community.

To progress this action in the Lachlan region we could:

- develop a cultural watering program that understands the location and water needs of important cultural assets – surface water-dependent and groundwater-dependent cultural sites. This could involve working with Department of Planning and Environment – Water, WaterNSW and environmental water holders to identify whether co-benefits could be achieved
- improve access to Country by removing impediments to accessing culturally significant areas and waterways in the Lachlan, including those located on Travelling Stock Reserves. This could also include an investigation of the benefits and constraints associated with setting up formal access arrangements between Aboriginal people and landholders or developing co-management arrangements for particular sites
- develop a river restoration program, which would incorporate cultural science and knowledge to rehabilitate Country. This could be applied though Action 2.1 and 2.2.

Have your say

How can Aboriginal place-based solutions be implemented in a way that creates opportunities for Aboriginal people and communities in the Lachlan region, while also delivering positive outcomes for the broader community?

98. www.mdba.gov.au/sites/default/files/pubs/rivers-the-veins-of-our-country-2020-21.pdf

Proposed action 1.5: Support groundwater use for towns and communities

Groundwater is important for towns in the Lachlan region – as a primary source for towns like Hillston or as an alternative supply for towns like Forbes. However, groundwater use is at or approaching the extraction limit for important groundwater sources like the lower Lachlan.[99] This means there is little potential for future increased use in these groundwater sources.

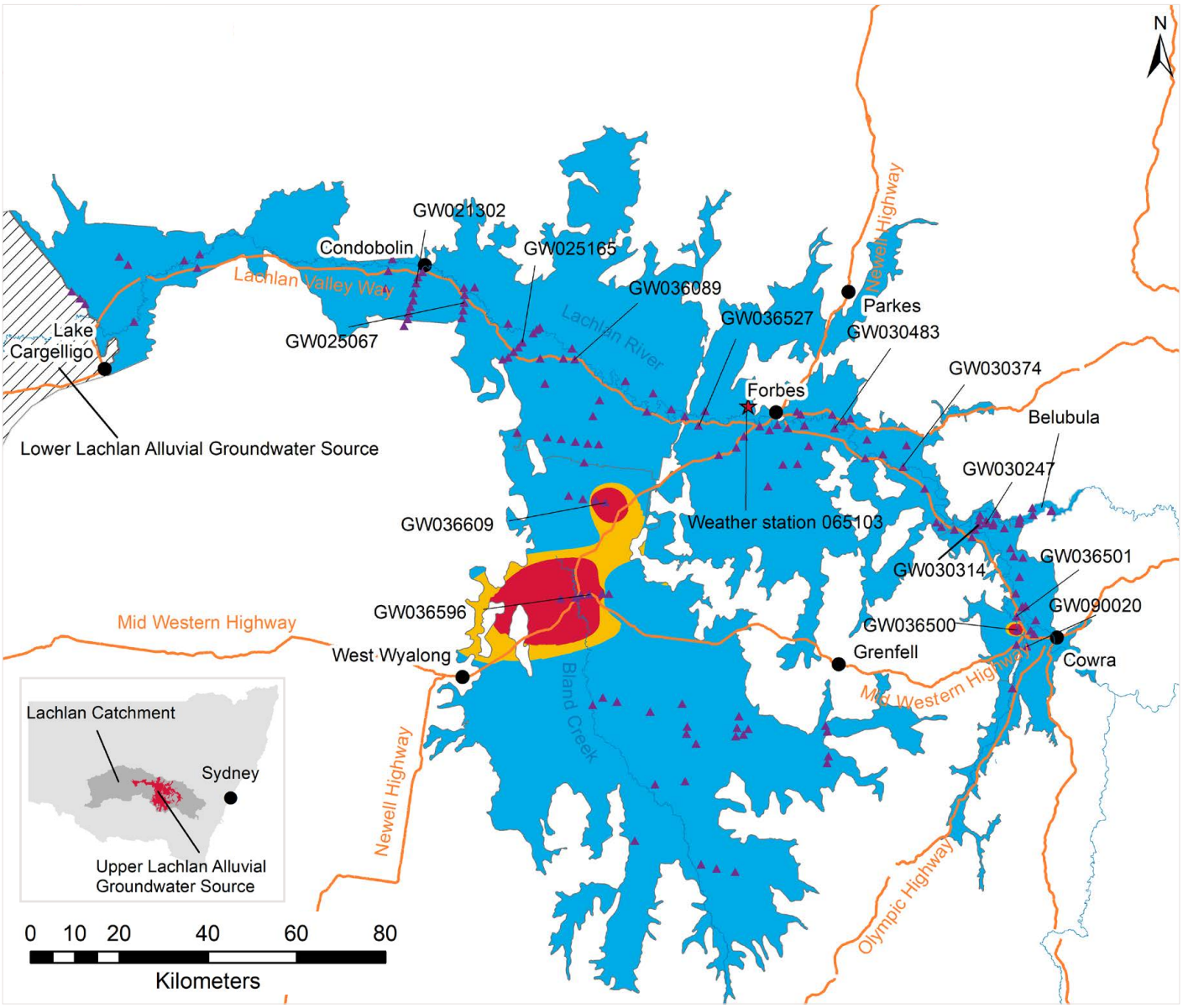
There are also areas of declining groundwater level in highly used aquifers like the upper Lachlan (Figure 19). Local groundwater levels can decrease during the pumping season where there is a high density of irrigation bores. This can make it harder to extract the same amount of water from nearby bores, including those used for town water. The problem is exacerbated during severe droughts because more water is extracted. Furthermore, groundwater levels do not recover as well because there is less rainfall to replenish the groundwater source.

The security of groundwater sources for town water supply is a concern. Water users – including councils – require more information on anticipated future demands and how groundwater is managed in the region.

Image courtesy of Destination NSW. The Swinging Bridge, Canowindra.

99. www.industry.nsw.gov.au/water/allocations-availability/tracking-groundwater

Figure 19. Recovered water levels after the pumping season of 2018-2019 as a percentage of total available drawdown in the upper Lachlan



Legend:

★ Forbes Airport Weather Station ▲ Monitoring Bores — Rivers/creeks — Road ● Town

2018–19 recovered water level as percentage Total Available Drawdown:

< 25% 25% – 30% > 30%

Note: The change in groundwater levels is expressed as a percentage of the total available drawdown (TAD) which is calculated based on the physical characterises of the groundwater system. In the Upper Lachlan Alluvial Groundwater Source, the maximum drawdown level after the pumping season (the recovered water level) should not exceed 25% of the total available drawdown.[100]

To maintain water supply security, towns need to protect their existing groundwater access and plan for their future water needs. Firstly, it is important to understand whether local town water bore infrastructure is sufficient to sustain town water supply during droughts – for example, an appropriate number of bores that are sufficiently deep and well-constructed so that bore yield is not affected by declines in the groundwater level during drought.

Secondly, it is important to quantify current and future groundwater demands. This will involve an analysis of trends in demand for groundwater from all users and where demands are most likely to change due to land use changes, climate changes, population growth and because of other private or public investments.[101] This analysis will determine the physical constraints (e.g. borefield infrastructure) and access constraints (e.g. licenced groundwater entitlements) for town water supply.

100. Department of Planning and Environment, *Upper Lachlan Alluvial Groundwater Source – 2021 Groundwater Level Review* (December 2021), www.industry.nsw.gov.au/water/allocations-availability/managing-decline-in-groundwater-levels
101. There should be further consideration whether certain industries could utilise lower quality groundwater to reduce future demand on high quality groundwater sources.

Groundwater research could allow under-utilised groundwater sources to be used as water supplies in the future

The NSW Geological Survey uses aerial electromagnetic survey methods to explore for minerals and groundwater between Dubbo and Forbes as part of a drought proofing project. They are looking at the groundwater potential of the deep sandstone and underlying fractured rocks. A similar project is using the same methods as well as seismic testing of the Darling Trough, which is located around Cobar and Ivanhoe.

There are opportunities for further collaboration between state government agencies as well as with federal agencies like Geoscience Australia on projects that maximise the technology and expertise on mineral exploration to gain valuable information about groundwater resources.

Progressing this action

The first step will be a desktop study to assess the towns and remote communities where the current capacity of infrastructure and groundwater resources is insufficient to meet demand, followed by determining the likelihood and consequences of shortfalls. A series of solutions could be proposed, such as:

- maintain or upgrade infrastructure such as bores and associated pipeline links – for example, a network of linked groundwater bores[102] to provide more strategic regional groundwater access
- use saline groundwater and desalination technology
- access under-utilised groundwater sources based on new scientific information, recognising potential impacts to other groundwater users in fully allocated systems
- explore innovative licensing options for groundwater-based drought resilience
- resolve groundwater regulatory and licensing issues for towns that slow access – for example, the process for local water utilities to apply for and extract water from new bores, when this action could have an impact on existing bores. This sensitive issue has the potential for community conflict and is currently managed on a case-by-case basis.

This proposed action would assess the feasibility of managed aquifer recharge for towns and industry including the recharge capacity of sites for temporary storage of stormwater, river flow or recycled water. A recent CSIRO feasibility study highlighted the Lachlan Alluvium as a potential candidate for managed aquifer recharge.

This action would not replace the need for councils to develop local water utility strategic plans (previously referred to as integrated water cycle management strategies); rather, this regional analysis would likely be informed by the local water utility strategic plans.

Have your say

What are your views on having a connected groundwater network to ensure towns and communities in the Lachlan region have access to water during times of emergencies?

Do you think managed aquifer recharge is a viable option for the Lachlan region?

Taking a closer look at groundwater sources in NSW

The NSW Government is developing a state-wide Groundwater Strategy[103] that identifies the key risks to NSW groundwater resources and the associated management challenges for NSW. The strategy sets out the actions required to respond to these challenges and provide a logical framework for funding of groundwater management reform work over the next 20 years. Some of the actions identified in the NSW Groundwater Strategy will inform the implementation of the proposed actions in the Lachlan Regional Water Strategy.

102. A network of linked groundwater bores may also contribute to the broader benefits of the future town water pipeline from Forbes to Parkes to Central Tablelands Water; that is, bores would spread out along the aquifer rather than be focused in the current bore field.
103. Department of Planning and Environment, *NSW Groundwater Strategy*, water.dpie.nsw.gov.au/plans-and-programs/nsw-groundwater-strategy

Proposed action 1.6: Investigate water security for small and remote communities

There are gaps in our understanding of the climate-related water security risks to some smaller and remote communities in the Lachlan region, as the department's existing hydrological models were built as compliance modelling tools for use in the development of water sharing plans and hence only model the regulated system in the Lachlan region.

While the models have enabled us to assess water-related risks to towns and licence holders in the Lachlan and Belubula regulated rivers, they don't currently enable a detailed water security assessment of towns on the unregulated tributaries. There are several small towns in the Lachlan region that rely on sourcing water from unregulated rivers and streams (Boorowa, Crookwell and Gunning in the upper Lachlan) or unregulated effluent creeks (Ivanhoe). In addition, towns like Euabalong and Euabalong West rely predominately on groundwater and our understanding of the climate risk impacts on groundwater sources in the Lachlan region remains limited.

Progressing this action

Building on proposed action 1.2, which focuses on improvements to the hydrological model of the regulated Lachlan system, this action will further investigate the need to build a new model for the upper Lachlan. Once a greater understanding of small and remote communities is achieved – either through new and improved models or through more comprehensive analysis of the existing data – we will work across government (particularly the department's Water Utility branch) to investigate opportunities to enhance water security for small communities who may have heightened water security risks under a future drier climate. This could include:

- investigate the need to develop specific guidelines to better manage extreme events for towns reliant primarily on unregulated water sources[104]
- investigate upgrades to aging assets, including town water supply pipelines
- investigate potential inter-regional pipeline connections
- investigate the feasibility of installing water tanks
- investigate the viability of introducing new and emerging technologies such as hydropanels or off-grid containerised water filtration units.

These investigations would also link with proposed action 1.7.

Have your say

Is there any local data available to inform the department's risk assessment for small and remote communities?

104. The NSW Government has developed an Extreme Events Policy and Incident Response Guidelines for inland NSW valleys which provide a framework for how decisions are made during extreme events and sets out a range of increasing drought contingency measures to secure water for critical needs. Most of the measures focus on the regulated rivers that are controlled by large state-owned headwater dams, like Wyangala Dam in the Lachlan valley. Further information on how extreme events are managed in NSW regions is available under: www.industry.nsw.gov.au/water/what-we-do/legislation-policies/eep

Safe and Secure Water Program

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

Recent projects in the Lachlan region funded under the program include;

- the Parkes-Peak Hill Water Supply Project which will deliver 39 km of new pipeline to link new and existing infrastructure, 2 new pump stations, an upgraded Lachlan River pump station, 2 new pre-treatment plants in Eugowra Road and Akuna Road and a new raw water dam at the Parkes Water Treatment Plant
- Condobolin bores and pipeline Project – to improve the drought security of Condobolin town water supply via the installation of 3 new bores and construction of a 28 km long pipeline and pump station to transfer water from the bores to Condobolin
- the Billimari to Cowra pipeline Project – to improve the drought security for Cowra town water supply via the installation of 2 new bores and construction of a 26 km pipeline and pump station to transfer water from the bores to Cowra
- the Central Tablelands Water emergency drought works, Lake Rowlands permanent pumping station and Caragabal water supply
- Cowra to Central Tablelands water emergency pipeline project and water emergency connection pipeline from Spring Creek Dam to Icely Road water treatment plant, East Orange harvesting wetlands (stage 2), and Gosling Creek Dam.

The 2022–23 budget has committed $370 million over the next 4 years, including $90 million in new funding to expand the program.

The program funds resolution of priority risks and issues through infrastructure and non-infrastructure solutions that align with one of the following categories:

- water security – risks that may affect current or future continuity of reliable and uninterrupted town water supply
- water quality – risks to health posed by drinking water supplies, considering the source waters and the barriers present in treatment systems
- environment – risks to human health or the environment from sewage management that does not satisfy community expectations or regulatory requirements.

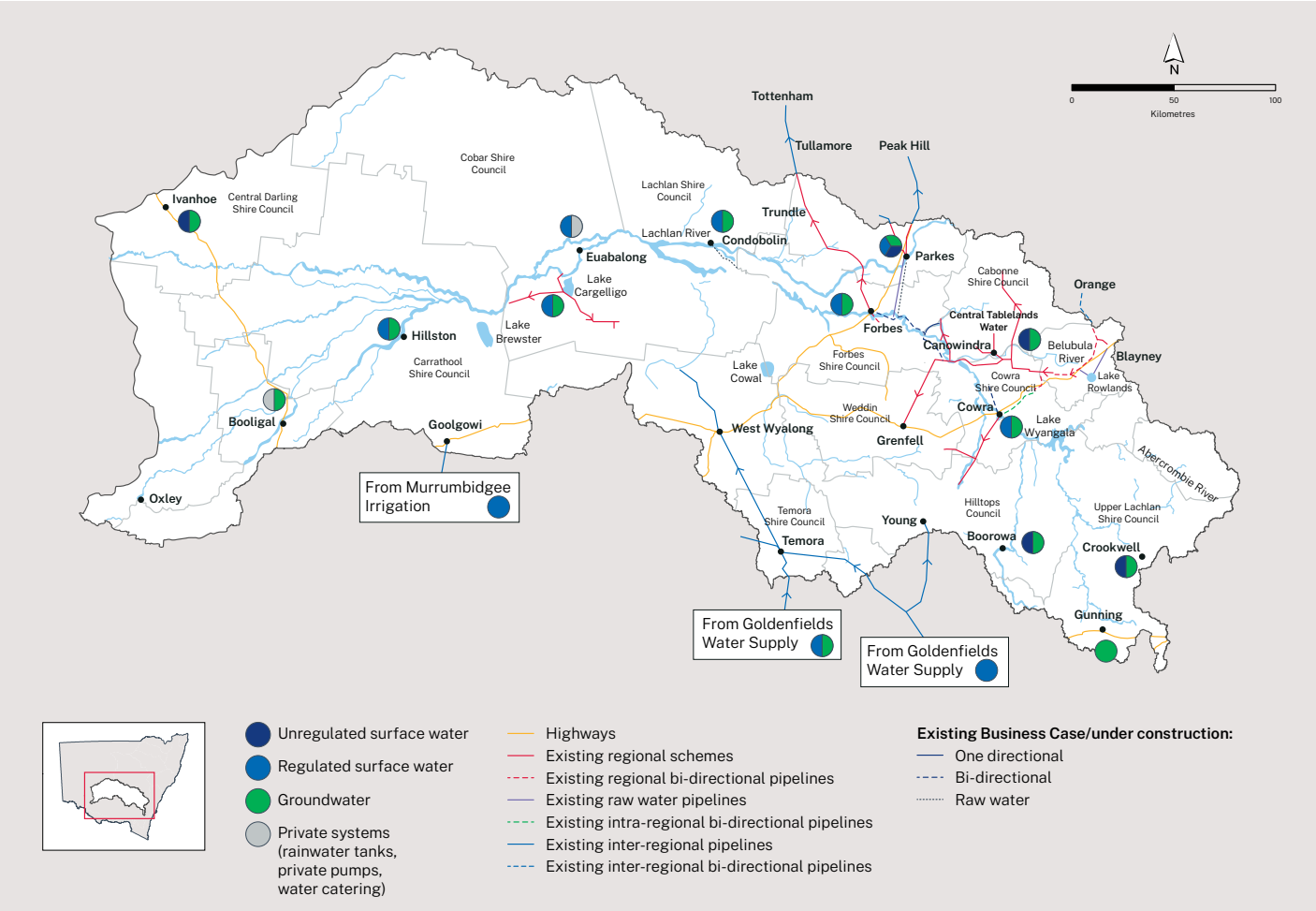
Each risk or issue is assessed against a prioritisation framework to determine how critical it is to regional NSW water safety and security. Risks and issues are ranked based on the result of the prioritisation assessment.

Proposed action 1.7: Investigate the need to further expand the regional water supply grid

There is an extensive water supply pipeline network in the Lachlan region (Figure 20), however not all pipelines are interlinked, and many towns are only connected by a single supply pipeline. This presents a potential risk to towns at the extremities of the network[105] if supply is interrupted.

The arrangements for how the existing town water supply pipeline linkages are operated are a matter of the relevant local water utilities who either have formal agreements in place or are in the process of negotiating these agreements. The NSW Government recognises that these pipeline linkages are important water infrastructure assets – in particular during times of drought or emergency situations. State and local government will work together to identify how best to utilise the existing town water supply pipeline network during extreme event situations to better protect town water security and build resilience in the region. We will also seek to work with local water utilities to publish information relating to the operation of the pipelines including when transfers are triggered (see proposed action 1.1).

Figure 20. Existing town water pipeline network in the Lachlan region



Source: Department of Planning and Environment, 2022

105. For example, Tottenham at the end of the B-Section pipeline (Forbes to Tottenham) and Manildra (if the emergency bore located at Cudal that supplies Cudal and Manildra fails)

During consultation for the Draft Lachlan Regional Water Strategy, we heard that protecting town water security should be a key priority for the Lachlan Regional Water Strategy and that there are benefits to taking a 'multi-source' approach to future town water security.

The NSW Government supports all options being on the table to ensure water security to towns and communities in the region. Therefore, we are committed to proactively supporting water utilities in diversifying sources of water and implementing demand management and water efficiency measures.

To best meet the needs of towns and communities in the Lachlan region during extreme events, we will need to better understand the minimum amount of water each town requires for critical human, social and environment needs. We also need to understand how long residents and businesses are willing and able to endure extended water restrictions. Given the existing town water supply pipeline network extends beyond local government boundaries, and in some instances beyond catchment boundaries, this may require a joint conversation between state and local government around developing guidelines and principles of how water should be shared to ensure all towns and communities receive the minimum amount of water required during extreme events. It will be important that such guidelines and principles are agreed by all interconnected local water utilities and are put in place well before they are needed. This will ensure they provide an overarching obligation for each local water utility to take into consideration the critical human needs of its interconnected neighbouring communities. In addition, such guidelines and principles will also help prioritise when the next major water supply augmentation may need to be implemented and at what cost. For example, the timing for large infrastructure investments could be pushed back by taking smaller incremental measures to reduce growth in demand such as reducing pipe leakage, adopting more water efficient technologies and practices, sharing water across local government boundaries and substituting to recycled water for some purposes.

Demand management and alternative, climate independent water supply sources, like recycled water, will be critical to support town's water security, build resilience and provide opportunities for population growth without increasing drought risks. The NSW Government has committed to progressing regulatory reform, guidelines and community acceptance campaigns to make the development and use of recycled water easier.[106] We will continue to investigate ways to address any limitations at the state and local level and work with local water utilities to identify policy and regulatory barriers to recycled water use.

In the Lachlan, water utilities and local councils are also investigating ways to upgrade the existing pipeline networks and are developing a sub-regional town water strategy to improve security and resilience. However, we have identified that there are additional strategic upgrades that could improve a regional water supply grid.

Alongside enhancing the efficiency and maximising the utilisation of the existing regional town water supply network, improving our understanding future demand and considering demand management measures, water reuse and recycling initiatives, we are proposing 2 actions that could further improve the security and resilience of town water supply across the region, including for towns at the extremities of the existing network and with major population centres:

- investigate the need to upgrade the trunk mains of the existing Central Tablelands Water network
- investigate the most feasible and cost-effective strategic option(s)[107] to address the water security issue to the towns along the B-section pipeline and consider additional offtake points.

Critical for these conversations will be determining how costs for any potential future upgrades should be shared amongst different local water utilities. This action links in with proposed action 1.5 (Support groundwater use for towns and communities) and the consideration of developing a network of linked groundwater bores. It also relates to the NSW Government's new Water Efficiency Program and Water Efficiency Framework.[108]

106. Department of Planning and Environment, *NSW Water Strategy*, www.dpie.nsw.gov.au/water/plans-and-programs/nsw-water-strategy
107. Options include:
    - Upgrading the B-section pipeline and associated pumping assets to meet current (and forecast) water demands.
    - Additional water storage and/or source in Tottenham.
    - source additional surface water – for example from the Bogan River or Trangie/Nevertire irrigation scheme, and pipe it approximately 20 to 30 km to Tottenham's Leg O Mutton dam.
    - Construct a local ground tank(s) for example the previously proposed 200 ML "Caloola" ground tank (piping 5 km to Leg O Mutton tank) or alternatively at Albert (piping 25 km), or a number of small local ground tanks (piping 5 to 10 km)
    - Operational and demand strategies to maximise existing assets
    - Access to additional groundwater sources.
108. Department of Planning and Environment, *Water Efficiency Program and Water Efficiency Framework*, www.industry.nsw.gov.au/water/plans-programs/water-efficiency-program-and-framework#:~:text=The%20program%20will%20focus%20on,2021%20and%20in%20early%202022.

Progressing this action

This action would include:

- facilitate discussions with local councils and Central Tablelands Water to better understand future town water demand in the region (and across neighbouring regions) and drive demand management, water reuse and recycling initiatives at a local and regional level
- facilitate discussions with local councils and Central Tablelands Water to further explore existing and emerging concepts to expand on the local water distribution networks to establish a broader regional water supply grid. These discussions will need to determine the project proponents, cost sharing arrangements, and who would be responsible for asset ownership, ongoing operation/maintenance and renewal costs
- undertake a joint investigation with Central Tablelands Water for a strategic upgrade of Central Tablelands Water trunk mains. Further modelling will be required to progress this investigation.
- undertake a joint investigation for the most feasible and cost-effective strategic option(s) to address the water security issue to the towns along the B-section pipeline, in particular Tottenham; as well as the need to have any additional offtake points from the B-section pipeline.

Have your say

Do you support the expansion of the existing regional water supply grid to share water across local government boundaries in times of need?

What are your views on best meeting the water needs of towns reliant on the existing B-section pipeline?

Is there a need to have additional offtake points from the B-section pipeline? If so, why?

Image courtesy of iStock. Cowabbie Creek, NSW.

Dealing with water-related challenges in the Belubula

During the last drought (2017–2020), drought declarations in the Belubula escalated from stage 1 to stage 3 over the course of 6 months, as there was insufficient water available to maintain a constant flow of 10 ML/day at Helensholme gauge[109] without the risk of draining Carcoar dam.

The Belubula catchment is especially sensitive to emerging drought. More akin to an unregulated system, the Belubula catchment experiences highly variable inflows into a comparatively small headwater storage (Carcoar dam capacity is 36 GL storage). The system also has no major re-regulating structures despite highly variable unregulated tributary flows downstream of Carcoar dam. There is a high connectivity between surface water and groundwater sources at the end of the Belubula system, which makes it difficult to meet some of the existing Water Sharing Plan requirements and means the Belubula doesn't always connect to the Lachlan River.

Significant work is already underway to review and address the water-related challenges in the Belubula catchment and to meet the future water needs of users and the environment.

The Natural Resources Commission is completing a statutory review of the Water Sharing Plan for the Belubula Regulated River Water Source 2012 and the Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012. This review will help identify opportunities to improve water sharing provisions and associated outcomes.[110]

Water Infrastructure NSW is leading the development of the Belubula Water Security Project, a business case that assesses a range of potential options to improve the efficiency and resilience of water management in the region. This business case will include an assessment of 2 interrelated pieces of infrastructure; a pipeline linking the Central Tablelands Water owned Lake Rowlands, and the WaterNSW owned Carcoar Dam and the augmentation of Lake Rowlands. An important aspect of the Belubula Water Security Project will be to further investigate the future town water demand from Central Tablelands Water's customers.[111]

Also, one of the options that has been investigated as part of the Lachlan Regional Water Strategy is a new weir in the Belubula. This option was proposed by stakeholders during the first public exhibition. We have undertaken some preliminary hydrological modelling on the Belubula weir option (see Attachment 2).

Have your say

Are there any specific water-related challenges in the Belubula that are not currently being addressed by the Belubula Water Security Project and the Natural Resources Commission Water Sharing Plan review?

109. A requirement of the *Water Sharing Plan of the Belubula Regulated Water Source 2012*.
110. The Minister for Water considers the Natural Resources Commission's report before deciding to extend or make a new Water Sharing Plan.
111. Action 1.6 of the *Macquarie-Castlereagh Regional Water Strategy* seeks to identify the best long-term augmentation solution for towns in the upper Macquarie and includes a consideration for supply of water to Bathurst and/or Orange from the Lachlan catchment. Several other options will also be investigated as part of action 1.6 in the *Macquarie-Castlereagh Regional Water Strategy*.

Image courtesy of Destination NSW. Parkes Railway Station, Parkes.

Priority 2

Ensure best use of existing water for the environment

There are significant and diverse wetland types along the Lachlan River, some of which are unique to the catchment. The NSW Minister for the Environment and the Commonwealth Environmental Water Holder hold and manage[112] a portfolio of water entitlements for environmental outcomes. The majority has been purchased from the consumptive pool, but a portion has been acquired through water efficiency projects.[113]

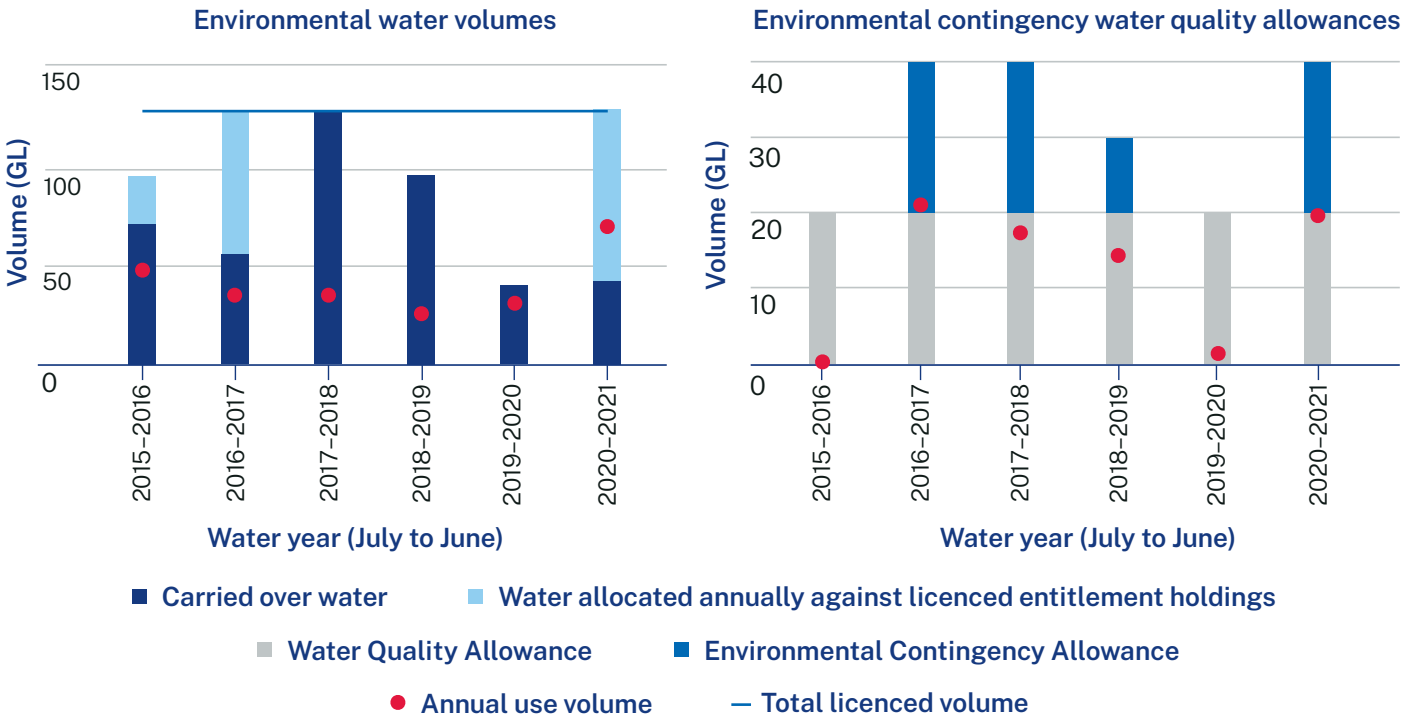
Given the inherent challenges, constraints and uncertainty around water resource planning and management, environmental water managers[114] have adapted to the prevalent conditions by using both preventative and responsive strategies to manage the needs of aquatic ecosystems. Watering events target a range of outcomes; from building resilience and promoting ecological restoration when water is abundant, to minimising loss or damage by maintaining drought refuges when water is scarce. A good understanding of the river system and ongoing communications with other water users and river operators are imperative to enable effective environmental watering events. Where possible, environmental managers work with communities, other water users, WaterNSW and Aboriginal people to take local actions that have catchment-wide outcomes and protect important environmental and cultural sites.

Held environmental water uses the same water access licence framework as consumptive users. However, as the watering requirements of environmental assets and functions in the Lachlan Long Term Water Plan are fundamentally different to other industries like mining and agriculture, management strategies differ accordingly.

Environmental water is managed at a catchment scale and the use of held water is linked to availability and use of planned environmental water.[115] This is reflected in the different held and planned environmental water used over the last few years (Figure 21).[116]

112. Day to day planning and management activities are carried out by the Department of Planning and Environment, Biodiversity and Conservation Division under delegated authority from the Minister for the Environment
113. Funding from the Commonwealth Government's Water Smart Australia fund was granted to extend NSW RiverBank investment under the NSW Rivers Environmental Restoration Program (RERP). By end of January 2011, NSW Rivers Environmental Restoration Program and RiverBank had purchased 24,103 megalitres (ML) of general security and 1,000 ML of high security water access entitlements in the Lachlan. In addition, the Lake Brewster Water Efficiency Project provided for 12,000 ML of general security in June 2009. A further 795 ML of high security was recovered in September 2012 from the Pipeline NSW Program (Noonamah Water Authority).
114. In the Lachlan region, existing management structures ensure the effectiveness of environmental watering.
    - The Environmental Water Advisory Group is made up of representatives from industry, the environment and government. Regular meetings are held throughout the year and as required to seek advice, ensure consistency of objectives, and maximise the outcomes from both held and planned environmental water.
    - The Biodiversity and Conservation Division of the NSW Department of Planning and Environment and Commonwealth Environmental Water Office are in regular communication (at the beginning of the water year, and during watering events) to develop and implement multi-year and annual water plans.
115. Measures of success are less tied to system operational efficiencies as outcomes are measured by different indicators
116. Department of Planning and Environment, *Environmental water dashboard and analysis*, www.industry.nsw.gov.au/water/environmental-water-hub/public-register/dashboard

Figure 21. Environmental water volumes available for use in the Lachlan region



Source: Department of Planning and Environment – Water, 2022, compiled from data available on the Allocations Dashboard, www.industry.nsw.gov.au/water/allocations-available/allocations/dashboard

Note: Figure 21 highlights the volumes of held and planned environmental water available and its uses in the Lachlan valley since 2015–16.

Image courtesy of iStock. Sheep grazing below the Blayney to Carcoar windfarm.

Water used for the environment is dependent upon a range of factors, including weather conditions, river flows, catchment conditions and water available against the entitlement held by environmental managers. All of these factors require environmental managers to be strategic and adaptable to achieve the best ecological outcomes. However, this can sometimes mean that not all of the water available for the environment is used in any given year.[117]

Environmental water managers have a range of strategies for a range of resource availability scenarios that are typical of a 'boom and bust' inland river system. The environment utilises all sources of water and environmental managers build on natural cues such as rainfall and runoff, and when translucent release[118] targets are triggered at Wyangala Dam. This helps target large overbank or wetland floodplain assets and maintain connectivity to the floodplain. During drier periods, there may be shift in focus to in-stream habitats and connectivity, and a mosaic of core wetlands where water can be delivered to under drought contingency measures.

Challenges for the environment remain with poor water quality and changes to instream flows under long-term climate change projections. In addition, water for the environment cannot always be used effectively when it is needed due to a range of constraints, or delivered to its best affect during dry times.

Actions under this category focus on:

- supporting natural resource management activities in the upper and lower Lachlan region
- addressing existing water quality issues in the region
- protecting important cultural assets and supporting co-benefit outcomes of the use of environmental water where feasible
- removing constraints and impediments to environmental water delivery.

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

The Natural Resources Commissions is undertaking an independent review of the Water Sharing Plan for the Belubula Regulated River Water Source 2012 and the Lachlan Unregulated River Water source 2012[119] as per Section 43A of the *Water Management Act 2000*. These reviews will help identify opportunities to improve water sharing provisions and associated outcomes.

The Lachlan Valley Salinity Technical Report supports the Water Quality Salinity Management Plan and includes options for improved salinity management.

The Water Quality Management Plan developed for the Lachlan Surface Water Resource Plan and the Lachlan Alluvial Water Resource Plan aims to provide a framework to protect, enhance and restore water quality for the region.

117. Carrying over unused water allocations is a strategy that is also adopted by other water users who hold general security water entitlements in the Lachlan region.
118. Water Sharing Plan Clause 15 (1). Date Window: 15 May to 15 November. Minimum inflow total: since 1 January Wyangala Dam inflows must exceed 250,000 ML. Minimum daily flow trigger: summed inflows upstream and downstream of the dam equal to 3,500 ML/day or 4,000 ML/day at Lake Brewster weir. Maximum total translucent volume: (including any surplus flows) since 1 June must be less than 350,000 ML as measured past Lake Brewster weir. If above is met, release the inflow or a lesser volume to meet the maximum daily flow target at Brewster weir [between 3,500 ML/day to 8,000 ML/day based on the level of Wyangala storage]
119. Natural Resources commission, Water Sharing Plan reviews, www.nrc.nsw.gov.au/wsp-reviews

Legend				
Managing water resources during more extreme events for people, industry, and the environment	Improving water quality	Addressing barriers to Aboriginal water rights	Sustaining the health and resilience of the region's water dependent ecosystems	Supporting economic growth and diversification

Table 3. Overview of proposed actions to ensure best use of existing water for the environment

Proposed action	Summary	Challenges addressed
Action 2.1 Reduce salinity and soil erosion in the upper Lachlan and Belubula catchment	Prioritise rehabilitation areas to improve soil retention on site and reduce sediment and salt transfer to waterways in the upper Lachlan and Belubula catchments in partnership with local groups such as Landcare.	
Action 2.2 Protect and rehabilitate regionally significant riparian and instream habitats in the regulated Lachlan River	Build on existing land management programs and other local initiatives to support whole-of-catchment programs to improve river health and ecosystem resilience in the Lachlan River downstream of Wyangala Dam.	
Action 2.3 Upgrade and automate existing public re-regulating structures in the mid- and lower Lachlan to build the functional resilience of critical ecosystems	Progress a system level assessment of existing re-regulating structures in the mid- and lower Lachlan with a view to identify critical infrastructure upgrades as well as undertake feasibility studies to assess the merit of constructing a new weir in the lower Lachlan.	
Action 2.4 Mitigate the impact of water infrastructure and disruption of natural flows on native fish	Progress work to seek the installation of fish passages at priority barriers in the Lachlan region and build on existing government commitments, which continue to encourage and incentivise the installation of diversion screens at priority sites.	
Action 2.5 Review and evaluate the Lake Brewster Water Efficiency Project	Review and evaluate the adaptive management processes associated with the Lake Brewster Water Efficiency Project and investigate ways to fully fund the implementation of monitoring and evaluation plans.	

Proposed action 2.1: Reduce salinity and soil erosion in the upper Lachlan and Belubula catchment

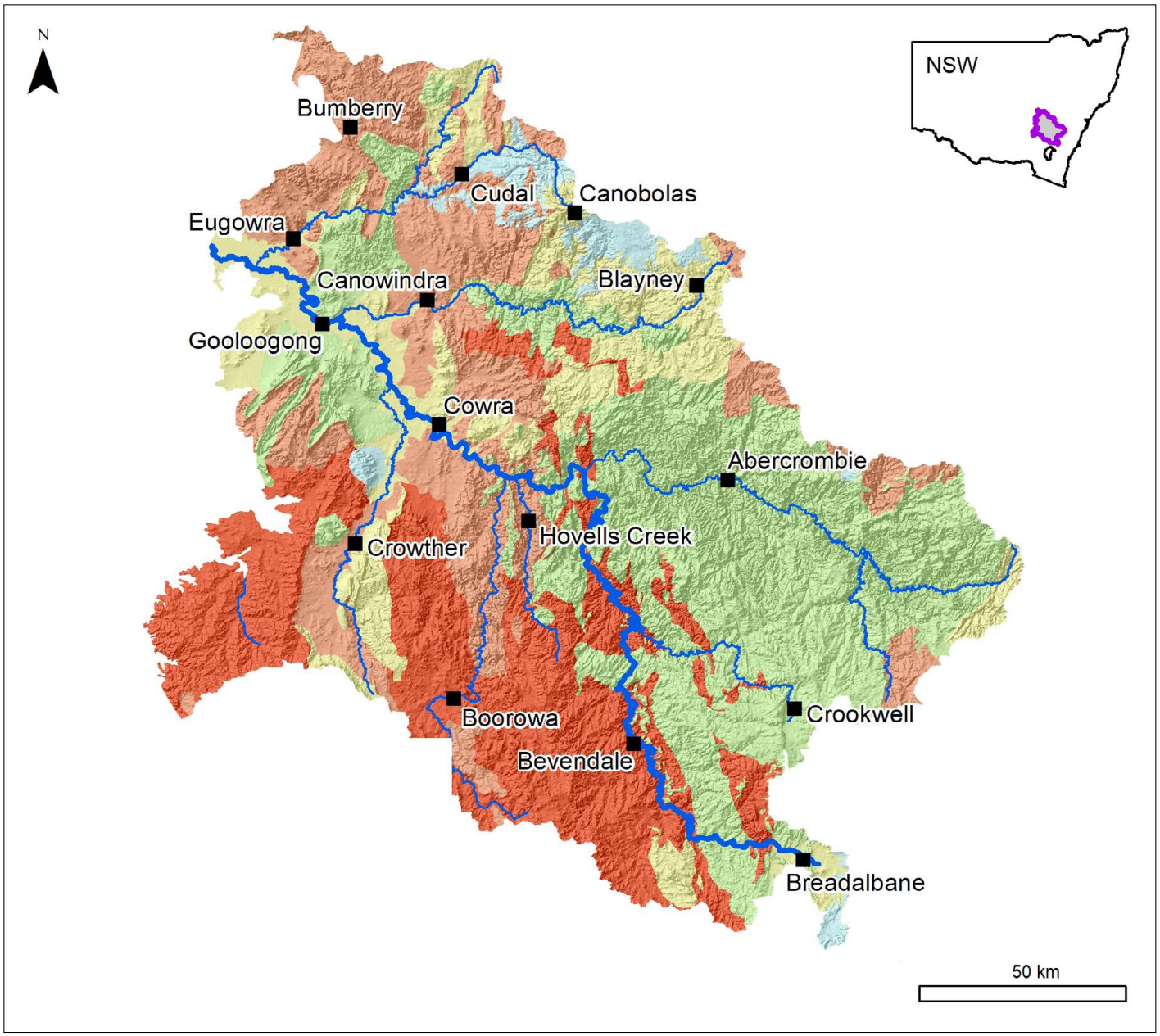
In the upper Lachlan and Belubula catchments, land use management is a driver contributing to salinity, high turbidity and nutrients entering waterways into unregulated rivers. Nutrient management in the catchment area of Wyangala and Carcoar dams is essential to reduce the risk of algal blooms within the dams.[120] Salinity (both dryland and instream) causes high salt concentrations in waterways and can also lead to vegetation die-off, which contributes to erosion and high turbidity.

The upper Lachlan and Belubula catchments contribute significant salinity (Figure 22) and turbidity to waterways.[121]

Image courtesy of Stef Schulte. Forbes, NSW.

120. *Water quality technical report for Lachlan water resource plan area* (SW10)
121. *Department of Planning and Environment – Water 2022, Water quality technical report for Lachlan water resource plan area, Valley Salinity Technical Report.*

Figure 22. Overall salinity hazard for the upper Lachlan region



Legend

Overall hazard

- Very High
- High
- Moderate
- Low
- Very low

- Towns
- Lachlan River
- Major Tributary

Source: Department of Planning and Environment – Water 2022, Lachlan Valley Salinity Technical Report

Historic land clearing resulting in large scale soil erosion has led to a 150 km sediment slug downstream of the junction of the Boorowa and Lachlan Rivers, which is causing problems with fish habitat and breeding, and localised flooding.[122] We have heard that local councils in the upper Lachlan have removed sand, silt and debris from low level road crossings and drains in areas around Hovells creek and Bevandale. In addition, Hovells creek Landcare are working to reduce instream sediment loads through funded programs in erosion control, planting, and fencing.[123]

This action would build on and expand past projects (partially funded through the NSW Catchment Management Action program) to improve land management practices and water quality in the upper parts of the catchment. To achieve effective outcomes, the NSW Government would seek to work with local groups such as Landcare groups, landholders, Aboriginal people and interested parties to prioritise areas to improve soil retention on site and reduce sediment and salt transfer to waterways in the upper Lachlan catchment.

To progress this action, we need to:

- better understand priority areas that should be targeted to address known salinity and erosion hot spots in the region. This will help to explore options to address salinity issues in the region
- ensure the soil chemistry is properly understood when using conventional earthworks at a saline site
- investigate ways to compliment catchment improvements outlined in existing plans such as the Lachlan Long Term Water Plan and the Central West Strategic Weed Management Plan
- consider setting up nutrient trading schemes or stewardship and certification systems, which could incentivise private land holders to undertake rehabilitation work on their land
- investigate opportunities to incentivise councils and other landholders to rehabilitate waterways and generate biodiversity offset credits which could provide additional income for landholders while achieving environmental gains.

Have your say

Are there particular land management interventions that could assist with the existing issues in the upper Lachlan and Belubula catchment?

Would a nutrient trading scheme or stewardship and certificate system work in the upper Lachlan and Belubula catchment?

122. Department of Primary Industries – Fisheries 2018, *Lachlan River Habitat Mapping – Inundation heights for key habitat features and management recommendations for Wyangala Dam to Cottons Weir reach of the Lachlan River.*
123. hovellscreeklandcare.org.au/current-activity/157-erosion-control-works-on-properties-to-address-threatened-species-and-sedimentation-issues-in-hovells-creek-and-the-lachlan-river

Proposed action 2.2: Protect and rehabilitate regionally significant riparian and instream habitats in the regulated Lachlan River

The degradation of native riparian vegetation is leading to bank slumping, which has been identified as a factor contributing to poor water quality and loss of instream habitats in the regulated system downstream of Wyangala Dam.[124] Restoring degraded riparian vegetation and instream habitats can strengthen the long-term resilience of rivers and improve the ecological response across the flow regime. The degradation of native riparian vegetation along water courses is recognised as a key threatening process under the *Fisheries Management Act 1994*.

Restoring and protecting riparian and instream habitats is particularly relevant for the regulated Lachlan River as the timing and volume of releases from Wyangala Dam and re-regulating storages can impact flows and lead to bank slumping. Furthermore, wetlands on private land – often adjacent to or part of riparian vegetation – are often used for grazing, which can impact the native vegetation cover and cause bank instability.

We heard during consultation that there needs to be more opportunities to encourage improved land management and investment in natural resource management initiatives and rehabilitation work. There are existing initiatives to improve native riparian vegetation and instream habitats though the Murray–Darling Basin Healthy Rivers Program, and some landholders are already investing in ways to rehabilitate riparian land and manage land in a way that supports healthy waterways.

This action proposes to improve native riparian vegetation, instream habitats and water quality in the regulated Lachlan River by building on existing land management programs and other local initiatives. Works could include introducing appropriately designed and approved large woody structures for instream habitat, as well as improved instream vegetation, to slow flow and filter pollutants. Improved riparian management, including controlled stock access, would provide bank stability, protect from banks from erosion, limit sediment and nutrient transfer into the river from hillslope and discontinuous watercourses and reduce sediment loss during floods.

To progress this action, we need to:

- coordinate existing programs and address potential overlaps in activities
- complete detailed habitat mapping for the regulated Lachlan River[125] and collate information on native fish conditions, threatened species distribution, or the River Styles framework
- understand and integrate local Aboriginal knowledge and expertise in delivering river improvement works
- develop a monitoring and evaluation framework based on the outcomes and targets developed through the Long-Term Water Plans
- Investigate opportunities to incentivise councils and other landholders to rehabilitate waterways and generate biodiversity offset credits which could provide additional income for landholders while achieving environmental gains.

Have your say

Which areas could be targeted as a priority for riparian and instream habitat restoration works in the Lachlan below Wyangala Dam?

124. *Water quality technical report for Lachlan Water Resource Plan area* (SW10)
125. Habitat mapping has been completed for most of the catchment except the lower reaches

The NSW Water Strategy is committed to long-term monitoring and state-wide improvements to water quality

In the right locations, long-term monitoring is important for determining trends and identifying sites for remediation. It is also crucial for assessing whether remediation was successful. Improved information about water quality could be used to inform future planning and management of the Lachlan River, such as improvements to environmental water requirements, identifying components for protection, and preventing ecosystem harm.

In that context, the NSW Water Strategy has committed to:

- invest in long-term and effective monitoring, evaluation, reporting and research (Action 3.4)
- implement monitoring, evaluation, and reporting frameworks to track the effectiveness of plans and policies and inform future management actions
- apply the updated River Condition Index across NSW to provide a baseline for addressing progress of the NSW Water Strategy and the regional and metropolitan water strategies
- adopt a more intense, state-wide focus on improving water quality (Action 3.5)
- continue to monitor and review the *NSW Water Quality Objectives* across NSW to ensure they reflect contemporary community and environmental values and uses[126]
- define clear roles, accountabilities, and frameworks for monitoring, assessing and addressing water quality risks across the state
- ensure the community can access information about water quality.

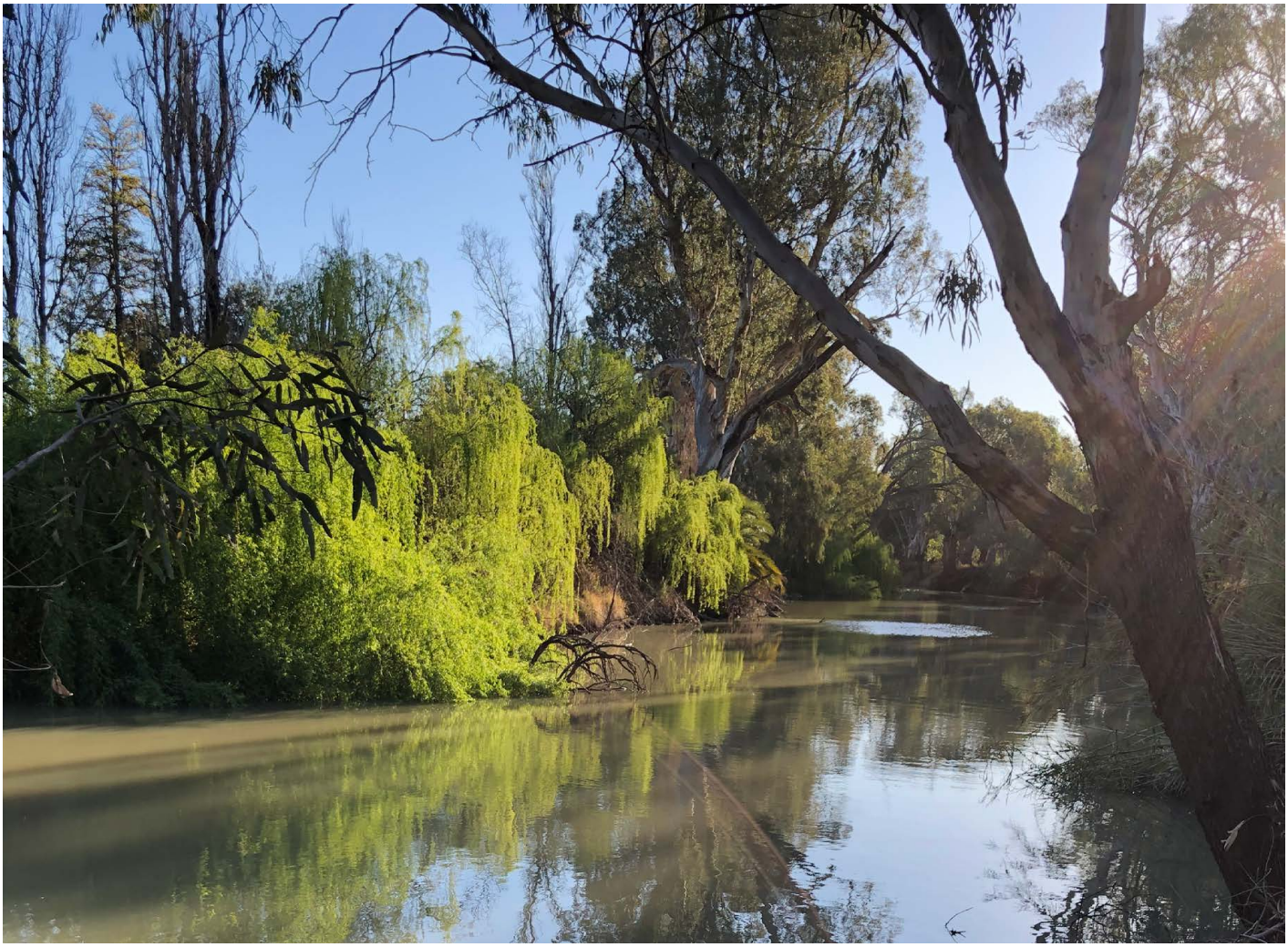


Image courtesy of Stef Schulte. Lachlan River, NSW

126. www.environment.nsw.gov.au/topics/water/water-quality/protecting-and-managing-water-quality

Proposed action 2.3: Upgrade and automate existing public re-regulating structures in the mid-and lower Lachlan to build the functional resilience of critical ecosystems

Re-regulating structures in the Lachlan region are important for delivering water throughout the catchment and for meeting the environmental water requirements that are outlined in the Lachlan Long Term Water Plan.[127]

During the public exhibition of the first Draft Lachlan Regional Water Strategy we heard there was a need to upgrade, automate or replace several re-regulating structures to better manage flow targets in the lower Lachlan. In particular, we heard that some structures were old, inefficient and have seen little investment in maintenance given the remoteness and small number of users they serve. We also heard that these structures are at risk of leaking or failing during environmental watering events, or are inaccessible and cannot be adjusted in line with adaptive management requirements. Enhancing the utilisation of existing re-regulating assets through upgrades and automations or considering the installation of new re-regulating assets will improve the sensitivity and strategic targeting of important environmental objectives in the mid- and lower Lachlan.

Progressing this action

This action will progress a system level assessment of re-regulating structures in the mid- and lower Lachlan with the view to identify critical infrastructure upgrades (Figure 23) and undertake a feasibility study to assess whether there is any merit of constructing a new weir in the lower Lachlan, noting environmental implications as part of any proposed activities and assessments.

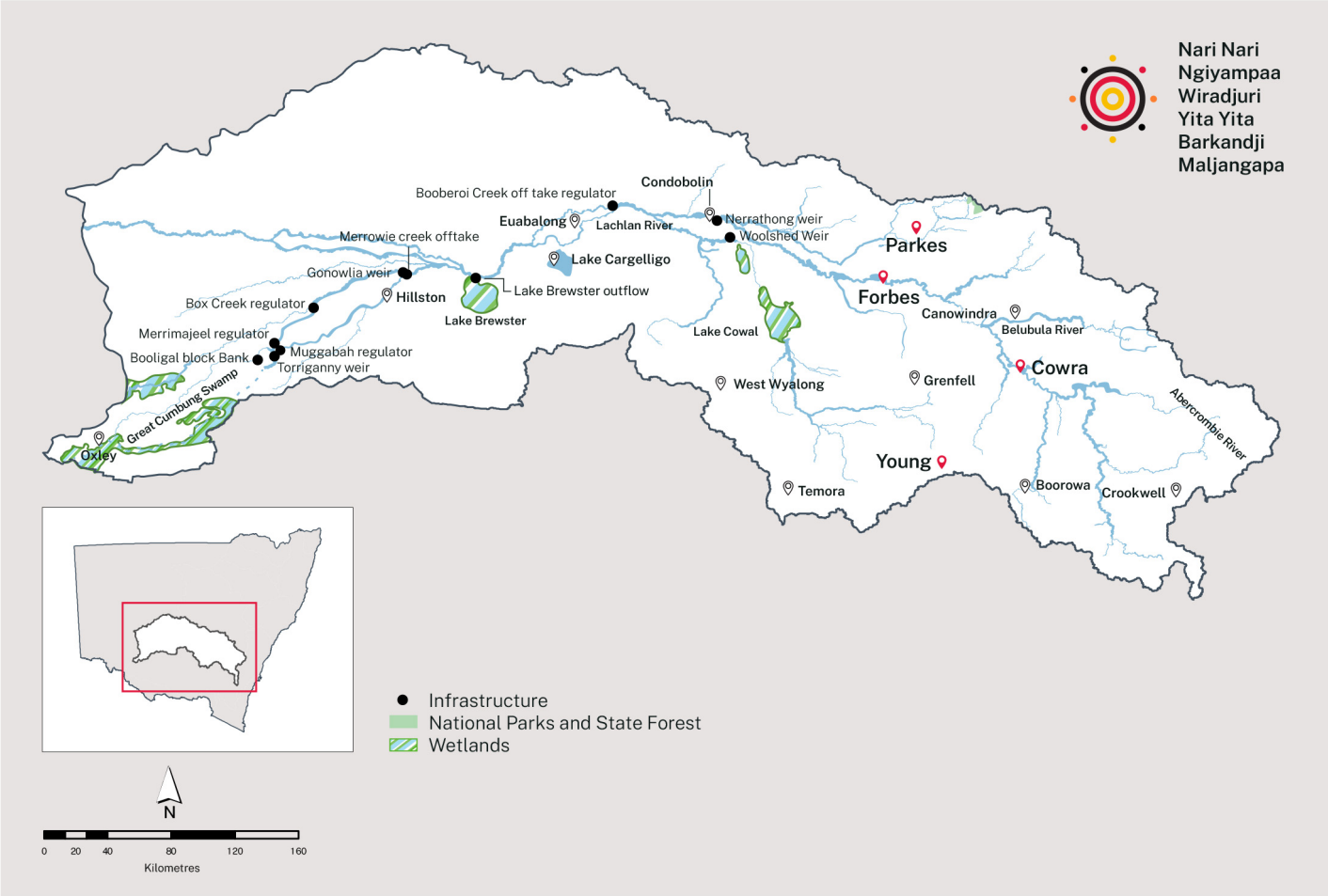
To the extent these infrastructure assets are not already being upgraded, the Lachlan Regional Water Strategy proposes to progress the following

- replace and automate Torriganny, Woolshed and Nerrathong weirs[128]
- install additional automated level gauges in Lake Brewster outflow wetlands and inflow channel (in conjunction with Action 2.5)
- automate Gonowlia weir (and Merrowie Creek offtake), Muggabah regulator, Merrimajeel regulator, Box Creek regulator, and Booberoi Creek off-take regulator and delivery channel
- conduct a feasibility study for the upgrade of the Booligal Block Bank. The Booligal Block Bank is operated by Department of Planning and Environment staff during major colonial bird-breeding events. Ownership of the Booligal Block Bank remains unclear, and the block bank itself plus additional infrastructure such as road culvert crossings, needs to be upgraded to ensure compliance with the *Water Management Act 2000* and floodplain management plans
- investigate the construction of a new weir in the lower Lachlan in the context of any other upgrades, replacement and automation of the existing re-regulating structures and the development of the business case for the Wyangala dam raising project.

Considering all of these structures at a system scale will allow for a broader assessment of the benefit and costs while factoring in that any work on the existing re-regulating structure interacts with the current final business case for the Wyangala Dam Wall raising project.

127. EWRs support water quality, system scale productivity and drought refugia and they also facilitate the movement of aquatic fauna from stressed state to more moderate conditions.
128. WaterNSW Lachlan Customer Advisory Group Presentation April 2021

Figure 23. Location of infrastructure requiring upgrades and investigations



Have your say

Are there any issues we need to consider for the upgrade and automation of some of these water infrastructure assets?

Proposed action 2.4: Mitigate the impact of water infrastructure and disruption of natural flows on native fish

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

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

Currently, native fish can only move freely through the Lachlan system during high flows when water flows over weirs and other instream barriers. Removing barriers to fish movement and allowing fish to breed and find food and essential habitat is critical to supporting resilient native fish populations in the Lachlan region.[129]

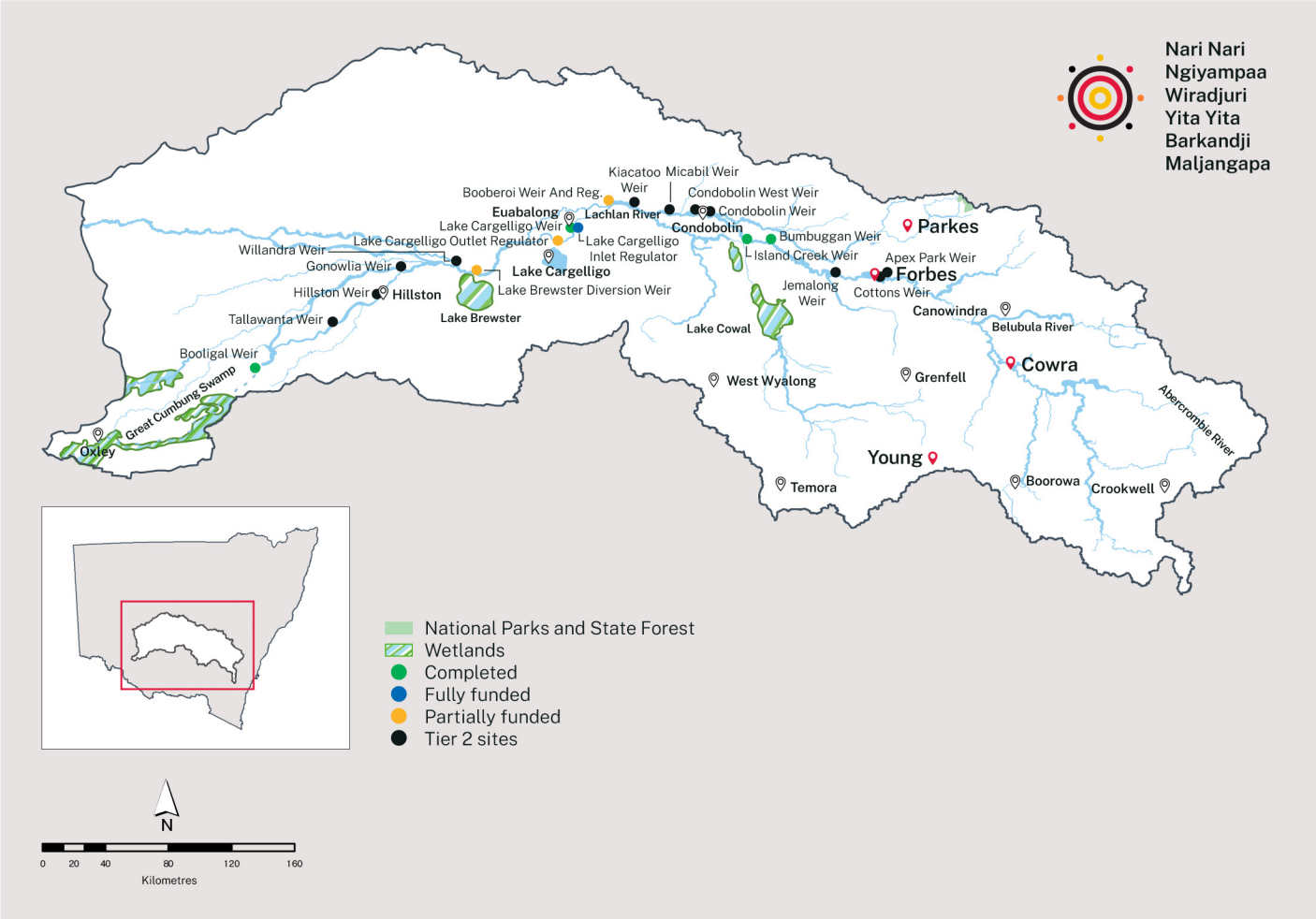
The NSW Fish Passage Strategy outlined several priority sites for improving fish passage (Figure 24). One of these sites[130] has been fully funded and 3 tier-one sites require further funding. These include:

- Lake Cargelligo Inlet – detailed design and construction
- Lake Brewster Diversion Weir – construction
- Booberoi Weir and Regulator – construction.

Four fish passages[131] have been completed in the Lachlan region and are now operational. This action would improve fish passage at the remaining priority tier-one sites within the Lachlan region and progress tier 2 sites[132] during the life of the regional water strategy as funding and opportunities become available.

129. www.dpi.nsw.gov.au/fishing/habitat/threats/barriers
130. Lake Cargelligo Outlet is scheduled for detailed design and construction by 2025
131. Island creek weir, Bumbuggan weir, Lake Cargelligo weir, Booligal weir
132. Tier 2 sites could include Tallawanta Weir, Hillston Weir, Gonowlia Weir, Willandra Weir, Kiacatoo Weir, Micabil Weir, Condobolin West Weir, Condobolin Weir, Jemalong Weir, Cottons Weir and Apex Park Weir

Figure 24. Location of NSW fish passage upgrade sites in the regulated Lachlan River



Implement diversion screens at priority pumps

Every year, large numbers of native fish are extracted from the Lachlan River by pumps and diverted into channels. Unscreened pumps or pumps with ineffective screens results in the death or injury of fish and other aquatic animals. With more than 750 pumps[133] in the Lachlan valley, there is an opportunity to prevent large scale injury and death of aquatic animals.

The Lachlan waterways and floodplains support up to 17 species of native fish of which 9 are listed as threatened or endangered in NSW. The removal of large numbers of native fish eliminates individuals from breeding populations and the consequences accumulate over generations, adding to the stress on threatened and endangered populations.[134]

This action would build on existing government commitments such as Fish Screens Australia, which continue to encourage and incentivise the installations of diversion screens at priority sites in the Lachlan region. The NSW government would develop incentive schemes for pump owners to install appropriate screens.

Cold water pollution mitigation

Wyangala Dam was ranked as a high priority within the Cold Water Pollution Strategy 2004. Recently, the terms of reference for the Ministerial Taskforce on Fish Passage were updated to include responsibility for developing and implementing a strategy on Cold Water Pollution Mitigation.

Remediating cold water pollution requires a long-term and collaborative effort between agencies, asset owners and river operators. The Lachlan Regional Water Strategy will reconsider further actions to mitigate cold water pollution over the life of the strategy.[135]

133. Department of Primary Industries – Fisheries, 2020
134. Boys et al 2021, Native fish losses due to water extraction in Australian rivers: Evidence, impacts and a solution in modern fish- and farm-friendly screens, *Ecological Management and Restoration*, Vol 22, Issue 2, pp 134-144.
135. No explicit action was proposed for this iteration of the Lachlan Regional Water strategy due to the final business case work on the Wyangala Dam Wall raising project.

Better outcomes for fish in the Lachlan

Fish Screens Australia[136] is an information hub that aims to provide the best and most current information on fish screens in Australia. It is a collaboration between senior fisheries scientists, water users, manufacturers, university researchers, engineers, anglers and conservation managers.

Screens have been installed at pilot sites near Cowra and Condobolin with the help of funding grants.

Image courtesy of Fish Screens Australia. Fish screen installed near Cowra in March 2020.[137]

Have your say

Are there any additional measures that would improve native fish outcomes in the Lachlan region?

136. Fish Screens Australia, *About Us*, www.fishscreens.org.au/about/
137. fishscreens.org.au/case-studies/jimm-dara/

Proposed action 2.5: Review and evaluate the Lake Brewster Water Efficiency Project

Lake Brewster, in the mid reaches of the Lachlan system, provides flexibility for water managers and river operators as a re-regulating storage. The lake assists in reducing water order lag-time, providing extra storage space for tributary inflows downstream of Wyangala Dam, or to mitigate flood releases. Lake Brewster is listed in the *Directory of Important Wetlands*[138] and supported the recent record-breaking pelican breeding event.[139]

To prevent the lake from drying out and improve water quality for downstream users, the Lake Brewster Water Efficiency Project was completed in 2010. It aimed to:

- reduce evaporation
- improve efficiency and water quality
- increase supply security to water users and the environment
- enhance wetland function and habitat for native fish, waterbirds and other species
- develop and implement an operational plan and monitoring plan.

Despite this, the lake can be prone to water quality issues, reducing its value as a re-regulating storage and a nationally significant wetland.

We heard during consultation that Lake Brewster is an important storage for the lower end of the Lachlan River but there are concerns about water quality and the operation of the storage.

To progress this action, we would review and evaluate the adaptive management processes associated with the Lake Brewster Water Efficiency Project and investigate ways to fully fund the implementation of monitoring and evaluation plans. The management of the system from 2010 to now has identified potential enhancement opportunities that could improve water quality, environmental water management and river operations.

This action would include a detailed review and evaluation of the:

- Lake Brewster land and water management plan (2009)
- Lake Brewster Water Efficiency Project Fish Management and Operations Plan (2009)
- Lake Brewster Water Efficiency Project Monitoring and Evaluation Plan (2009).

The Lake Brewster Water Efficiency Project was designed as an example of how adaptive management and variability in the hydrological regime can achieve improvements in water quality whilst maintaining storage capacity. Now that the project has been operational for over 10 years it is timely to review and learn from this approach and determine whether successful aspects can be applied in similar lakes.

Have your say

Are there additional actions we should be pursuing at Lake Brewster?

138. www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW&doiw_refcodelist=NSW048
139. www.abc.net.au/news/2022-05-08/pelicans-lake-brewster-breeding-season/101033032

Record Breaking Pelican Breeding at Lake Brewster

Over the summer of 2021–2022 Lake Brewster supported a record-breaking pelican breeding event. Through collaboration with environmental water holders and WaterNSW, storage water levels were kept at optimum levels to give the pelicans the best chance of breeding success without impacting on third parties.

It is vital that nests are in an area with a ready supply of food, as it takes 4 months for chicks to become totally independent. Pelican chicks can eat up to 900 grams of food each day, while an adult can consume close to 2 kilograms. Their fishy diet is supplemented with tadpoles, turtles and even other birds. Breeding seasons like these are vital for preserving pelican populations across Australia.

Image courtesy of John Spencer, Department of Planning and Environment. Pelican (Pelecanus).

Lake Cargelligo work progress

For the other re-regulating storage in the Lachlan (Lake Cargelligo), WaterNSW is currently completing modifications to the existing 3 embankment dams of Lake Cargelligo to stabilise, strengthen and increase their integrity. This is to reduce the risk of failure and to ensure the embankments function effectively for the long-term.[140]

In the first Draft Lachlan Regional Water Strategy, we proposed 2 draft options to augment the storage of the Lake Cargelligo system (option 27 and 31). These 2 suggested options were not progressed in this second draft due to strong feedback from the community that progressing these options would cause irreparable environmental harm, disturb important cultural sites, and significantly impact the community and tourism at Lake Cargelligo.

The Lake Cargelligo system remains an important re-regulating storage for the lower Lachlan region and there is increasing research to show its significance in providing habitat for native species.[141]

140. www.waternsw.com.au/projects/regional-nsw/lake-cargelligo-embankment-dams
141. Kerezsy, A 2021, *The aquatic fauna of the Lack Cargelligo system in the Lachlan catchment 2017–2021*, A report prepared for NSW Department of Planning, Industry and Environment.

Priority 3

Support economic prosperity in a capped system

The Lachlan region lies at the geographic heart of NSW, leveraging its position along nationally significant rail and road corridors that encourage further industry development as well as population and job growth. The industry profile of the Lachlan region is changing and new and expanding industries will drive further demand for water and increase competitive pressure on existing water resources.

Actions under this priority seek to strengthen the resilience of the regional economy to climate-related challenges by providing access to the new climate datasets, supporting industry adaptation efforts and back research efforts to better understand water use in the region.

Additional actions under this priority seek to support water-related employment, training and economic opportunities for Aboriginal people. These opportunities will help to meet the priorities and actions of the NSW Water Strategy, support the state-wide Aboriginal water strategy and align with NSW's commitment under the Basin Plan.

Actions shortlisted under this priority focus on:

- facilitating access to data and information to assist industry to better assess risks and develop mitigation strategies
- exploring water use and water demand of the region's industries and their resilience to a more variable and changing climate
- advancing economic opportunities for Aboriginal people and developing culturally appropriate placed-based initiatives
- improving our hydrological modelling capabilities to pursue further analysis on a range of infrastructure options that could improve system efficiencies and enhance reliability in the region.

What we're already doing

The NSW Government has committed to developing a final business case for the Wyangala Dam Wall-raising project to drive economic prosperity in the region. Water Infrastructure NSW, who leads the development of the Wyangala business case, has also developed a strategy for delivering Aboriginal community outcomes to help guide how it works with communities so they can share and benefit from the outcomes of investments in new water infrastructure.

The NSW Government's $48 million expanded **Farms of the Future program**, which will support on-farm connectivity and encourage farmers to adopt agtech to boost productivity, including water efficiency and drought preparedness. In 2022, a grants program will be delivered to help farmers purchase agtech devices and applications.

The **Future Ready Regions Strategy** includes a commitment to upgrade the Enhanced Drought Information System to provide farmers with world-leading weather and climate data so they can make better business decisions.

The NSW Government has developed a **Critical Minerals and High-Tech Metal's Strategy**. The Strategy outlines the NSW Government's vision to build on the existing potential and position NSW as a major global supplier and processor of critical minerals and high-tech metals well into the future.

The **20-Year Economic Vision for Regional NSW** is the NSW Government's plan to drive sustainable, long-term economic growth in regional NSW. It is the roadmap to unlock significant economic potential in regional NSW.

The NSW Government has assisted local councils to develop Regional Economic Development Strategies (REDS) based on the concept of a Functional Economic Region. The REDS provide a clear economic development strategy for the region and are currently under review.

Legend				
Managing water resources during more extreme events for people, industry, and the environment	Improving water quality	Addressing barriers to Aboriginal water rights	Sustaining the health and resilience of the region's water dependent ecosystems	Supporting economic growth and diversification

Table 4. Overview of proposed actions to support economic prosperity in a capped system

Proposed action	Summary	Challenges addressed
Action 3.1 Improve public access to climate information and water availability forecasts	Improve existing platforms and products to provide information about water availability and climate change in a format tailored for water users and their business planning needs in the Lachlan region.	
Action 3.2 Investigate water use in the Lachlan region	Undertake a detailed investigation into water use and water user behaviour in the Lachlan region. This work is a precursor to investigate how surface water use in the Lachlan Regulated River Water Source tracks against the Water Sharing Plan extraction limits.	
Action 3.3 Undertake a climate impact study	Undertake, in consultation with industry, a comprehensive long-term study of the impacts of climate variability and climate change on future water availability to determine the resilience of water dependent industries to future climate change – including understanding the socio-economic impacts on secondary industries.	
Action 3.4 Support employment and business opportunities for Aboriginal people in the Lachlan region	Support Aboriginal business development opportunities in the Lachlan region, some of which may require access to water resources. This action would also investigate ways to expand water-related employment opportunities for Aboriginal people in the Lachlan region, including by establishing cultural water officers and/or river rangers.	
Action 3.5 Support system water delivery efficiency measures	Upgrade the Department's hydrological model to better represent the effluent streams in the mid-Lachlan to undertake a more detailed assessments of the benefits and costs of the mid-Lachlan efficiency measure option. In addition, continue the conversation with industries and communities in the Lachlan for ways to enhance water efficiency measures in the region.	

Proposed action 3.1: Improve public access to climate information and water availability forecasts

While the provision of climate and water availability information has improved in recent years, more can be done to ensure it meets the needs and expectations of water users.

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

During public consultation we heard that stakeholders are interested in the new climate datasets and our modelling to be made publicly available so it can be used by water users and communities to better prepare for future extreme events.

Since the first public exhibition of the Draft Lachlan Regional Water Strategy, the Department of Planning and Environment has made the Lachlan Regional Water Strategy climate datasets available online via the NSW Government SEED portal.[142]

In addition, stakeholders also requested that the department utilises on-ground local knowledge and on-ground research to better understand the specific circumstances in the Lachlan region. We are committed to having ongoing conversations with local stakeholders as we finalise and implement the regional water strategy.

This action will build on and complement existing state and national information platforms and products[143] and focus on specific products that could assist water users in better strategic planning, including:

- a forward workplan on advancing the department's climate science – e.g. refinement of our assumptions and additional scenario modelling
- more detailed information about the regional water strategies' new climate datasets and climate risk modelling and the implications of long-term climate data on:
  - surface water availability and water quality
  - the likelihood of consecutive years of low or no water availability
  - periods where access to water allocations may be restricted by delivery problems in the regulated river system
  - groundwater availability.
- 12-month water storage outlooks and how this could influence water allocation decisions and other operational water sharing decisions
- a transparent framework for how available water determinations are made based on use, compliance triggers, and carryover.

Have your say

What water-related information and information products are most critical to inform your business planning?

How can long-term climate information be communicated in a way to help water users and businesses better assess risks to their business?

Would the department need to provide further training on the new climate datasets and updated modelling?

142. NSW Government, *Sharing and Enabling Environmental Data in NSW*, datasets.seed.nsw.gov.au/dataset/water-modelling-stochastic-climate-data
143. Including the WaterNSW Water Insights Portal (www.waternsw.com.au/waterinsights/water-insights), WaterNSW's customer portal (www.waternsw.com.au/customer-service/customer-portal) the NSW Allocation Dashboard (www.industry.nsw.gov.au/water/allocations-availability/allocations/dashboard), the Trade Dashboard (www.industry.nsw.gov.au/water/licensing-trade/trade/dashboard), the Environmental Water Hub (www.industry.nsw.gov.au/water/environmental-water-hub) and the WaterNSW Water Added Value Environment (WAVE). WAVE is a portfolio of work that commenced in September 2020 that will deliver significant improvements to core customer, community, water delivery and water modelling operations through the streamlining, automation and digitalisation of processes.

Collecting more data and better data

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

Non-urban water metering framework[144]

Under the framework, water supply works in the Lachlan region will be subject to the new metering rules to install meters on their pumps.

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

This program will support better knowledge of water use and behaviour in the system including improved data on water use in unregulated river systems.

Murray–Darling Basin Compliance Compact

NSW is currently undertaking a review of its hydrometric (river gauge) network as part of the Murray–Darling Basin Compliance Compact.[145] The review is looking at the coverage and data quality obtained from the existing hydrometric network and identifying ways to improve information collected.

The gauging stations will deliver transparent, accurate and accessible data in real time to water users, communities and stakeholders alike, building on more than 1300 monitoring sites already available in real time to the public. Information available from the new stations will include stream levels, flow volumes, and water quality.

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

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

144. Department of Planning and Environment, *Non-urban metering*, www.dpie.nsw.gov.au/water/nsw-non-urban-water-metering
145. Department of Planning and Environment, *Hydrometric Network Review*, www.industry.nsw.gov.au/water/science/data/hydrometric-network-review

Proposed action 3.2: Investigate water use in the Lachlan region

We need to better understand water use and future water demand in the Lachlan region. Although our new climate datasets and updated modelling has enabled us to enhance our understanding of potential future water supply and water availability risks,[146] we know that more detailed work is needed to understand these risks and future water demand in the region, particularly the drivers of water use

Undertaking further research into water demand will also help us better represent different water demands in our hydrological models, which support our management and policy decisions and help us better understand emerging water security risks.

We heard during the first public exhibition that stakeholders would like us to expand the toolkit for the regional water strategies to consider demand management initiatives. We recognise that this gap in our actions that needs to be addressed. However, we firstly need to better understand water demand across the Lachlan so that we can tailor actions in future iterations of the Lachlan Regional Water Strategy.

This action would focus on:

Investigating water use and future water demand in the Lachlan region for:

- industry – timing and pattern of water use, and drivers to substitute surface water and groundwater
- non-residential users in towns – those reliant on town water supplies
- the environment – collect data on water orders and site-specific use of environmental water to gain a better understanding of water demand and environmental watering behaviour
- growth in town water users – collaborate with other NSW government agencies and local councils to better understand growth in town water needs over the next 20 years.

Based on this information and with the assistance of the Lachlan water resource plans we would further investigate how water use in the region tracks against the Water Sharing Plan extraction limits to understand if there are any issues that need to be addressed.

Have your say

What are the key drivers that influence your water use?

Is there information available that would help better understanding water use and demand in the Lachlan region?

Support economic prosperity in a capped system

The Basin Plan and NSW rules limit how much water can be taken from river and groundwater systems. In the Lachlan region, average regulated surface water account utilisation (water use relative to the maximum available for use) over the last 18 years has been around 44% (see Figure 16). We need to better understand what drives surface water use in the Lachlan region and to determine whether there are issues that prevent water use from reaching the Water Sharing Plan extraction limits. To progress this analysis, it is critical that the Lachlan water resource plans are accredited so that we can further assess water availability in the region and diversions against the sustainable diversion limit.

146. A detailed explanation of the new climate data and modelling being used for the regional water strategies is provided at www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/climate-data-and-modelling/approach

Proposed action 3.3: Undertake a climate impact study

It is imperative that we focus future research on the impacts of climate variability and climate change on the region's diverse industries – both primary and secondary.

The NSW Department of Primary Industries is conducting a $8 million project to better understand the vulnerability and adaptability of NSW's primary industries to climate change. This project includes a sub-component to assess the climate vulnerability of key broadacre crops to climate change. This work will identify climate risks and opportunities of a changing climate for the highest value broadacre cropping industries and provide the evidence base to support NSW Government policies and industry plans to address climate change impacts, which will support resilience and adaptation in the sector.

There are opportunities for regional water strategies to build on and support this work – for example by recommending further research into the potential impacts of climate change on secondary and supporting industries, including agrifood processors, abattoirs, cotton gins, as well as regional communities, particularly those where agriculture is a key industry. The findings of this work could be used by industry and government to inform policies and industry plans to address climate change impacts and improve industry resilience.

In addition, we heard during the first public exhibition of the Lachlan Regional Water Strategy that stakeholders would like the NSW Government to undertake a comprehensive long-term study on the impacts of climate variability and climate change on future water availability to determine the potential impacts on water dependent industries in the region. We are proposing to address this request as part of this action.

Understanding the impacts of climate change on industries provides an opportunity to look for opportunities to strengthen industry resilience. This can be in the form of further research and development and extension to retain the productive capacity of the region's industries.

In addition, there are opportunities to support research, trial and demonstration projects for:

- evaporation mitigation technology, particularly suspended and floating covers, building on the significant amount of research already undertaken by the NSW Department of Primary Industries and the cotton industry
- smart sensors and automated irrigation systems
- reconfiguration of on-farm storages to reduce the surface area-to-volume ratio
- limiting deep drainage by increasing the soil water holding capacity using novel compounds such as hydrophilic polymers
- explore opportunities to expand water recycling and water reuse in the Lachlan for future industry and town water uses.

There are also opportunities to fast-track research and development into new practices and businesses that are best suited to the potential warmer and drier conditions projected for regional NSW. This would build on the climate vulnerability assessment being undertaken by the Department of Primary Industries and help the agricultural sector diversify incomes and ensure long-term sustainability.

Finally, individual businesses, industry associations, research institutions and governments have worked together for decades to improve traditional crop and livestock production systems, including their water use efficiency and productivity, and support farmers in adopting technologies and practices that increase the economic return from land and water. For the cotton industry this work has contributed to a doubling of productivity, meaning the industry is now producing twice as much cotton from the same amount of water as it was 25 years ago. Continuing this research, as well as other research on commodities grown in the Lachlan region,[147] is critical to supporting agricultural industry resilience in a potential future with increased climate variability and climate change.

147. This would include the Department of Primary Industries' nutrient and water management systems for commercial citrus production research.

To progress this action, we need to:

- undertake a comprehensive long-term study on the impacts of climate change on future water availability to determine the impacts on water dependent industries in the Lachlan and Belubula catchments
- undertake research and development to identify innovative and emerging technologies that support and promote water efficiency, which could potentially be developed into suitable water efficiency projects for future key industries to drive economic growth and productivity
- undertake a water pricing study to assess how evidence and climate change data gathered through the Lachlan Regional Water Strategy would impact on future water charge determinations under a 'no change scenario'. This will help better understand what the financial implications for water-dependent businesses would be if we were to continue using the current water charge determination framework in the Lachlan in a changing climate.

Some of this work will be progressed through the NSW Department of Primary Industries – Agriculture's research projects and programs, which will lead efforts to translate world-leading research into practical improvements, including drawing on research to develop and coordinate local pilot initiatives, and information and training programs.

A coordinated whole of government approach is required to improve industry resilience across the Lachlan region as well as regional NSW. This will involve relevant government agencies working in close collaboration as well as regional communities across the region to ensure policy settings are aligned and working in harmoniously.

Helping primary producers adapt farming systems to climate change

The NSW Government *Climate Change Research Strategy* is supporting projects that help primary industry sectors adapt to climate change. For example, the NSW Department of Primary Industries – Agriculture's Vulnerability Assessment Project is assessing the vulnerability of 28 primary industries and 14 related biosecurity risks to climate change.

The assessment is being conducted in 2 stages:

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

Have your say

How can your industry's resilience be improved in a potential future with increased climate variability?

Are there opportunities for future water efficiency projects in the Lachlan and is there a role for government?

Proposed action 3.4: Support employment and business opportunities for Aboriginal people in the Lachlan region

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

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

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

This action will support Aboriginal people's business development opportunities in the Lachlan region and will be led by the Department of Regional NSW. Through the Aboriginal Partnership Program, a dedicated Aboriginal Senior Regional Coordination officer will work with Aboriginal organisations, businesses and individuals to identify and develop new business opportunities or better manage existing ones and access support or grant funding. Other support is also available through NSW Department of Aboriginal Affairs, NSW Aboriginal Lands Council and National Indigenous Australians Agency.

Have your say

What support is required to improve employment and business opportunities for Aboriginal people?

Proposed option 3.5: Support system water efficiency delivery measures

During the consultation on the Draft Lachlan Regional Water Strategy, we heard that stakeholders were supportive of the NSW Government driving further water efficiency actions in the Lachlan region to improve water security, increase productivity and better meet the needs of the environment. For example, several stakeholders suggested that upgrades to the Jemalong Irrigation District (JID) could have broader system benefits by reducing operational losses and improving delivery. The NSW Government supports JID to consider further water efficiency work in order to best meet the needs of users of their system.

Across NSW, industry association, research institutions and government have worked together for decades to improve traditional crop and livestock production systems, including through water use efficiency works. Whilst the Lachlan region was not a recipient of significant funding for irrigation efficiency projects under the Basin Plan's Private Irrigation Infrastructure Operators Program, opportunities for funding still exists under the Off Farm Efficiency Program[148] and many farm businesses have taken it amongst themselves to privately implement water efficiency works, deploy best practice management and adopt new technologies.

From a regional water strategy perspective, we need to advance our thinking on broader system efficiencies which would support actions taken by individual businesses, and communities in the region.

With the transition of the Department hydrological models for the Regulated Lachlan River from the current platform to Source (see proposed action 1.2), we have the opportunity to upgrade the representation of the river system which will enable us to test a number of potential system-wide efficiency measures.

For example, the original mid-Lachlan efficiency measures option in the Draft Lachlan Regional Water Strategy (option 26) cannot currently be assessed with our hydrological model. This limits our ability to understand the benefits and costs and prevents us to recommend this option for further detailed assessment.

As part of this larger investigation into potential water efficiency opportunities, further consultation with stakeholders is required to better understand if there is any appetite to pursue alternative water efficiency programs that would be supported financially by the NSW Government (see original option 32 – Efficiency for Drought Security).

Progressing this action:

- alongside the transition of the Department's hydrological model for the Lachlan regulated river to a different modelling platform, enhance the model to better represent the effluent streams in the mid-Lachlan which would enable a more detailed assessments of the benefits and costs of the mid-Lachlan efficiency measure option
- continue the conversation with industries and communities in the Lachlan around possible water efficiency measures, including any existing Off Farm Efficiency Programs or other ways to support industry to invest in water efficiency, where the savings could be shared between industries and regional communities
- support water efficiency initiatives and projects that could be paired with other water reuse/recycling and demand management initiatives which could reduce the demand for water.

148. Department of Planning and Environment, *Off Farm Efficiency Program*, www.dpie.nsw.gov.au/water/water-infrastructure-nsw/off-farm-efficiency-program. One of the funded projects under the Program is the Gunbar Hay Booligal Carrathool Goolgowi Water Group Feasibility Study. This project seeks to increase water security and quality to the Hay region through modernising existing water delivery systems and constructing new infrastructure as well as benefiting the Hay region and communities of Booligal, Carrathool and Goolgowi.

Lachlan Regional Water Strategy options that interact with existing business cases

Options that were contained in the original Draft Lachlan Regional Water Strategy were refined following feedback from stakeholders during the first public exhibition period.

The updated options list (see Attachment 1.5) has been assessed using the regional water strategy options assessment framework,[149] assuming current system conditions and operations as the baseline condition – for example, existing infrastructure, including the existing Wyangala Dam configuration.

As the Wyangala Dam Wall-raising project and the Belubula Water Security Project may influence several options from the Lachlan Regional Water Strategy, we have identified those updated long list infrastructure options from the strategy that directly interact with these projects, including:

- the lower Lachlan Weir option – original option 39
- the lower Lachlan efficiency measures option – original option 25
- the mid-Lachlan efficiency measure option – original option 26
- cold water pollution mitigation measures – original option 11
- a Belubula weir option – proposed as a new option during the public exhibition process.

For the lower Lachlan weir option, the lower Lachlan efficiency measure option and the Belubula weir option, the Lachlan Regional Water Strategy has undertaken some preliminary modelling to understand the benefit and cost of these options if pursued. Of these 3 options, we are proposing to progress the lower Lachlan weir option further investigations as part of the proposed action 2.3.

As the lower Lachlan weir option is sensitive to a decision on the Wyangala Dam Wall raising project, the Lachlan Regional Water Strategy proposes to defer progressing a more detailed assessment of this options until a decision on the final business case has been made.

The mid-Lachlan efficiency measures option could not be assessed at this stage as the Department's current hydrological model is inadequate to undertake a detailed assessment. The Lachlan Regional Water Strategy has proposed to upgrade its modelling capabilities to enable this option to be assessed as part of proposed action 3.5.

In addition, Wyangala Dam was ranked as a high priority within the Cold Water Pollution Strategy 2004. Recently, the terms of reference for the Ministerial Taskforce on Fish Passage was updated to include responsibility for developing and implementing a strategy on Cold Water Pollution Mitigation. Remediating cold water pollution requires a long-term and collaborative effort between agencies, asset owners and river operators and could be considered alongside the Wyangala Dam raising final business case.

It is to note that there are several additional policy and regulatory options – for example, options to convert general security water access licences to high security water access licences and reviewing the water allocation and accounting framework – which also interact with the development of the business cases. Where this is the case, the Lachlan Regional Water Strategy has conducted some preliminary assessment assuming current infrastructure and system conditions (see 'For further discussion' under priority 4 and Attachment 1.3).

149. Department of Planning and Environment, *Identifying and assessing strategic options*, www.water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/identifying-and-assessing

Priority 4

Improve our knowledge of water resources

We want to have a conversation with communities about how we should share water resources during times of scarcity and abundance. The NSW Government has, in consultation with communities, developed an Extreme Events Policy and regionally specific incident response guides. Together with recent initiatives from the 2017–2020 drought, we have developed a comprehensive toolkit of measures that can help us manage droughts.

Our new climate research provides an opportunity to enhance this work and ensure it is fit-for-purpose for addressing and mitigating more extreme conditions in the future. It also provides us with an opportunity to explore more flexible approaches to our water allocation and accounting framework that could help us proactively respond to prevalent climate conditions whilst ensuring water use remains within existing extraction limits.

With the development of the NSW Groundwater Strategy, we have an opportunity to improve our understanding of the region's groundwater sources and how groundwater and surface water interacts in the Lachlan catchment. In this context, we need to enhance our modelling capabilities to better understand the impact of climate change on groundwater sources in the region.

Closer integration of land and water planning and the development of valley-wide floodplain management plans will be equally critical to better protect our water resources and the environment as well as better manage growth in the region. For example, mechanisms that would help inform water resource constraints or risks to water resources early in the land planning process would avoid non-strategic growth in areas with existing water availability or access constraints. It would also help us to better manage water quality incidents in the catchments, which impact on all water user in the region.

Actions under this category focus on:

- improving our understanding and management of groundwater resources in the Lachlan region
- updating our existing floodplain management plans so they are better integrated and meet our legislative requirements
- better integrating water and land management planning to protect water resources in the Lachlan region.

What we are already doing?

The NSW Government published a report on how groundwater levels have been changing since monitoring began in the 1970s – 80s across 29 alluvium groundwater systems.[150] The Department of Planning and Environment reviewed and analysed data from 1,300 groundwater monitoring sites. A specific report about the Upper Lachlan Alluvial Groundwater Source, Management Zone 2 was published.

The NSW Government is progressing work to replace floodplain management plans in the southern NSW regions, including the Lachlan valley.[151] The existing 10 plans will be remade and expanded to ensure they align with the principles of the *Water Management Act 2000*.

The NSW Department of Planning and Environment has developed a suite of regional plans, so the whole of NSW is covered by strategic land-use plans. The Department is currently undertaking the first 5-year reviews of all regional plans to reset priorities and to extend the plans' reach from 2036 to 2041.

150. Department of Planning and Environment, *Managing decline in groundwater levels*, www.industry.nsw.gov.au/water/allocations-availability/managing-decline-in-groundwater-levels
151. www.industry.nsw.gov.au/water/news/new-floodplain-management-plans-to-be-developed-for-southern-nsw-murray-darling-basin

Legend

Managing water resources during more extreme events for people, industry, and the environment	Improving water quality	Addressing barriers to Aboriginal water rights	Sustaining the health and resilience of the region's water dependent ecosystems	Supporting economic growth and diversification

Proposed action	Summary	Challenges addressed
Action 4.1 Improve the understanding and management of groundwater resources in the Lachlan region	Improve the understanding of groundwater sources and processes as well as demand on groundwater sources in the Lachlan region. This would involve progressing the scientific understanding of groundwater recharge rates and patterns, water level dynamics, connectivity between groundwater and surface water, and how this understanding can inform better groundwater management approaches, including under a changing climate. This action will also seek to improve our groundwater modelling capabilities.	
Action 4.2 Update southern inland floodplain management plans and audit floodplain structures	Develop valley-wide, connected floodplain management plan for the Lachlan region and help identify current floodplain works that do not meet the plan requirements.	
Action 4.3 Better integrate strategic land and water planning	Work across government to better integrate future strategic land use and water planning so that water resources can be considered upfront in the future land use planning processes. This action would also consider projected population and industry growth trends and identify water-related gaps in the current land use planning framework.	

Proposed action 4.1: Improve the understanding and management of groundwater resources in the Lachlan region

We heard during the first public exhibition of the Draft Lachlan Regional Water Strategy that stakeholders are concerned about the current conditions of the region's main productive groundwater sources. The region's main groundwater sources – the upper Lachlan Alluvial, the Belubula Valley Alluvial and the lower Lachlan Groundwater Source – are important water sources, which help to meet the water needs of towns, communities, industries and groundwater dependent ecosystems in the catchment. The volume of extraction, the number of existing bores and areas of water level decline mean these groundwater systems are under pressure. A drier future climate will likely increase these pressures and could reduce the availability of water for high priority needs such as towns and communities, and stock and domestic users.

There are several groundwater sources in the region – like the upper Lachlan Alluvial and the Belubula Valley Alluvial – where the number of entitlements significantly exceeds the long-term average annual extraction limit. That is, if each entitlement share were equal to 1 ML, the sum of the entitlement shares plus unlicensed rights to take groundwater exceed the groundwater source extraction limit. The average annual use in these groundwater sources remains under the extraction limit because many licence holders do not use their full entitlement. Those that are using their full entitlement are currently accruing the benefits of under use by others.

If these under-used entitlements – 'sleeper licences' – were activated in a drier future climate scenario, the annually announced 'value' of a share would need to decrease for all shares, to keep total use within the groundwater source extraction limit. To maintain current levels of allocation in such circumstances, water licence holders can purchase entitlements or annual allocations from other licence holders provided they are willing to sell.

Intensive and continuous groundwater pumping over years can cause groundwater drawdown (a drop in the water table). When groundwater levels are close to or exceed the 'trigger level' for acceptable levels of drawdown, recovery assessments can be used to bring levels back. Publishing guidelines on what interventions will be used in the recovery assessment would provide certainty to all water users about what actions the NSW Government will take and when, and help towns, stock and domestic as well as industry users plan for more extreme droughts when groundwater may not be a viable backup. To progress this action, we need to:

- quantify the risk of unused licences being activated in the upper Lachlan Alluvial and the Belubula Valley Alluvial, and if needed, respond to risks associated with the activation of inactive licenses if it should occur in the future
- identify groundwater systems where the entitlements plus basic landholder rights exceed the extraction limit, particularly where usage is high
- prepare a guideline with a series of escalating management actions corresponding to stages of groundwater level decline
- investigate the degree of connectedness between groundwater and surface water and the influence that each has on the successful management of the other and explore a joint trigger arrangement in areas where it would be effective.

Groundwater models

Groundwater system models are computer-based tools that simulate the behaviour of aquifers over time, including recharge, the movement of water and the take of water through bores. By investing in improved groundwater modelling, we will have better tools to identify and manage risks to some of the most highly used and valuable groundwater sources in NSW.

The government will:

- update its software, maintain, recalibrate and review the current numerical models
- update groundwater models with shifts in demand that are likely driven by climate variability
- include any new understanding of the interconnectivity between surface water and recharge into groundwater models
- develop multi-disciplinary models that incorporate socio-economic and physical data, as well as groundwater volume, level, and quality data
- upgrade and expand the monitoring bore network to fill in gaps that are important to improving our models
- develop 3D geological, numerical flow and reactive transport models to inform future water quality management practices.

Have your say

Do you agree with the above actions or are any key actions missing?

Proposed action 4.2: Update southern inland floodplain management plans and audit floodplain structures

Department of Planning and Environment – Water has recently completed a review under Section 43 of the *Water Management Act 2000* and intends to replace the current floodplain management plans for the Lachlan region, potentially consolidating these into one valley-wide floodplain management plan.[152] A whole-of-valley approach to floodplain management will benefit some of the Lachlan's most critical wetlands that are located at the end of the regulated system.

The review was undertaken in response to the Natural Resources Commission audit of 10 existing southern Basin floodplain management plans,[153] which found several shortcomings that, if unaddressed, could:

- increase the risk to life and property from the effects of flooding
- adversely impact the health of riverine and floodplain ecosystems – like those 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*.

During the first public exhibition of the Draft Lachlan Regional Water Strategy, stakeholders highlighted the lack of action on floodplain management in the southern NSW regions, including the Lachlan, and raised concerns that resources were mostly directed to developing floodplain management plans in the 5 northern NSW regions. Stakeholders also raised concerns about existing structures on floodplains in the Lachlan and their impact on the environment and Aboriginal cultural assets and values.

Given the commitment the NSW Government has already made with respect to updating the southern inland floodplain management plans, this action would support the completion of this work and also audit existing infrastructure within the Great Cumbung Swamp and the Booligal wetlands.

To progress this action, we need to:

- support the preparation of a new valley-wide, connected floodplain management plan for the Lachlan region
- identify existing flood works and hotspots that pose a risk to the environment and Aboriginal cultural values
- address flood works and hotspots, including existing approved structures and illegal works by undertaking targeted activity with affected landholders to bring existing structures into compliance
- upgrade inefficient and ageing infrastructure, which could include eco-hydrological modelling capabilities – e.g. LiDAR – to ensure these objectives and targets can be met.

Have your say

Are there specific aspects of the existing floodplain management plans that could be improved?

152. Department of Planning and Environment, *Review process*, at www.industry.nsw.gov.au/water/plans-programs/plans/review-process
153. Including the Lachlan River (Gooloogong to Jemalong Gap) Floodplain Management Plan 2011, the Lachlan River (Jemalong Gap to Condobolin) Floodplain Management Plan 2012 and the Lachlan River, Hillston Floodplain Management Plan (Lake Brewster to Whealbah 2005) Natural Resources Commission, Water Management plan audits, www.nrc.nsw.gov.au/wsp-audits

Proposed action 4.3: Better integrate strategic land and water planning

Water resources are not always considered up-front in the planning process, which can create inefficiencies and challenges around capitalising on the broader regional opportunities these changes and investment bring. A lack of coordination between strategic land and water planning can also impact other existing water users and the environment and can lead to population and industry growth in areas with pre-existing water availability constraints. This can increase pressures on already stressed surface and groundwater resources.

There are opportunities to better integrate water resources in strategic planning processes, which will help to more closely integrate future iteration of the regional (land use) plans and future iterations of the regional water strategies. As captured in several updated draft regional (land use) plans 'Strategic water and land use planning, at the regional and local scale, must consider opportunities to (...), locate, design, construct and manage new development to minimise impacts on water catchments, including downstream impacts and groundwater sources' and (...) 'consider water needs and sources early in planning and development processes'.[154]

To progress this action, we need to:

- 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 – such as new developments
- discuss if and how to make a decision on which area of the region should be elevated regarding water security due to planned strategic growth areas or concentration of particular industries in the region
- 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.

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

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

The main statute governing land use planning in NSW is the *Environmental Planning and Assessment Act 1979* (EP&A Act). Other relevant legislation that affects land use includes the *Local Government Act 1993, Crown Land Management Act 2016, Aboriginal Land Rights Act 1983* (ALR Act), *Mining Act 1992, Biodiversity Conservation Act 2016* (BC Act) and *Water Management Act 2000*. Federal statutes, such as the Water Act 2007 and the *Environmental Protection and Biodiversity Conservation Act 1999*, also affect land use outcomes in the region.

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

In 2015 the EP&A Act was amended to legally require regional plans and set out what they need to address and include a requirement for regular review.

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

154. Draft Central West and Orana Regional Plan 2041 (Strategy 4.1), www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/Central-West-and-Orana

Improving town amenity through blue and green grids and riverfront activation

A green, cool and resilient NSW with sufficient tree canopy, healthy waterways with native vegetation, and access to quality green open spaces is essential to healthy, resilient and liveable communities. While the use of water to improve amenity sits with local government under the local water utility strategic planning process, regional (land use) plans[155] are progressing actions to improve amenity and public connectivity through blue and green grids and riverfront activation. Proposed actions in the updated draft regional (land use) plans[156] seek to develop a framework for western rivers to identify priority areas for activation where riverfront land could be purchased and managed for public and environmental benefit. This supports the Premier's priority to increase the proportion of homes in urban areas within a 10-minute walk of public space by 10% by 2023. Green and blue grids provide a spatial understanding of the network of open spaces and waterways in the region and how to improve and better connect them. The development of any green and blue grid should feature leadership from the Aboriginal community and would benefit of close collaboration with the regional water strategies program.

Have your say

Do you see any opportunities to better align strategic land and water planning that could lead to better outcomes for the Lachlan region?

Should particular areas in the Lachlan region be prioritised in terms of water security due to planned strategic growth?

155. Draft Central West and Orana Regional Plan 2041 and Draft South East and Tablelands Regional Plan 2041, www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans
156. Designing with Country www.governmentarchitect.nsw.gov.au

For further discussion – Increase the availability of high security water access licences in the Lachlan

Some stakeholders have suggested that the Lachlan Regional Water Strategy should consider increasing the proportion of high security access licences compared to general security licences in the Lachlan.

General security water access licences make up around 89% of all water licences in the Lachlan Regulated River Water Source and these licences are used predominantly by industry and to deliver water to the environment. Only 4% of the water access licences in this water source are high security.[157] In drought, general security water licences typically receive no or very low allocations and access restrictions are sometimes applied to conserve water for critical needs.

As we saw during the most recent drought (2017–2020), general security licences received 0% allocation[158] compared to high security licences, which received over 87%.[159]

We have undertaken some preliminary modelling to better understand the opportunities and impacts of converting some general security water access licences to high security water access licences. We have done this assessment based on the existing water-related infrastructure – including Wyangala Dam – and river operations.[160]

We acknowledge that converting a proportion of general security licences to high security licences would reduce the overall volume of licensed water, but it would increase the availability of licences that can be allocated with high reliability each year. We were also cognisant that the conversion of water access licences is currently prohibited under Section 58 of the Water Sharing Plan for the Lachlan Regulated River Water Source, hence progressing the action would require further detailed conversations with the community as part of a future review of the Water Sharing Plan.

Our analysis has shown that converting 10% and 20% of all existing non-held environmental water general security water access licences[161] to high security water access licences (adopting a 4:1 conversion ratio), assuming the use of the new high security licences is at Forbes/Parkes,[162] could result in the following outcome:

For a 10% conversion (4:1 ratio) – modelled outputs

- create 11.6 GL of new high security water access licences with a high reliability of 98.4%, without changing the average effective allocation for existing general security water access licence holders at the end of the water year
- reduce the time that Wyangala Dam sits at or below 300 GL – the volume when drought operation measures would commence in the valley.

For a 20% conversion (4:1 ratio) – modelled outputs

- create 23.3 GL of new high security water access licences with a high reliability of 98.4%, without changing the average effective allocation for existing general security licences at the end of the water year
- reduce the time that Wyangala Dam sits at or below 300 GL – the volume when drought operation measures would commence in the valley.

The storage drawdowns for Wyangala Dam are generally more severe during drought periods under this scenario. When Wyangala Dam is drawn down to low levels, operational measures are usually taken to ensure that remaining general security account water and supplies to higher priority licence categories can be maintained.

The environmental impacts or benefits, as measured by Environmental Metrics included with these hydrological models, still need to be investigated.

157. In comparison, 10% of licences in the Murrumbidgee are high security water access licences and 2.5% of water access licences are high security water access licences in the Macquarie-Castlereagh
158. General security water licence holders in the Lachlan Regulated River Water Source received 0% allocation in the 2018–19 and 2019–20 water year and temporary water restrictions were placed on general security carryover in the 2019–20 water year and in parts of the 2020–21 water year.
159. High security water licence holders in the Lachlan Regulated River Water Source continued to receive 100% allocation in the 2017–18 and 2018–19 water year. In the 2019–20 water year, allocations were reduced to 87% and in the 2020–21 water year, they were set at 70% at the beginning of the water year
160. Three constraints were considered when creating additional high security volumes:
    - end of year allocation reliability for any remaining licence holders must not decrease on average below current conditions
    - total diversions must not exceed the Water Sharing Plan extraction limits
    - end of system flows must not decrease below the current conditions.
161. Only non-held environmental water general security licences were used for the analysis due to upgrades to the Department's hydrological model to better represent environmental water use in the Lachaln. The intention of this preliminary analysis was not to exclude non-held environmental general security licence holders from the licence conversion analysis. Further work on licence conversation would, if progressed, consider all general security water access licences, including held environmental water.
162. Forbes/Parkes was chosen for this preliminary analysis due to the central location in the Lachlan catchment and due to the Parkes Special Activation Precinct.

At this point, we have not added this option as a proposed action in the Draft Lachlan Regional Water Strategy as more detailed analysis and consultation is required to:

- assess the demand for high security water access licences
- undertake a preliminary assessment about level of interest in licence conversion in the Belubula Regulated River Water Source
- assess the location(s) where the high security water is used
- complete more detailed modelling, consultation and impact assessment to confirm the conversion factor and any rules needed to mitigate impacts on other licences, basic landholder rights, and environmental outcomes
- further consult the Murray–Darling Basin Authority and Australian Competition Consumer Commission, who currently do not endorse conversion of licences if the licence conversions impact on the reliability of remaining licence holders
- consider current constraints within existing statutory instruments to allow applications for licence conversion to occur
- gather further information on the outcome of the business cases for the Wyangala Dam raising Project and the Belubula Water Security Project.

Have your say

Do you see there being an appetite for conversion of general security licences to high security licences in the Lachlan or Belubula Regulated River Source?

Image courtesy of iStock. Lachlan River valley, Cowra.

How to have your say

5

Image courtesy of iStock. Wyangala, NSW.

When will the actions be implemented?

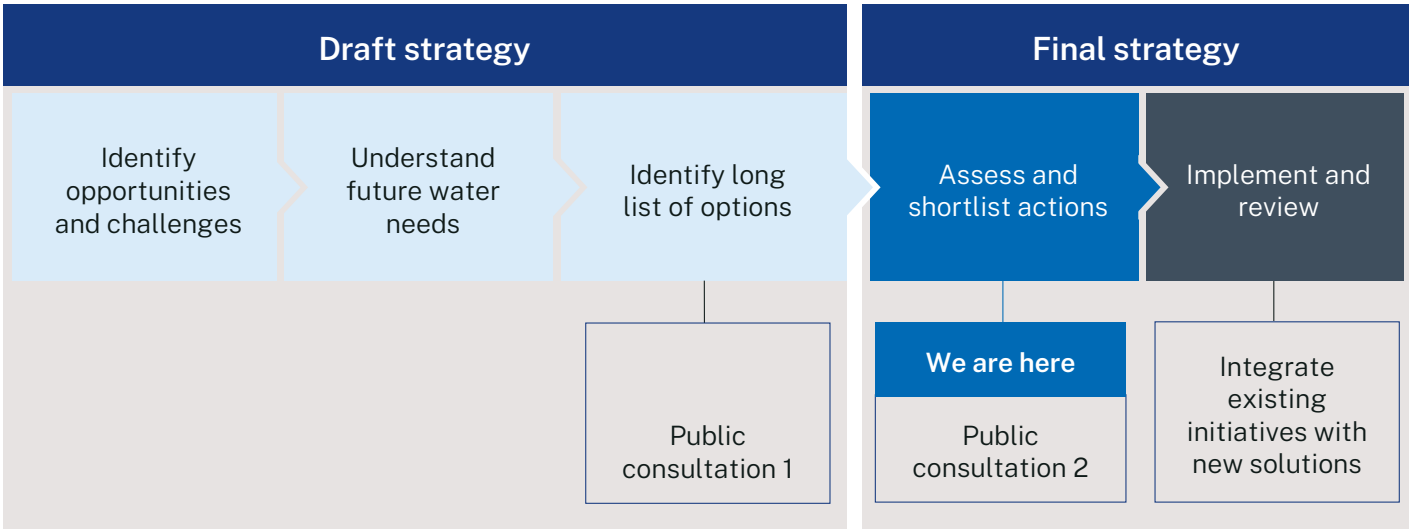
A critical feature of the final Lachlan Regional Water Strategy is making sure we clearly identify what actions and investments are needed now and those that will or may be needed further into the future. The strategy considers a 20-year timeframe that aims to chart a progressive journey and prepare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

Following public consultation, we will develop an implementation plan that establishes when we plan to commence each action and what we plan to achieve by when. The implementation plan will also identify key partners in effectively delivering these actions, including local councils, government agencies, local community and industry groups and local Aboriginal communities.

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

We want your feedback on which actions should be prioritised for implementation over the next 3 to 5 years, and which ones should be implemented in the medium and longer term.

Figure 25. Lachlan Regional Water Strategy delivery timeline



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

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

Progressing the shortlisted actions from the strategy to on-ground implementation can be supported by more detailed assessment of the flood mitigation benefits of some of the water security options presented in this strategy and whole of government input.

The floodplain management plans being developed for northern NSW valleys is the cornerstone for whole of catchment floodplain management in western NSW and will be extended into the southern NSW valleys over the coming years. The Office of Local Government and the Department of Planning and Environment – Environment and Heritage also take the specific lead role in flood risk management for towns and regional centres across the state.

Your voice is important. This consultation paper is on public exhibition in October – November. Supporting information is available at dpie.nsw.gov.au/lachlan-regional-water-strategy

You can also have your say by providing written feedback to the Department of Planning and Environment via:

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

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

Throughout this consultation paper we have provided questions that indicate what we'd like to hear your thoughts on. We would also be interested to know:

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

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

We will be holding community engagement sessions to give participants an understanding of the context for this regional water strategy and an overview of the key proposed priorities and actions. Face-to-face sessions will be subject to COVID-19 restrictions and risks, otherwise they will be held online. Details of these sessions can be found at the department's website.

Image courtesy of Destination NSW. Bellevue Hill Lookout, Cowra.

Attachments

6

Image courtesy of Kevin Roche. Lachlan River.

Attachment 1.1: Lachlan town water supply shortfall analysis

To improve our understanding of the risks to town water security in the region, we have used the department's existing hydrological models to identify whether towns in the Lachlan are at risk of experiencing a shortfall in meeting its unrestricted demand from surface water supplies under different climate scenarios.

A shortfall – for the purpose of the Lachlan Regional Water Strategies – is defined as conditions where surface water supplied is less than a water utilities' unrestricted demand.[163]

At this stage, the regional water strategy shortfall assessment has only considered towns sourcing surface water from the regulated Lachlan River and towns supplied by Central Tablelands Water via Lake Rowlands. Further work is needed to undertake a similar analysis for other towns and communities in the Lachlan region which are currently not captured in the Department's hydrological models.

The regional water strategy shortfall analysis methodology is conservative as many local water utilities in the Lachlan region have access to alternative sources of water, including from unregulated creeks and streams, groundwater, and recycled water that could potentially be used to make up shortfalls from regulated surface water supplies.

Table 5 outlines the existing surface water and groundwater entitlements held by Local Water Utilities in the Lachlan region and who are at least partially reliant on the regulated Lachlan River or on Lake Rowlands.

Table 5. Town water supply – water sources

Town	Surface water entitlement	Groundwater entitlement
Cowra	5,026	3,050
Forbes	4,700	1,260
Parkes	3,225 (regulated) 1,502 (unregulated)	5,050
Condobolin	1,500	8,00
Lake Cargelligo	699	600
Hillston	270	1,600
Central Tablelands Water	3,150 (unregulated)	1,488

163. The modelled unrestricted demands for the region's local water utilities reliant on the regulated Lachlan River are provided in Table 7.

For the shortfall analysis, the Department of Planning and Environment has used the 2019 NSW Common Planning Assumptions population projections. (Table 6).

We recognise that updated population projections were publicly released in mid-2022, however as the hydrological modelling was already underway, these updated population projections could not be used for the analysis. The Department commits to rerun the analysis with the updated population projects to verify the shortfall analysis results.

Table 6. Population projections for towns reliant on the regulated Lachlan River (based on 2019 NSW Common Planning Assumptions)

Towns	Local Government Area	Population				
		2016	2021	2041	% annual growth (2016–2041)	2061
Cowra	Cowra	12,659	12,686	12,797	0.043%	12,908
Forbes	Forbes	9,817	9,913	10,304	0.194%	10,711
Parkes	Parkes	14,924	14,924	14,924	0.0%	14,924
Condobolin	Lachlan	4,406	4,406	4,406	0.0%	4,406
Cargelligo	Lachlan	1,950	1,950	1,950	0.0%	1,950
Hillston	Carrathool	2,095	2,095	2,095	0.0%	2.095
Central Tablelands Water	Blayney + Cabonne + Weddin	24,597	24,597	24,597	0.0%	24,597

Note: For any Local Government Area where the NSW Common Planning Assumptions Population Projections suggest a negative population growth, the Lachlan Regional Water Strategy has assumed zero growth instead.

The modelled local water utility demands used in the shortfall assessment are outlined in (Table 7). Further refinement of these demands will be required as we rerun the analysis with the updated 2022 population projections.

Table 7. Demands used in hydrological modelling

Town/Supply	Modelled demand (ML/year) 2021	Modelled demand (ML/year) 2041	Modelled demand (ML/year) 2061
Cowra	2,800	2,824	2,849
Forbes	2,260	2,349	2,442
Parkes	4,350	4,350	4,350
Condobolin	915	915	915
Lake Cargelligo	405	405	405
Hillston	270	270	270
Central Tablelands Water	1,970	1,970	1,970

The demands for Parkes do not include an explicit allowance for the Parkes Special Activation Precinct. Although commercial water demand arising from the Parkes Special Activation Precinct would need to be met by the individual business intending to settle at the precinct,[164] further work is required to better understand the impact of future population growth (and hence changes in town water demand) because of the precinct.

In addition to the historical climate, 1,000 x 40-year periods from the new 10,000-year climate datasets have been modelled to estimate the average length and magnitude of each town's expected annual shortfall (Table 8).

Table 8. Demands used in hydrological modelling

Town/Supply	Average annual shortfall (ML)	Average annual demand (ML)	Shortfall as a % of demand	Averages months/ year with shortfall[165]
Historical data				
Cowra	13.5	2,889.9	0.5	2.5
Forbes	63.5	2,238.6	2.8	10.8
Parkes	39.5	4,147.4	1.0	4.5
Condobolin	25.5	954.9	2.7	8.9
Lake Cargelligo	1.3	400.8	0.3	0.2
Hillston[166]	4.0	267.0	1.5	7.1
Central Tablelands Water	100.3	1,899.4	5.3	3.6
Long-term historical past climate				
Cowra	31.0	2,893.5	1.1	2.6
Forbes	76.8	2,257.1	3.4	10.8
Parkes	40.0	4,166.3	1.0	4.8
Condobolin	31.0	953.8	3.3	9.1
Lake Cargelligo	3.3	400.8	0.8	0.5
Hillston	5.5	267.0	2.1	6.5
Central Tablelands Water	105.0	1,899.4	5.5	3.7

164. This would occur via acquiring an appropriate level of water access entitlements to meet their needs
165. A monthly shortfall is defined as when 3 or more days of shortfall occur in any month
166. Hillston predominately rely on groundwater to meet their town water needs, however it has been included for completeness.

Town/Supply	Average annual shortfall (ML)	Average annual demand (ML)	Shortfall as a % of demand	Averages months/ year with shortfall[165]
Dry future climate				
Cowra	422.5	2,955.1	14.3	4.9
Forbes	398.0	2,376.4	16.7	11.2
Parkes	72.3	4,288.6	1.7	4.9
Condobolin	159.5	989.7	16.1	9.7
Lake Cargelligo	52.8	400.8	13.2	3.1
Hillston	38.3	267.0	14.3	8.2
Central Tablelands Water	228.8	1,899.4	12.0	5.8

The economic consequences have been estimated based on the economic cost of putting in place measures such as water restrictions and alternative supplies to address town water supply shortfalls.

The economic cost to towns such as Cowra, Forbes, Condobolin, Lake Cargelligo and Hillston and towns supplied by Central Tablelands Water is based on the level of water restrictions imposed and the volume of shortfall:

- Level 1: $1,680/ML
- Level 2: $2,400/ML
- Level 3 & 4: $16,000/ML
- Level 5: $20,000/ML.

For Cowra, Forbes, Condobolin, Lake Cargelligo and Hillston levels in Wyangala Dam have been used as a proxy for when local water utility restrictions would be enacted (Table 9).

We recognise these proxies need to be refined through a better understanding of the actual restriction regime applied by each Local Water Utility and by understanding the capacity of each local water utility to access other sources of water, including groundwater.

Table 9. Local Water Utility Restriction simulated restriction regime

Restriction stage	Wyangala Dam level (GL)
No restrictions	300
1	250
2	125
3	120
4	80
5	65

In the Belubula catchment, the Department of Planning and Environment has worked with Central Tablelands Water to better understand the potential water security risks as part of the Belubula Water Security Project.

Central Tablelands Water captures water in Lake Rowlands from Coombing Creek, an unregulated tributary of the Belubula River. Central Tablelands Water uses this water to supply 14 towns and villages in Blayney, Cabonne and Weddin Council areas through an extensive water supply pipeline network.

For Central Tablelands Water the drought restrictions were sourced from Central Tablelands Water Drought Management Plan 2011 and are based on the current configuration of the existing infrastructure (Table 10).

Table 10. Central Tablelands Water simulated restriction regime

Supply – triggers	Water restrictions
100% bore supply & 70% Lake Rowlands Storage Level	Level 1 – Low
100% bore supply & 60% Lake Rowlands Storage Level	Level 2 – Moderate
100% bore supply & 50% Lake Rowlands Storage Level	Level 3 – High
100% bore supply & 40% Lake Rowlands Storage Level	Level 4 – Very High
100% bore supply & 35% Lake Rowlands Storage Level	Level 5 – Extreme
100% bore supply & 30% Lake Rowlands Storage Level	Level 6 – Critical

Further refinement of these restriction regimes is critical and further work under the Belubula Water Security Project will inform a more detailed understanding of Central Tablelands Water's water security risks.

For Parkes, the economic cost of a reduction in local water utility surface water entitlements from the regulated Lachlan River has been estimated based on the volume of shortfall and the duration of the shortfall in months, rather than time in water restrictions. This approach has been taken for Parkes as the regulated Lachlan River is only one of several water sources and Parkes also has access to groundwater and surface water captured from unregulated streams stored in Lake Endeavour and Lake Metcalf.

- Less than 6 months: $1,500/ML
- 6-12 months: $3,500/ML
- More than 12 months: $16,000/ML

While the configuration of the hydrological model captures the range of water sources available to Parkes, there remains a need for improvement in model set-up to better represent the actual water supply risks to Parkes through the understanding and incorporation of Parkes actual water supply system operation – particularly during drought.

The economic consequences of town water supply shortfalls have been calculated as the net present costs of the shortfalls over the 40-year planning horizon. 1,000 X 40-year periods were assessed with average net present costs detailed in Table 11.

Table 11. Town Water Supply Average 40-year Shortfall Net Present Costs ($, million)

Town/Supply	Town Water Supply Average 40 year Shortfall Net Present Costs ($, million)		
	Historical data	Long-term historical past climate	Dry future climate
Cowra	$ -0.1 Mil	$ -2.5 Mil	$ -83.4 Mil
Forbes	$ -0.1 Mil	$ -2.0 Mil	$ -69.7 Mil
Parkes	$ -0.8 Mil	$ -0.9 Mil	$ -1.7 Mil
Condobolin	$ 0.0 Mil	$ -0.9 Mil	$ -28.3 Mil
Lake Cargelligo	$ 0.0 Mil	$ -0.3 Mil	$ -10.6 Mil
Hillston	$ 0.0 Mil	$ -0.2 Mil	$ -7.1 Mil
Central Tablelands Water	$ -15.0 Mil	$ -15.4 Mil	$ -42.4 Mil

Note: The dry future climate results are based on a deliberate conservative dry climate change scenario. Such a scenario may not necessarily eventuate. However, it gives us an idea of the possible climate risk and will allow us to begin planning to mitigate these risks should such conditions start to emerge in future decades.

Attachment 1.2: Direct connection to Wyangala Dam

Local councils in the Lachlan region have long advocated for a direct connection to Wyangala Dam – the region's major water storage – to underpin town water security during extreme drought emergencies. Given the design of Wyangala dam, there are currently no significant constraints on releases to the Lachlan River even at very low storage levels.

In considering the merit of constructing a pipeline that could connect Cowra Shire Council to Wyangala Dam, our assessment indicates that the pipeline would likely only be operated when drought emergency is so severe that a decision has been made to halt Wyangala Dam releases, cutting off supply to Cowra and all downstream communities.

Assuming that at a Wyangala Dam storage volume below 10,000 ML the pipeline would be operated, our new climate risk assessment and hydrological modelling updated to reflect current operational rules suggests that there is no need to utilise the pipeline under the historical climate and only a very low probability of the pipeline being required in the long-term historical past climate dataset. The statistics contrast for a dry future climate scenario in which the pipeline could be required in one out of 10 years.

Although this finding is material, we have determined that there is currently no need for action to consider constructing the pipeline at this stage. Should a future review provide evidence that the climate in the Lachlan region is trending towards a very dry climate change scenario, the option to connect to the major headwater storage and further upgrades to the broader regional town water supply network will be reviewed in the light of the new evidence.

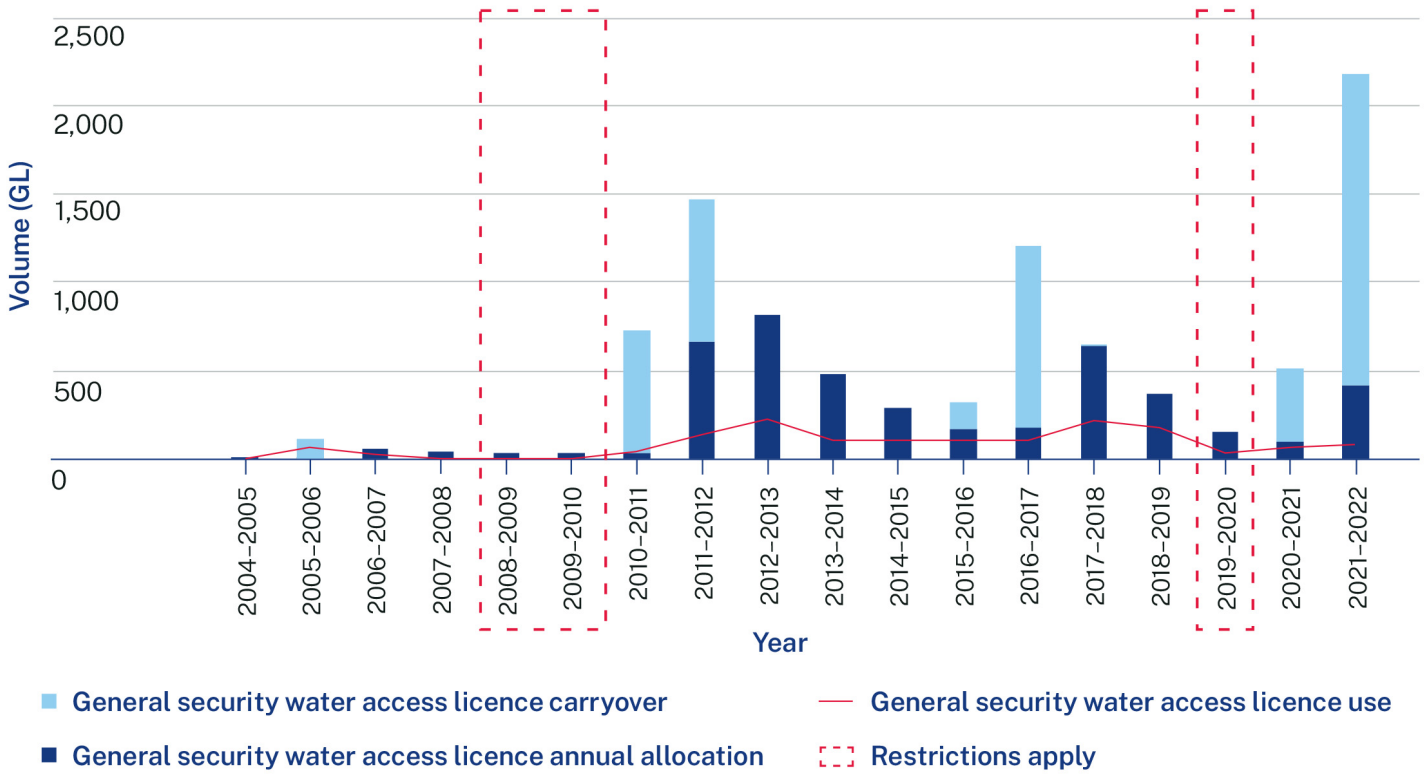
Image courtesy of iStock. Wyangala Dam, NSW.

Attachment 1.3: Water availability for different licence holders in the Lachlan regulated river under different climate scenarios

There are a range of different water access licence classes in the Lachlan region. In the regulated river system, general security water access licences are the predominant licence class, making up about 89% of all water access licences.

As general security entitlements are last in the hierarchy of the allocation framework, these licences generally have a lower reliability and often receive zero or low water allocations during severe and extended drought periods. This is evident when observing the end-of-year allocation results in the regulated Lachlan River for the period 2004–2021 (Figure 26).[167] During this time period, general security water access licence holders experienced very low allocations in several years and restrictions were applied which limited these licence holders to access water in their water accounts.

Figure 26. End of year allocations to general security licence holders and carry-over in the regulated Lachlan River



Source: Department of Planning and Environment, NSW General Purpose Water Accounting Reports, www.industry.nsw.gov.au/water/allocations-availability/water-accounting/gpwar

167. In the Belubula catchment, allocation to general security licence holders have also been very variable, with 7 years out of 10 without an allocation. Users in the Belubula catchment periodically have access to supplementary water – Supplementary flow events are announced periodically during the season when high flow events occur, with the period of extraction and volume of water to be extracted determined based on the rules as set out in the Water Sharing Plan.

Water account rules provide industries with flexibility to meet their water needs

The Water Sharing Plan for the Lachlan Regulated River Water Source has some unique features that assist general security entitlement holders to meet their water needs despite the variable water supply:

- the ability to 'carry-over' allocations between years
- the provision of a 200% account limit[168]
- the potential access to other water sources, including groundwater or town water supply systems.

Despite the 200% account limit, water use is managed by way of a 'use limit', which cannot exceed 100% of the licenced entitlement in any year, regardless of how much water is held in accounts.[169] As general security entitlements are last in the hierarchy of the allocation framework, the 200% account limit allows these entitlement holders to manage their water needs over multiple years.

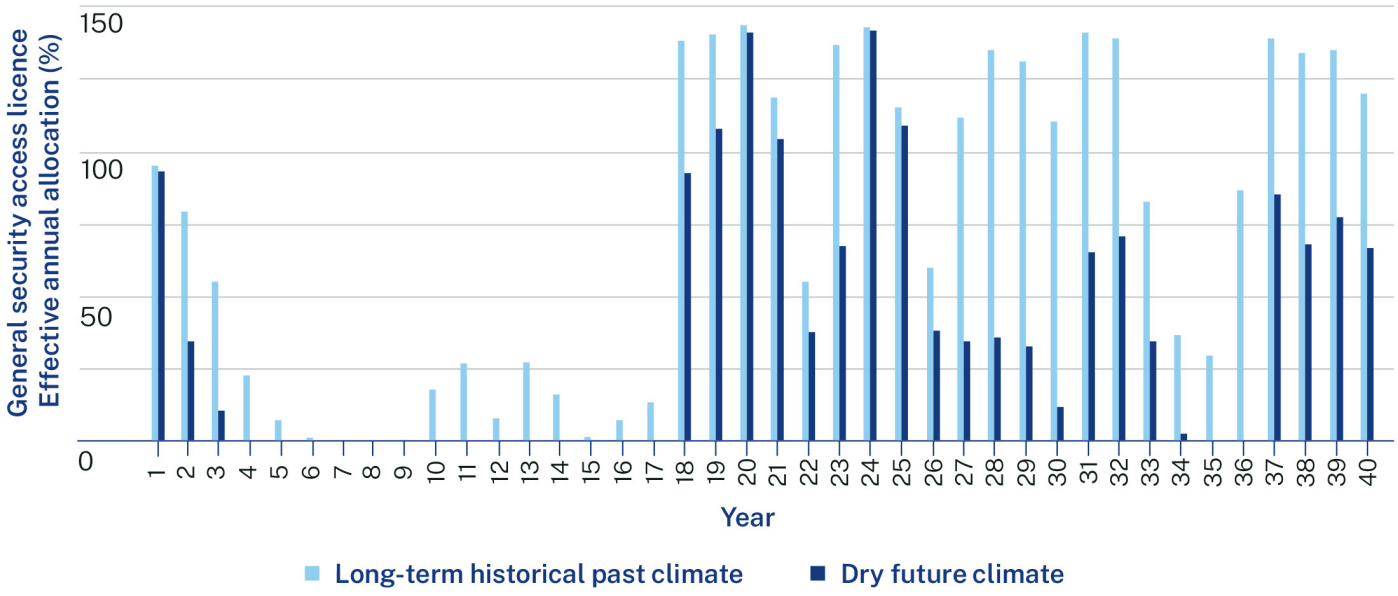
Under a dry future climate scenario, surface water supply is predicted to become more variable, which would impact on water allocations, particularly general security water access licences who are the last in the hierarchy of our allocation framework in the Lachlan region.

Although the regional water strategy climate risk assessment does not directly provide us with information about how much water each general security licence holder may have available in the future – as this also depends on each individual licence holder's water use behaviour – our new climate risk work provides some insights into potential future water supply risks to this class of water access licence holders.

The graphs below represent 2 randomised 40-year realisations from our 10,000-year datasets and illustrate potential end-of-year effective annual allocation outcomes for general security water access licences (Lachlan Regulated River Water). It is important to stress that the long-term historical past climate outcomes from both realisations (light blue in Figure 27 and Figure 28) are equally likely to occur. The dry future climate scenario from both realisations (dark blue in Figure 27 and Figure 28) are also equally likely to occur, assuming our adopted 'dry' future climate scenario eventuates.

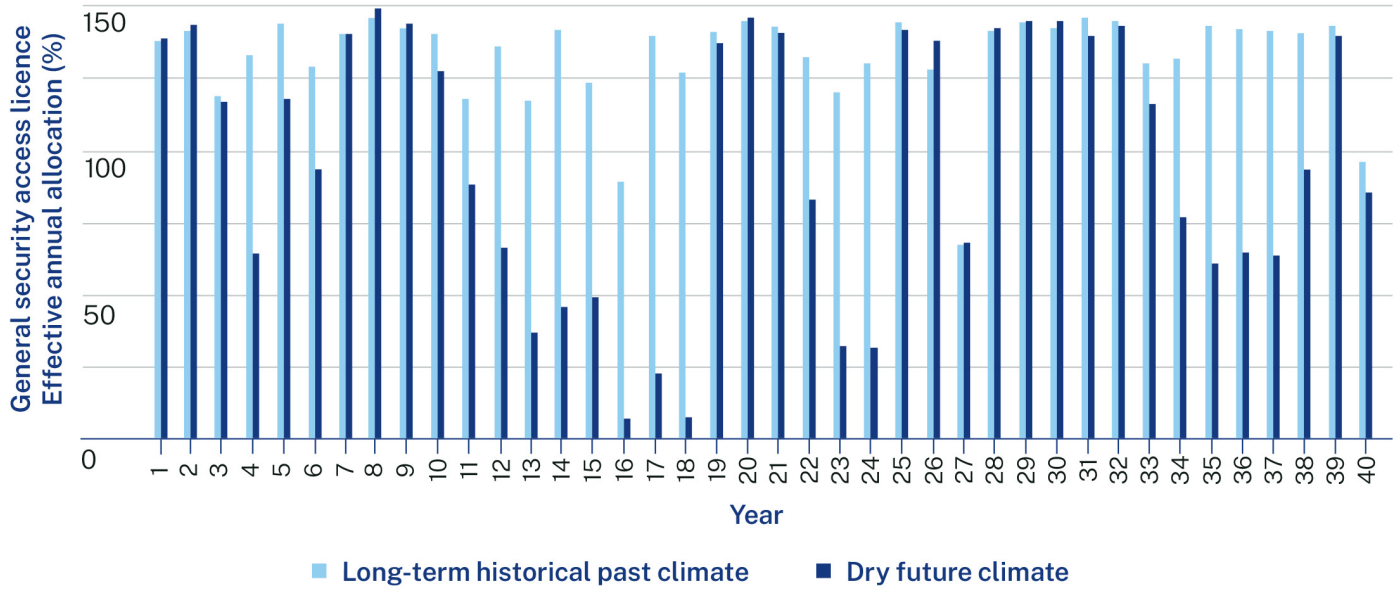
168. General Security accounts are split between a 'take' sub-account to hold water that can be used with a water year and a 'hold' sub-account' that enables general security entitlement holders to park water that can be used in future years. The take account cannot be more than 100% of the licenced entitlement unless take water from another licence is transferred during the year. Although there is no direct limit to the volume of water that can be transferred into a general security account in any one year, the account balance cannot exceed 200% of the licenced entitlement at any time.
169. If Wyangala Dam, Lake Cargelligo, and Lake Brewster are all at full capacity, any water held in (spillable) sub-accounts is at risk of spill (both physical spills and airspace operations will result in account resets)

Figure 27. Effective annual allocations for general security water licence holders under different climate scenarios – random realisation 1



Source: Department of Planning and Environment – Water 2022, current hydrologic and climate data

Figure 28. Effective annual allocations for general security water licence holders under different climate scenarios – random realisation 2



Source: Department of Planning and Environment – Water 2022, current hydrologic and climate data

Figure 27 and Figure 28 illustrate that our long-term records provide a wide range of possible allocation outcomes, including those that resemble the millennium drought, or the wetter conditions experienced during the 1950's, 1980's and recent years.

As the above graphs are 2 randomised 40-year realisations from our 10,000-year datasets, we have developed some statistics to show how likely a particular water availability outcome is under the long-term historical past climate and dry future climate datasets. We were particularly interested to understand the number of consecutive years that the effective allocation is below a particular threshold.

The outcomes in Table 12 shows the percentage of 40-year realisations from our 10,000-year datasets where the effective allocation is below a particular threshold level (e.g. 10% to 50%) for at least 3, 5, and 8 consecutive years.

Overall, our analysis has shown that the probability of long periods with very low effective annual allocations (less than 10%) is very small under the long-term historical past climate datasets. Under a dry future climate scenario, the probability increase notably. This is not unexpected noting that the dry future climate outcomes are a 'bookend' worst-case scenario, however it requires further consideration of how these licence holders can be supported under a changing climate.

Table 12. Percentage of 40-year runs under (x) effective allocation for at least (y) consecutive years

Consecutive years	10% effective allocation	20% effective allocation	30% effective allocation	40% effective allocation	50% effective allocation
Long-term historical past climate					
3	12	20.4	27.9	37	43.2
5	2.8	8.6	15.3	21.1	28.2
8	1.4	2.9	5.9	10.6	16.8
Dry future climate					
3	71.1	77.1	84.3	87.7	90.7
5	60.6	69.1	74.4	78.8	83.5
8	35.4	42	48.6	54.0	60.5

Source: Department of Planning and Environment – Water, 2022, Current hydrologic and climate data

Continue conversations with communities about the existing surface water allocation, accounting and drought management frameworks

Sharing water between communities, the environment and productive users is a careful balancing act.[170] The NSW Government ensures, as far as practical, that essential requirements and high priority needs[171] can be met first before allocating water to other water access licence categories.

In addition, the Millennium Drought led to the development of several drought operation measures that help protect scarce water supplies in the Lachlan region.[172] These measures are now included in the Lachlan Incident Response Guide.[173]

All these measures help us manage available surface water resources in the Lachlan Regulated River Water Source. However, as we saw in the most recent drought (2017–2020), events worse than those we have seen over our historical records can occur and may occur more frequently in the future. The most recent drought was the worst in terms of storage inflows for any 24-month and 36-month consecutive period for Wyangala Dam over the historical record from the 1890's until now.

Under a drier future climate scenario, these events could re-occur and Wyangala Dam could sit at lower storage levels for longer, placing high priority needs, including basic landholder rights and critical environmental needs at further risk, and reducing the certainty of available water delivery for all water users.

During the first public consultation process we also heard varied views about whether the drought of record informing water sharing plans needs to be changed and whether the water allocation process should be amended to consider our new climate information.

To inform further discussions with communities about their appetite for risk and their willingness to try a more flexible and risk-based approach to the current water allocation and accounting framework, we have done a preliminary assessment to test the effect of decreasing and increasing the current reserve volumes.

Increasing the reserve volume in Wyangala dam by 20% to enhance the security of high priority needs

Our investigation found that this could impact:

Towns and communities

- The change in average annual amount of water that is supplied as % of full demand (i.e. a supply shortfall) is small. Increasing the reserve volume by 20% would reduce the shortfall by less than 1% (under historical and long-term historical past climate) and by 2% under a dry future climate.

Wyangala dam storage level

- Increasing the reserve by 20% would reduce the time that Wyangala Dam sits at or below 300 GL,[174] but it would not eliminate the risk of the dam falling below this level.
- Historical climate: from approximately 10% to 7% of the time.
- Long-term historical past climate: from approximately 19% to 16% of the time.
- Dry future climate: from approximately 52% to 47% of the time.

170. Department of Planning and Environment, *How water is allocated*, www.industry.nsw.gov.au/water/allocations-availability/allocations/how-water-is-allocated
171. This high priority needs include the amount of water required for town water supplies, high security licences, minimum dam releases, stock and domestic replenishment needs and water conveyance volumes, which are based on average transmission and evaporation losses.
172. The overarching policy is the Extreme Events Policy, which is currently being reviewed.
173. Murray–Darling Basin Authority, *Lachlan Surface Water Resource Plan*, www.mdba.gov.au/publications/policies-guidelines/lachlan-water-resource-plan
174. 300 GL is the volume at which drought operation measures typically commence.

General security licence holders

- Reduces the modelled general security available water determination, particularly in wet years (e.g. the probability of years where available water determinations are greater than 50% decreases under this scenario compared to the modelled base case outcomes).
- Reduces the modelled diversion for general security entitlements (GL/year) compared to the respective base cases for historical, long-term historical past climate and dry future climate scenarios.
- Reduces the average effective allocation[175] for general security entitlements by 5% historical; 5% (long-term historical past climate); and 4% dry future climate compared to the modelled based case outcomes.

This preliminary investigation indicates that setting aside greater reserve would lead to a small improvement in towns and communities security at the expense of other water access licence holders.

As most licenced water for the environment is general security and the environmental water allowance is tied to general security allocations, this would mean that the available water for the environment would also reduce. This illustrates that in addition to an economic cost, there would likely also be an environmental cost associated with changing the current allocation framework to a more conservative allocation approach.

Alternative mechanisms, including tying the allocation process more closely to existing climate drivers (e.g. El Nino or La Nina) or reviewing existing drought operations rules and drought triggers in the Incident Response Guide could be a more effective and less costly alternative option to ensure that high priority water needs are protected when climate conditions deteriorate.

Decreasing the reserve volume by 20% to support the reliability of water access licence holders

We have also undertaken some preliminary modelling to better understand the consequences of decreasing the reserve by 20%.

Our investigation found that this could impact:

Towns and communities

- The change in average annual amount of water supplied as % of full demand (supply shortfall) is small. Decreasing the reserve volume by 20% would increase the shortfall by less than 1% (under historical and long-term historical past climate scenario) and by 2% under a dry future climate.

Wyangala dam storage level

- Decreasing the reserve by 20% would increase the time that Wyangala Dam level sits at or below 300 GL.
- Historical climate: from 10% to 12% of time.
- Long-term historical past climate: from 19% to 22%.
- Dry future climate: from 52% to 55%.

General security licence holders

- Increases the modelled general security available water determination, particularly in wet years (e.g. the probability of years where available water determinations are greater than 50% increases under this scenario compared to the modelled base case outcomes).
- Increases the modelled diversion for general security entitlements (GL/year) compared to the respective base cases for historical, long-term historical past climate and dry future climate scenarios.
- Increases the average effective allocation[176] for general security entitlements by 6% (historic); 5% (long-term historical past climate); and 3% dry future climate compared to the modelled based case outcomes.

175. Effective end of year allocation includes carry-over as at the start of the year plus accumulated Available Water Determination during that year
176. Effective end of year allocation includes carry-over as at the start of the year plus accumulated Available Water Determination during that year

This preliminary investigation indicates that reducing the reserve to provide more reliability to general security licence holders could trigger water restrictions for towns and communities more often and increase the risk that drought contingency measures would need to be enacted more frequently.

In addition, while decreasing the reserves could benefit the regional economy, it could accelerate the need for all towns to pursue alternatives to surface water supplies, for example groundwater, recycled water and stormwater.

In addition to analysing the impacts of changing reserve volumes in Wyangala dam, additional investigations could be undertaken to further inform the conversations with communities. This include:

- assess whether the allocation framework could be more closely tied to existing climate drivers like El Nino and La Nina
- analyse whether different water allocation periods should apply to different categories of access licences
- assess whether the reserve level should be increased during a sequence of dry years and reduced during a sequence of wet years
- assess the impact of any options for changes to planned environmental water and each category of licence.

The results of these additional investigations would inform whether a 'case for change' to the water allocation and accounting framework in the regulated Lachlan River is warranted in response to extreme events.

This recognises that a decision on whether to progress and implement a change depends on a level of risks that the community is willing to accept. In addition, this option also recognises that further conversation on changes to the existing water accounting, allocation and drought management frameworks are dependent on and will be informed by the work on the Wyangala Dam Wall raising project.

Further work around the drought of record and assessing it through a risk framework will be considered as part of the implementation of the NSW Water Strategy.

Changes to water accounting

We have also tested the impact of changing the existing water take limit for general security licence holders under the existing water accounting framework.

General security licence holders in the Lachlan Regulated River Source operate under continuous accounting. The maximum balance allowed in any General Security water access licences is 2 ML/unit share plus net transfers. Currently, general security water access licence holders who wants to use more than 100% of their licenced entitlement have to buy water in that year.

To provide more flexibility for licence holders in any given year and to see whether changes in the water accounting framework could increase the account utilisation against the existing Water Sharing Plan extraction limits, we have tested the implications of increasing the take limit for general security water access licence holders from 1 ML/unit share to 1.1 ML/unit share.

Preliminary modelling undertaken for the regional water strategy is not showing any significant impacts of changing the water take limit to 1.1 ML/unit share. These results need to be further investigated and progressing option 3.2 will enable us to enhance the representation of water use in the Department's hydrological models which is needed to undertake further investigate the issue.

Have your say

Do you think changes to the existing water allocation, accounting and drought management framework are required in the Lachlan region? If so, why?

What additional scenarios should we be testing to inform a conversation with communities about this issue?

Attachment 1.4: Summary of the options assessment

The original Draft Lachlan Regional Water Strategy identified 48 options. In response to the public exhibition, these original options were updated and expanded. Additional options were also added to the list.

The process we followed to move from the long list to the short list is summarised in Figure 29 and described in the *Options assessment process: Overview*.[177]

Figure 29. Going from a long list of options to a short list

Stage 1 Filtering	**Stage 2** Rapid assessments	**Stage 3** Detailed assessments
Options were initially filtered based on the extent to which they addressed the key regional challenges.	Options that passed through Stage 1 underwent a rapid assessment based on the objectives they were aiming to achieve. This included a rapid cost-benefit analysis for options that aimed to improve outcomes for town water security and industry, a rapid assessment of ecological impacts based on expert opinion, and an assessment of whether Aboriginal communities had positive views on options that were aimed at improving Aboriginal water rights and access.	Options that passed through Stage 2 and impact on the allocation and supply of water underwent more detailed hydrological, economic and environmental watering requirement assessments.

At each step of the assessment, we narrowed down and filtered out the long list of options from the Draft Lachlan Regional Water Strategy, based on evidence we gathered, the discussions we had with communities, and the analysis we undertook. Based on our analysis, several options were consolidated, refined, or not progressed and converted into proposed actions.

This attachment summarises the outcomes of our options assessment. Results from the cost-benefit and environmental watering requirement analyses is presented in Attachment 1.5.

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

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

177. Department of Planning and Environment, Options Assessment Process, available at: water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/identifying-and-assessing

Attachment 1.5: Assessment results – Long list of options to proposed shortlist of options

This section summarises how each of the options in the Draft Lachlan Regional Water Strategy were shortlisted or filtered out at a different assessment stage.

Table 13. Assessment of the long list of options

✓ Options progressed to next step

› To be considered in other NSW processes

× Option not progressed

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?	Rapid environment assessment		
4. Expansion to the piped town water supply system	✓	not assessed	minor impact	✓	Amended and incorporated into **proposed action 1.7:** Investigate the need to further expand the regional water supply grid.
5. Replacement and upgrade of existing pipelines	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 1.6:** Investigate water security for small and remote communities, and **proposed action 1.7:** Investigate the need to further expand the regional water supply grid.
6. Inter-regional connections project investigation	✓	not assessed	minor impact	×	The original option 6 was not carried forward. Instead, **proposed action 1.7:** investigate the need to further expand the regional water supply grid has been included in this iteration of the strategy.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?	Rapid environment assessment		
7. Water quality treatment works	✗	not assessed	little/no change	✗	Infrastructure solutions and asset replacement are the responsibility of the asset owner with co-funding available from the NSW Government $1 billion Safe and Secure Water Program.
8. Managed aquifer recharge investigation and policy	✓	not assessed	little/no change	✓	Amended and incorporated into p**roposed action 1.5:** Support groundwater use for towns and communities.
9. Re-use, recycle and stormwater projects	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed action 1.7:** Investigate the need to further expand the regional water supply grid.
10. Reliable access to groundwater by towns	✓	not assessed	minor impact	✓	Amended and incorporated into **proposed action 1.5:** Support groundwater use for towns and communities.
11. Cold water pollution mitigation measures	✓	not assessed	major improvement	✗	Given the interaction with the final business case for the Wyangala Dam Wall raising project, this option was not carried forward at this stage. See breakout box: Lachlan Regional Water Strategy options that interaction with existing business cases under **proposed action 3.5.**
12. Environmental restoration works	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed action 1.2:** Upgrade the existing hydrological models to better represent river operations and drought contingency measures and **proposed action 2.1:** Reduce salinity and soil erosion in the upper Lachlan and Belubula catchment, and **proposed action 2.2:** Protect and rehabilitate regionally significant riparian and instream habitats in the regulated Lachlan River.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?	Rapid environment assessment		
13. Improved management of wetlands on private land	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed actions 2.2:** Protect and rehabilitate regionally significant riparian and instream habitats in the regulated Lachlan River, **proposed action 2.3:** Upgrade and automate existing public re-regulating structures in the mid- and lower Lachlan to build the functional resilience of critical ecosystems.
14. NSW Fish Passage Strategy	✓	not assessed	major improvement	✓	Amended and incorporated into **proposed action 2.4:** Mitigate the impact of water infrastructure and disruption of natural flows on native fish.
15. Active management of flows	✓	not assessed	minor improvement	✗	This option was deemed not feasible for the Lachlan region.
16. Water quality restoration works	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed actions 2.1:** Reduce salinity and soil erosion in the upper Lachlan and Belubula catchment and **proposed action 2.2:** Protect and rehabilitate regionally significant riparian and instream habitats in the regulated Lachlan River.
17. Floodplain management works	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed action 4.2:** Update southern inland floodplain management plans and audit floodplain structures.
18. Diversion screens to prevent fish extraction at pump offtakes	✓	not assessed	major improvement	✓	Amended and incorporated into **proposed action 2.4:** Mitigate the impact of water infrastructure and disruption of natural flows on native fish.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?	Rapid environment assessment		
19. River Ranger Program	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 3.4:** Support employment and business opportunities for Aboriginal people in the Lachlan region.
20. Secure flows for water-dependent cultural sites	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 1.4:** Support place-based initiatives to deliver cultural outcomes for Aboriginal people.
21. Improved understanding of groundwater processes	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed action 4.1:** Improve the understanding and management of groundwater resources in the Lachlan region.
22. Sustainable access to groundwater	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 4.1:** Improve the understanding and management of groundwater resources in the Lachlan region.
23. Improved clarity in managing groundwater sustainably	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 4.1:** Improve the understanding and management of groundwater resources in the Lachlan region.
24. Water efficiency projects (towns and industries)	✓	not assessed	minor improvement	✗	This option is covered by the department's Water Efficiency Framework, which is currently under development.
25. Lower Lachlan efficiency measures	✓	✗	major impact	✗	Rapid cost-benefit analysis showed that costs outweighed the benefits. Refer to Attachment 2 for details.
26. Mid-Lachlan efficiency measures	✓	not assessed	major impact	✓	Amended and incorporated into **proposed action 3.5:** Support system water delivery efficiency measures.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?	Rapid environment assessment		
27. Improvements to the storage effectiveness of Lake Cargelligo	✗	not assessed	major impact	✗	Based on the feedback during the public exhibition and further assessment, option 27 was not carried forward due to significant environmental, social, cultural and recreational impacts.
28. Review of water trade in the Lachlan region	✗	not assessed	little/no change	✗	This option is subject to the outcome and implementation of the Australian Competition and Consumer Commission's Murray–Darling Basin water markets inquiry and has a state-wide focus. It has not been carried forward explicitly in the Lachlan Regional Water Strategy.
29. Water pricing pilot study	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 3.3:** Undertake a climate impact study.
30. Urban water restriction policy	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 1.1:** Establish a governance framework to coordinate actions under Priority 1.
31. The 'Sheet of Water' storage	✗	not assessed	major impact	✗	Based on the feedback during the public exhibition of the first draft strategy and further assessment, option 31 was not carried forward due to the significant environmental, social, cultural and recreational impacts.
32. Efficiency for drought security program	✓	not assessed	minor impact	✓	Amended and incorporated into **proposed action 3.5:** Support system water delivery efficiency measures.
33. Drought operation rules	✓	not assessed	major impact	✗	This option has been not carried forward as a proposed action as more detailed consultation is required with stakeholders.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?	Rapid environment assessment		
34. Review of water accounting and allocation process	✓	✗	little/no change	✗	This option has been not carried forward as a proposed action as more detailed consultation is required with stakeholders.
35. Investigation of licence conversions	✓	✓	minor impact	✗	This option has been not carried forward as a proposed action as more detailed consultation is required with stakeholders.
36. Improved data collection and storage	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed action 3.1:** Improve public access to climate information and water availability forecasts and **proposed action 3.2:** Investigate water use in the Lachlan region.
37. Training and information sharing programs: **- new climate data/modelling** **- managing groundwater resources sustainably**	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 3.1:** Improve public access to climate information and water availability forecasts.
38. Investigation to maintain amenity for regional towns during drought	✓	not assessed	minor impact	✓	Amended and incorporated into **proposed action 1.5:** Support groundwater use for towns and communities, **proposed action 2.2:** Protect and rehabilitate regionally significant riparian and instream habitats in the regulated Lachlan River and **proposed action 4.3:** Better integrate strategic land and water planning.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?	Rapid environment assessment		
39. In-stream storage for the lower Lachlan	✓	✗	minor impact	✓	Amended and incorporated into **proposed action 2.3:** Upgrade and automate existing public re-regulating structures in the mid- and lower Lachlan to build the functional resilience of critical ecosystems. Despite the rapid CBA results (Attachment 2), this option was carried forward as a broader systemwide assessment of re-regulating structures in the mid- and lower Lachlan.
40. Land use change impact on water resources	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 4.3:** Better integrate strategic land and water planning.
41. Culturally appropriate water knowledge program	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 1.4:** Support place-based initiatives to deliver cultural outcomes for Aboriginal people.
42. Water-dependent cultural practice and site identification project	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 1.4:** Support place-based initiatives to deliver cultural outcomes for Aboriginal people.
43. Shared benefit project (environment and cultural outcomes)	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed action 1.2:** Upgrade the existing hydrological models for the Lachlan catchment to better represent river operations and drought contingency measures.
44. Aboriginal cultural water access licence review	✓	not assessed	little/no change	>	This option requires more than a regional focus and will be addressed by the NSW Water Strategy and the Aboriginal Water Strategy.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?	Rapid environment assessment		
45. Water portfolio project for Aboriginal communities	✓	not assessed	minor improvement	>	This option requires more than a regional focus and will be addressed by the NSW Water Strategy and the Aboriginal Water Strategy.
46. Co-management investigation of Travelling Stock Reserves	✓	not assessed	minor improvement	✓	Amended and incorporated into **proposed action 1.4:** Support place-based initiatives to deliver cultural outcomes for Aboriginal people.
47. Regional Aboriginal Water Advisory Committee	✓	not assessed	little/no change	✓	Incorporated into **proposed action 1.3:** Develop ongoing arrangements for participation of local Aboriginal people in water management.
48. Regional Cultural Water Officer employment program	✓	not assessed	little/no change	✓	Amended and incorporated into **proposed action 3.4:** Support employment and business opportunities for Aboriginal people in the Lachlan region.
NEW option: Investigate water utilisation against extraction limits in the Lachlan and Belubula	✓	not assessed	minor impact	✓	Incorporated into **proposed action 3.2:** Investigate water in the Lachlan region.
NEW Option: Water-dependent industry resilience study	✓	not assessed	little/no change	✓	Incorporated into **proposed action 3.3:** Undertake a climate impact study.
NEW Option: New weir in the Belubula	✓	✗	major impact	✗	See breakout box: 'Dealing with water-related challenges in the Belubula'.
NEW Option: Southern inland floodplain management plan replacement	✓	not assessed	major improvement	✓	Incorporated into **proposed action 4.2:** Update southern inland floodplain management plans and audit floodplain structures.

Attachment 2: Assessment of options that impact supply, demand or allocation of water

This attachment summarises the results of the hydrologic, economic and environmental assessment of options in the Draft Lachlan Regional Water Strategy that were able to be hydrologically assessed as they directly impacted supply, demand or allocation of water in the regulated river system.

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

Importantly, the modelling assumed:

- the diversion limit set by the Basin Plan is not exceeded. This was done by reducing the amount of water for lower priority licences if an option resulted in the diversion limits being increased.

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

The long-term climate data sets comprise:

- a 10,000-year synthetic data set based on the paleoclimatic analysis (referred to as the long-term historical past climate), and
- a 'worst-case' dry climate change scenario, which is based on the paleoclimatic analysis and a set of scaling factors developed for the NARCliM26 project (referred to as the dry future climate).

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

The Lachlan Regional Water Strategy is considering actions that address a wide range of objectives. However, the detailed cost-benefit analysis process focusses on those actions that address the reliability of water supply to towns and communities and water for agriculture.

Ecological assessment methodology

The ecological effects of the options portfolios were modelled and assessed at selected flow gauge sites on the Lachlan and Belubula rivers. The sites were selected based on their proximity to the impacts of the option and relationship to the likely or potential ecological requirements of aquatic flora and fauna.

Following on from the rapid ecological assessment which involved high level assessment based on expert opinion, flow metrics used for the assessment include the frequency and duration of cease-to-flow events and base flows; the frequency of freshes, large and infrequent bankful and overbank flows, and low flows (90th and 95th percentile flows); and the annual volume of flows.

These metrics were assessed for the long-term historical past climate and dry future climate scenarios. The results were then categorised as having an impact from extreme improvement to extreme impact. It uses a categorisation system to rate the potential impacts or benefits to the environment. The rapid environmental assessment uses a 5-category ranking (stage 1) and the detailed assessment used an expanded 11-category ranking Table 14. These impact categories are used in the environmental assessments and their associated changes in hydrology.

Table 14. Explanation of categories used in ecological assessment

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

It is important to note that the environmental assessment results presented below (Table 15) are based on standard flow metrics that describe typical components of the flow regimes upon which flow-dependent species and communities rely. However, flow-dependent species and communities often have different and more complex environmental water requirements that cannot be represented with simple or generic metrics. More comprehensive and detailed assessment outcomes are presented in the detailed economic and environmental analysis report for the Lachlan.

Table 15. Options that were subject to rapid and detailed quantitative assessments

Title		Rapid cost-benefit-analysis	Detailed assessment
Option 25: Lower Lachlan efficiency measures	Construction of a piped scheme to deliver water more efficiently to landholders (including stock and domestic users) along the Muggabah, Merrimajeel, Merrowie, Booberoi and Willandra Creeks.	✓	✓
Option 34: Review of water accounting and allocation processes (Lachlan and Belubula regulated systems)	Increase the take account limit to 1.1 ML/unit share.	✓	✓
Option 35: Investigation of licence conversion (Lachlan and Belubula regulated systems)	20% conversion of general security entitlements to high security entitlements (conversion ratio of 4 general security entitlements to one high security entitlement).	✓	✓
Option 39: In-stream storage for the lower Lachlan	Construction of a new weir between Hillston and Booligal (near Whealbah).	✓	✓
NEW Option: New weir in the Belubula regulated river	Construction of a new re-regulating weir on the Belubula River located near Needles gauging station.	✓	✓

High level results of the cost-benefit assessments are presented below.

Option 25: Lower Lachlan efficiency measures

Purpose	Provide an alternative water supply to stock and domestic users in the lower Lachlan, improve water delivery in effluent creeks and reduce transmission losses associated with otherwise replenishment flows in the effluent creeks.
Description	Construction of a piped scheme to deliver water more efficiently to landholders (including stock and domestic users) along the Muggabah, Merrimajeel, Merrowie, Booberoi and Willandra Creeks. The costing of this option includes the construction of infrastructure and the development of groundwater resources to supplement demand and assumes the creation of 10,000 high security entitlements near Forbes.
Results	Not viable due to a high average negative net present value (> -$400 million) and a very low benefit-cost ratio. This option shows some benefit due to the increase in permanent agriculture uptake with an approximately 10 GL/year increase in take under historical and long-term historical past climate datasets, reducing to 8 GL/year under the dry future climate dataset. The increase of economic outcomes for permanent agricultural producers within the historical and long-term historical past climate records is approximately $60 million and $55 million respectively on average, although the average negative outcome under the dry future climate dataset indicates that the system may not be able to sustainably support the large increase in high security entitlements. Some disbenefit may be realised as a decrease in town water security, increasing the economic cost of water supply shortfalls. The benefits of the option are not enough to outweigh the costs of the infrastructure, shown through the low average benefit cost ratios across all climate datasets.
Limitations	Modelling assumes a 50% reduction of replenishment flow requirements comprising: 12,500 ML/year at Booberoi, 12,000 ML/year at Willandra, 9,000 ML/year at Merrowie, 4,500 ML/year at Muggabah, 4,500 ML/year at Merrimajeel – meaning 42,500 ML/year in total reduced to 21,250 ML/year, and creation of 10,000 high security entitlements near Forbes.

A summary of hydrological and rapid cost benefit assessment results for Option 25: Lower Lachlan efficiency measures are shown below (Table 16 and Table 17). These changes are compared to the base case (i.e. without the option).

Table 16. Option 25: Lower Lachlan efficiency measures – Hydrological results

Climate dataset	Change in long-term average water take under licences (GL/year)		Surface water supply shortfalls (% of unrestricted demand that cannot be met)	Change in % of time system storage <300 GL (25% Full Supply Level)	Change in total simulated end of system flow (GL/year)
	General security	High security			
Historical (130-years of instrumental data)	Reduces from 154.9 GL/year to 154.5 GL/year	Increases from 10.8 GL/year to 20.5 GL/year	Increases from 0.7% to 1.3%	Increases from 9.8% to 11.1%	Reduces from 183.9 GL/year to 181.2 GL/year
Long-term historical past climate (10,000-year dataset)	Reduces from 151.4 GL/year to 150.1 GL/year	Increases from 10.8 GL/year to 20.5 GL/year	Increases from 1.0% to 1.4%	Increases from 19.2% to 21.2%	Reduces from 198.3 GL/year to 196.9 GL/year
Dry future climate (10,000-year dataset)	Reduces from 102.4 GL/year to 100.9 GL/year	Increases from 9.2 GL/year to 17.3 GL/year	Increases from 14.6% to 16.3%	Increases from 51.6% to 54.0%	Reduces from 91.2 GL/year to 90.3 GL/year

Table 17. Option 25: Lower Lachlan efficiency measures – Cost-benefit analysis result

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical (130-years of instrumental data)	-1.3 (-118%)	-3 (-0.5%)	59.8 (126.1%)	452.7	-397.3	< 1
Long-term historical past climate (10,000-year dataset)	-4.2 (-61.9%)	-3.7 (-0.6%)	55.3 (123.9%)	452.7	-405.4	< 1
Dry future climate (10,000-year dataset)	-23.4 (-11.6%)	-4.8 (-1.1%)	-6.5 (-87%)	452.7	-487.6	< 0

Ecological assessment – Lower Lachlan efficiency

The lower Lachlan efficiency option was associated with extreme impacts on the duration of zero flow events and major impacts on number of zero flow events every 130 years under the long-term historical past climate scenario (Table 18). These extreme impacts on the duration of low flows were observed at ten gauges ranging from Nanami, Forbes and down to the end of the Lachlan system. Although these registered as extreme in percentage change these changes were, however, all less than a day in duration and therefore of little environmental significance.

Impacts on the frequency of years with zero flows were manifest at 7 gauges under the long-term historical past climate scenario, including Forbes, Nanami and Corrong with the greatest proportional impact being at Fairholme. In terms of the number of events the greatest change was at Forbes where the frequency went from once to twice per 130 years. So again, while this was a large percentage change, the initial impact tended to not be very high.

Under dry future climate modelling the impacts on duration of zero flow events and number of zero flow events every 130 years were less than observed under the long-term historical past climate modelling and within the minor-to-moderate categories of change.

There was also a moderate impact on very low flows and minor impact on low flows under dry future climate modelling. There was only one gauge (Merrowie Creek) that experienced a moderate impact which was reduced to 0.9 ML/day from 5.7 ML/day. The minor impact affected 3 gauges (Merrowie Creek, Goobang Creek and Booberoi). The largest volumetric change was at Booberoi where low flows were reduced to 3.4 ML/day from 87 ML/day.

These forecast changes to zero flow characteristics are unlikely to greatly affect environmental values in the system. The changes in low and very low flows under climate change modelling may lead to minor increases in risk, particularly in tributary creeks during extreme events. However, given these values are from averaging over time at a gauge, if this option was to progress then impacts during low flow time series should be explored further.

Table 18. Predicted environment effects for the lower Lachlan efficiency option using long-term historical past climate and dry future climate modelling

	Long-term historical past climate	Dry future climate
Metric	**Average (Min–Max)**	**Average (Min–Max)**
Number of years with greater or equal to one zero flow spell in 130 years	0 (-1.3 to 0.5)	-0.2 (-1.4 to 1)
Average duration of zero flow spells (days)	34 (0 to 171)	12 (0 to 71)
Number of zero events per 130 years	22 (0 to 129)	6 (0 to 27)
Very low flow rate (ML/day) measured as the 95th percentile discharge of daily flows	0.2 (-13.6 to 10.4)	-14 (-44 to 1)
Low flow rate (ML/day), measured as the 90th percentile discharge of daily flows	-0.4 (-7.6 to 8.8)	-5 (-60 to 4)
Median annual low flow days	-0.9 (-7.9 to 1)	-0.4 (-1.6 to 0.8)
Median days below low flow	-0.4 (-31 to 6.9)	0.4 (-50 to 9.1)
Low flow standard deviation	0.6 (-11.9 to 5.2)	2 (-1 to 5)
Low flow days below the 75th percentile	-0.2 (-38.5 to 19)	-2 (-50 to 24)
Base flow rate (ML/day), measured as the 80th percentile discharge of daily flows	-0.2 (-5.3 to 9.4)	-2 (-9 to 7)
Mean annual discharge (ML/year)	-0.4 (-0.9 to 0)	-0.7 (-1.2 to 0.2)
Fresh flow rate (ML/day), measured as discharge of daily flows	-0.7 (-2.6 to 0.6)	-0.7 (-3.5 to 0.2)
Average number of freshes per year	-0.1 (-1.1 to 0)	-0.1 (-1.3 to 0.1)
Average duration of freshes (number of days)	-0.4 (-2.8 to 1.8)	0.3 (-1.6 to 1.6)
High flows – 2.5-year Annual Return Interval	-0.7 (-5.4 to 1)	-0.5 (-3 to 1)
High flows – 5-year Average Recurrence Interval (ARI) flow rate (ML/day)	-0.5 (-2 to 1)	-0.6 (-3.3 to 1)
Very high flows – 10-year ARI flow rate (ML/day)	-0.3 (-1 to 0)	-0.8 (-6.7 to 1)
Monthly flow coefficient of variation	0.3 (-1.7 to 3)	2 (0 to 4)
Daily flow coefficient of variation	0.2 (-2.1 to 2.7)	1 (0 to 4)
Weekly flow coefficient of variation	0.3 (-1.9 to 3.2)	2 (0 to 5)

Note: The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios. Cells are colour coded as per the shading in Table 14.

Option 34: Review of changes to take account limit

Purpose	To investigate if by increasing the take account limit from 1 ML/share to 1.1 ML/share it could enable some highly geared users access more water in some years.
Description	The option assessed increasing the annual take account limit to 1.1 ML/unit share in any given year.
Results	Not viable due to low benefits, resulting in low benefit-cost ratios. Despite being a low-cost policy option, without the high costs of an infrastructure option, increasing the take limit does not produce benefits higher than its estimated costs. The benefits to agricultural users are typically less than a percent over the base case results on average over a 40-year analysis period. This amounts to long-term increase in diversions of between 0.5 GL/year to 0.2 GL/year with negligible changes to average economic outcomes over a 40-year period. The economic assessment of the long-term historical past climate and dry future climate datasets indicate that, on average, towns may experience small increases in water supply shortfalls due an account limit increase.
Limitations	The model results did not show much sensitivity to an increase in the Annual Take Account limit, given the 'average' modelled utilisation behaviour of General Security Entitlement user groups. Presented for illustrative purposes.

A summary of hydrological and rapid cost benefit assessment results for Option 34: Review of changes to take account limit are shown below (Table 19 and Table 20. These changes are compared to the base case (i.e. without the option).

Table 19. Option 34: Review of changes to take account limit – Hydrological results

Climate dataset	Change in long-term average water take under licences (GL/year)		Surface water supply shortfalls (% of unrestricted demand that cannot be met)	Change in % of time system storage <300 GL (25% Full Supply Level)	Change in total simulated end of system flow (GL/year)
	General security	High security			
Historical (130-years of instrumental data)	Increases from 154.9 GL/year to 155.4 GL/year	No change	No change	Increases from 9.8% to 10.0%	Reduces from 183.9 GL/year to 183.7 GL/year
Long-term historical past climate (10,000-year dataset)	Increases from 151.4 GL/year to 151.7 GL/year	No change	No change	Increases from 19.2% to 19.3%	Reduces from 198.3 GL/year to 198.2 GL/year
Dry future climate (10,000-year dataset)	Increases from 102.4 GL/year to 102.6 GL/year	Increases from 9.2 GL/year to 17.3 GL/year	No change	No change	Reduces from 91.2 GL/year to 91.1 GL/year

Table 20. Option 34: Review of changes to take account limit – Cost-benefit analysis result

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical (130-years of instrumental data)	0 (0.7%)	-0.1 (0%)	0 (0%)	4.2	-4.3	< 0.1
Long-term historical past climate (10,000-year dataset)	-0.2 (-3.6%)	1.5 (0.2%)	0 (-0.1%)	4.2	-3.1	< 1
Dry future climate (10,000-year dataset)	-0.8 (-0.4%)	0.9 (0.2%)	-0.3 (-3.7%)	4.2	-4.5	< 0

Ecological assessment – increasing the account limit to 1.1 ML/share

Increasing the general security account limit from 1 ML/share to 1.1 ML/share had no significant impacts overall (Table 21). An examination of specific gauges revealed a major improvement on the number of years with zero flows at Muggabah Creek, however, the actual change was from one in 2,600 years to one in 3,250 years. There was a similar change in the years with zero flows at Fairholme which was once again a trivial change.

Given the negligible flow regime changes it is very unlikely that implementation of the scenario would lead to any impact or improvement of environmental values. However, again, given these values are from averaging over time at a gauge, if this option was to progress then impacts during low flow time series should be explored further and especially during lower flow periods during drought.

Table 21. Predicted environment effects of increasing the general security take account limit from 1.0 to 1.1 ML/unit share) using long-term historical past climate and dry future climate modelling

	Long-term historical past climate	Dry future climate
Metric	**Average (Min-Max)**	**Average (Min-Max)**
Number of years with greater or equal to one zero flow spell in 130 years	0 (-0.2 to 0.1)	0 (-0.1 to 0.1)
Average duration of zero flow spells (days)	1 (-2 to 16)	0.7 (-0.1 to 3.7)
Number of zero events per 130 years	-0.3 (-25 to 9.5)	0.3 (-0.3 to 1.9)
Very low flow rate (ML/day) measured as the 95th percentile discharge of daily flows	-0.3 (-6.7 to 0.1)	-0.4 (-2.1 to 0)
Low flow rate (ML/day), measured as the 90th percentile discharge of daily flows	0 (-0.4 to 0.8)	0 (-0.4 to 0)
Median annual low flow days	0 (-0.8 to 0.2)	0 (-0.2 to 0.2)
Median days below low flow	-0.2 (-3.2 to 0)	-0.5 (-9.1 to 0.2)
Low flow standard deviation	0.1 (-0.3 to 0.3)	0 (-0.1 to 0.2)
Low flow days below the 75th percentile	0.1 (0 to 1.2)	0 (0 to 0.4)
Base flow rate (ML/day), measured as the 80th percentile discharge of daily flows	-0.1 (-0.8 to 0)	0 (-0.1 to 0.4)
Mean annual discharge (ML/year)	0 (-0.1 to 0)	0 (-0.1 to 0)
Fresh flow rate (ML/day), measured as discharge of daily flows	0 (-0.1 to 0.1)	0 (0 to 0.1)
Average number of freshes per year	0 (-0.1 to 0)	0 (-0.1 to 0.1)
Average duration of freshes (number of days)	0 (-0.4 to 0.2)	0 (-0.4 to 0.6)
High flows - 2.5-year Annual Return Interval	-0.1 (-0.3 to 0.1)	-0.1 (-2.1 to 0.3)
High flows – 5-year Average Recurrence Interval (ARI) flow rate (ML/day)	0 (-0.5 to 0.3)	0 (-0.3 to 0.3)
Very high flows – 10-year ARI flow rate (ML/day)	0 (-0.3 to 0.2)	-0.1 (-1.9 to 0.2)
Monthly flow coefficient of variation	0 (-0.1 to 0.2)	0.1 (0 to 0.3)
Daily flow coefficient of variation	0 (0 to 0.1)	0.1 (0 to 0.2)
Weekly flow coefficient of variation	0 (0 to 0.1)	0.1 (0 to 0.2)

Note: The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios. Cells are colour coded as per the shading in Table 14.

Option 35: Investigation of licence conversion

Purpose	Make more high security water entitlements available to give water users more flexibility in production, including long-term transition to higher value enterprises that require high security water. A small amount of non-held environmental water general security entitlement is converted to assess the benefit and impact on reliability of the remaining water access licence holders. The objective of the analysis is to identify the level of 'discount' to be applied to convert a general security entitlement to a high security product such that third party impacts are avoided. This facility would enable individual water users to target improved reliability as a trade-off for reduced entitlement volume.
Description	Convert 20% of general security entitlements to high security entitlements. A conversion ratio of 4:1 was adopted.
Results	Not viable due to low benefits, resulting in low benefit-cost ratios. The performance of this option is highly uncertain, as noted by the varying range of outcomes realised under the 3 climate datasets. Inherent in the conversion of general security licenses is a reduction in output of annual crop production and an increase in the production of higher value permanent crops. Long-term takes of general security licenses drops by approximately 30 GL/year under the historical and long-term historical past climate datasets, and by 22 GL/year under the dry future climate dataset. The average economic impact to annual crop producers is consistent across all datasets with an average of nearly 20% decrease in economic outcomes. The historical dataset and the dry future climate dataset show significant average increases in permanent crop productions, with smaller benefits being realised under the long-term historical past climate dataset. Despite these benefits, only in the historical dataset do the benefits to permanent crop producers potentially outweigh the estimated loss to annual crop producers. Across all climate datasets the option, on average, also as a minor impact of reducing town water supply shortfalls. The highest average economic benefits for towns are realised under the long-term historical past climate dataset with an average improvement of $2.5 million over 40 years.
Limitations	Analysis undertaken considering only non-held environmental water entitlements. Series of iterative runs for 3:1 and 4:1 conversion ratio. The results show that the 4:1 ratio brings general security entitlement back to near base case performance (in terms of ML/year diversion per unit entitlement and with respect to AWD outcomes). Further discussion with the community on appetite for this option will help refine the modelling assumptions. Detailed assessments of environmental impacts will then be undertaken. This option was chosen to highlight the scale of economic benefits that could be achieved under a 20% conversion and it achieves this objective.

A summary of hydrological and rapid cost benefit assessment results for Option 35: Investigation of licence conversion are shown below (Table 22 and Table 23). These changes are compared to the base case (i.e. without the option).

Table 22. Option 35: Investigation of licence conversion – Hydrological results

Climate dataset	Change in long-term average water take under licences (GL/year)		Surface water supply shortfalls (% of unrestricted demand that cannot be met)	Change in % of time system storage <300 GL (25% Full Supply Level)	Change in total simulated end of system flow (GL/year)
	General security	High security			
Historical (130-years of instrumental data)	Reduces from 154.9 GL/year to 123.9 GL/year	Increases from 10.8 GL/year to 34.1 GL/year	Reduces from 0.7% to 0.4%	Reduces from 9.8% to 5.5%	Increases from 183.9 GL/year to 185.8 GL/year
Long-term historical past climate (10,000-year dataset)	Reduces from 151.4 GL/year to 120.6 GL/year	Increases from 10.8 GL/year to 34.0 GL/year	Reduces from 1.0% to 0.6%	Reduces from 19.2% to 14.4%	Increases from 198.3 GL/year to 200.4 GL/year
Dry future climate (10,000-year dataset)	Reduces from 102.4 GL/year to 80.8 GL/year	Increases from 9.2 GL/year to 29.5 GL/year	Reduces from 14.6% to 13.7%	Reduces from 51.6% to 45.8%	Increases from 91.2 GL/year to 92.0 GL/year

Table 23. Option 35: Investigation of licence conversion – Cost-benefit analysis result

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical (130-years of instrumental data)	0.1 (12%)	-115.2 (-18.1%)	142.4 (300.4%)	8.4	18.9	> 1
Long-term historical past climate (10,000-year dataset)	2.5 (37.1%)	-107.8 (-18.1%)	1.2 (2.7%)	8.4	-112.5	< 0
Dry future climate (10,000-year dataset)	11.3 (5.6%)	-83.5 (-19.1%)	5.9 (79.4%)	8.4	-74.3	< 0

Ecological assessment – convert 20% of general security entitlements to high security entitlements near Forbes/Parkes

This option had numerous minor impacts across the 2 climate scenarios, and 2 minor improvements under the long-term historical past climate scenario (Table 24). Across the valley, changes were all minor and although there were some extreme effects, none of these represented major threats in isolation.

The minor impacts included increases in frequency of low flows below the 75th percentile, decline in the discharge value for the low flow rate at the 90th percentile and for base flows (80th percentile) across both climate scenarios.

Under the long-term historical past climate scenario there were impacts on:

- frequency of flows below the 75th percentile, which was greatest at Fairholme, Hillston and Bumbuggan Creek. At Fairholme the change was from 10 to 17 days
- base flows, which showed the greatest decline at Bumbuggan Creek (17 to 11 ML/day) and Merrowie (47 to 37 ML/day). However, base flows improved at Nanami (144 to 166 ML/day).

There were minor improvements in the number of zero flow events per 130 years, and the average duration of zero flow spells under the long-term historical past climate scenario which are unlikely to be meaningful.

Years with zero flows experienced extreme improvements at 3 gauges (Muggabah Creek, Booberoi Creek and Cargelligo Weir) under the long-term historical past climate scenario. The percentage change was greatest at Muggabah EOS was only a change from one in 2,000 years to one in 13,000 years. The greatest material change was at Booberoi Creek, where the improvement was from one in 3 years to one in 5 years.

Table 24. Predicted environment effects of converting 20% of general security entitlements to high security entitlements near Forbes/Parkes using long-term historical past climate and dry future climate modelling

	Long-term historical past climate	Dry future climate
Metric	**Average (Min–Max)**	**Average (Min–Max)**
Number of years with greater or equal to one zero flow spell in 130 years	-0.1 (-1.3 to 1.4)	0 (-1.1 to 2.8)
Average duration of zero flow spells (days)	-3 (-44 to 38)	5 (-8 to 55)
Number of zero events per 130 years	-6 (-75 to 24)	0 (0 to 0)
Very low flow rate (ML/day) measured as the 95th percentile discharge of daily flows	-0.5 (-37.9 to 26.7)	-5 (-26 to 7)
Low flow rate (ML/day), measured as the 90th percentile discharge of daily flows	-3 (-23 to 17)	-5 (-73 to 14)
Median annual low flow days	0.5 (-7.1 to 14.5)	-1 (-10 to 1)
Median days below low flow	2 (-60 to 26)	4 (-70 to 45)
Low flow standard deviation	2 (-32 to 15)	1 (-1 to 3)
Low flow days below the 75th percentile	4 (-67 to 70)	9 (-100 to 100)
Base flow rate (ML/day), measured as the 80th percentile discharge of daily flows	-5 (-35 to 15)	-4 (-30 to 17)
Mean annual discharge (ML/year)	0 (-4.7 to 1.4)	-0.3 (-5.8 to 1.9)
Fresh flow rate (ML/day), measured as discharge of daily flows	0 (-3.6 to 5.9)	-2 (-15 to 1)
Average number of freshes per year	0 (-0.7 to 0.6)	0 (0 to 0)
Average duration of freshes (number of days)	1 (-2 to 5)	0 (0 to 0)
High flows – 2.5-year Annual Return Interval	2 (0 to 18)	0.3 (-3 to 1.8)
High flows – 5-year Average Recurrence Interval (ARI) flow rate (ML/day)	1 (0 to 4)	2 (0 to 21)
Very high flows – 10-year ARI flow rate (ML/day)	0.6 (-0.1 to 4.3)	2 (0 to 9)
Monthly flow coefficient of variation	1 (-2 to 8)	0.8 (-2.1 to 4.1)
Daily flow coefficient of variation	1 (-3 to 10)	0.8 (-3.2 to 6.4)
Weekly flow coefficient of variation	1 (-3 to 10)	0.7 (-3.1 to 5.1)

Note: The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios Cells are colour coded as per the shading in Table 14.

Option 39: In-stream storage (near Whealbah) for the lower Lachlan

Purpose	Give greater operational flexibility for WaterNSW and provide a tool to capture/manage surplus flows in the lower Lachlan.
Description	Upgrading 2 existing weirs and the installation of a new weir to allow for the re-regulation of water released from Wyangala Dam (such as delivery surpluses). The new weir was estimated to provide an additional 3 GL of in-stream storage in the lower Lachlan near Whealbah. Addition of 6,500 ML high security entitlement near Forbes/Parkes brings General Security Entitlement back to about Base Case diversions and performance.
Results	Unlikely to be viable as an independent option due to high estimated costs, resulting in low benefit-cost ratios. A re-reg weir located near Whealbah may result in overall better outcomes for the region, as evident by the average benefits for towns and permanent crop producers. These outcomes are achieved with a small average impact of less than 1% to annual crop producers in the region (reductions of less than 1 GL/year in take and between $2 and $4 million reduction in average total output on across a 40-year period). These improvements are achieved through increases of long-term average take by high security licenses of nearly 8 GL/year and reduces the severity of town water supply shortfall events by approximately 1%. Although the reductions in surface water supply shortfalls may seem small, this could amount to savings of $21.5 million on average over 40 years under a dry future climate scenario. These average benefits to the region (approximately $40 million under historical, $2 million under long-term historical past climate, and $24.3 million under dry future climate) of the re-reg weir are significantly less than the estimated $70 million cost of the option.
Limitations	The estimated cost of this option contains a high degree of uncertainty. It is likely that the cost of the infrastructure would significantly increase in the event of further site-specific considerations and costings based on a progressed design.

A summary of hydrological and rapid cost benefit assessment results for Option 39: In-stream storage (near Whealbah) for the lower Lachlan are shown below (Table 25 and Table 26). These changes are compared to the base case (i.e. without the option).

Table 25. Option 39: In-stream storage (near Whealbah) for the lower Lachlan – Hydrological results

Climate dataset	Change in long-term average water take under licences (GL/year)		Surface water supply shortfalls (% of unrestricted demand that cannot be met)	Change in % of time system storage <300 GL (25% Full Supply Level)	Change in total simulated end of system flow (GL/year)
	General security	High security			
Historical (130-years of instrumental data)	No change	Increases from 10.8 GL/year to 17.3 GL/year	Reduces from 0.7% to 0.4%	Reduces from 9.8% to 7.1%	Reduces from 183.9 GL/year to 177.3 GL/year
Long-term historical past climate (10,000-year dataset)	Reduces from 151.4 GL/year to 151.0 GL/year	Increases from 10.8 GL/year to 17.2 GL/year	Reduces from 1.0% to 0.6%	Reduces from 19.2% to 16.3%	Reduces from 198.3 GL/year to 192.6 GL/year
Dry future climate (10,000-year dataset)	Reduces from 102.4 GL/year to 101.9 GL/year	Increases from 9.2 GL/year to 15.0 GL/year	Reduces from 14.6% to 13.7%	Reduces from 51.6% to 47.7%	Reduces from 91.2 GL/year to 86.3 GL/year

Table 26. Option 39: In-stream storage (near Whealbah) for the lower Lachlan – Cost-benefit analysis result

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical (130-years of instrumental data)	0.1 (11.8%)	-2.3 (-0.4%)	39.5 (83.4%)	70.6	-33.3	< 1
Long-term historical past climate (10,000-year dataset)	3.2 (46.8%)	-2.5 (-0.4%)	1.3 (3%)	70.6	-68.7	< 0.1
Dry future climate (10,000-year dataset)	21.5 (10.7%)	-3.8 (-0.9%)	6.6 (89.3%)	70.6	-46.2	< 1

Ecological assessment – installation of a weir at Whealbah (lower Lachlan)

This option predominantly affected low and zero flows, producing one major, 4 moderate and 3 minor impacts as well one minor improvement in flow under the long-term historical past climate scenario (Table 27). The major impact was on low flow duration below the 75th percentile where the number of days increased by 22%. Extreme impacts on the number of days below the 75th percentile was recorded at 6 gauges with the greatest change at Muggabah Creek on the Cobb Highway, where the frequency went from 18 to 45 days per year. The size (in ML/day) of very low flows were also impacted, with 5 gauges showing extreme impacts. Of these 5, the Lachlan River at Booligal and Coombing creek at Neville (a tributary of the Belubula River) had their 95th percentile flows decline to zero.

The frequency of years with a period of zero flow experienced moderate impact overall, although this result was heavily influenced by the gauges at Lake Brewster outlet (754% increase (GS412102+048)) and downstream at Muggabah at Cobb Hwy (85% increase). At Lake Brewster the frequency climbed from one in 30 to one in 3.5 years. The implications of this are still being explored, as it will depend on the assumptions about Lake Brewster operations in the model. Lake Brewster is an off-river storage critical for ensuring lower Lachlan consumptive water demands are met, and it is also a nationally important wetland, especially for large-scale pelican breeding events. The increase at Muggabah Creek was from one in 3 to one in 2 years.

Similar responses were observed under the dry future climate scenario although the zero flow, very low and flow metrics were all minor (rather than major) impacts. The duration of time below low flows and below the 75th percentile both increased. Five gauges experienced extreme impacts on the frequency of flows below the 75th percentile. The greatest changes in terms of days were the Lake Brewster outlet (23 extra days per year) and Muggabah at Cobb Hwy (27 extra days).

The Long-Term Watering Plan identified that the regulated Lachlan River is already at risk for meeting zero flow and base/low flow environmental flows. High Risks to zero flows, base/low flows and freshes were identified for the Lachlan River at Jemalong weir, Willandra weir and Booligal weir. Similarly, the combined effects of flow regulation and climate change on the time between large extended floods during winter- and spring required to sustain lower Lachlan wetland systems, Booligal and Great Cumbung Swamp, is about 2.4 and 5 times greater than at pre-development levels under a future dry climate scenario.[178] Hence, this option could magnify these existing risks for wetlands and streams, and especially the nationally significant wetlands in the lower Lachlan. Muggabah Creek and Merrimajeel Creek are strongly affected by flows at the Lachlan River at Booligal and contain the nationally significant Booligal wetlands. The changes to low flows may affect the invertebrate, fish and bird communities that require lateral connection.[179] This would reduce the amount of available habitat for flow-dependent flora and fauna and limit food resources, which, for example, could affect the abundance and fecundity of threatened fish species such as Murray Cod and freshwater catfish when flows return.[180] Low flows would also lead to declines in water quality and, as such, cause additional stress and mortality for various aquatic organisms.

This assessment is not able to determine the effect of impeded movement of aquatic organisms, and transportation of organic material and nutrients which are also critical to stream function caused by an instream structure. These impacts are well documented, and partial mitigation of these effects can be enabled through construction that allows fish passage.

178. Driver et al 2010, *Ecosystem response models for lower Calare (Lachlan River) floodplain wetlands: managing wetland biota and climate change modelling*. In: Ecosystem Response Modelling in the Murray–Darling Basin, CSIRO Publishing, pp 183-196.
179. The importance of invertebrate production for waterbirds in these naturally ephemeral systems has been well established, e.g., see Crome, F. H. J 1988, *To drain or not to drain? – Intermittent swamp drainage and waterbird breeding*, Emu, 88(4), pp 243-248, and Maher, M., & Carpenter, S. M 1984, *Benthic studies of waterfowl breeding gabitat in south-western New South Wales*, II. Chironomid populations. Marine and Freshwater Research, 35(1), pp 97-110.
180. Many threatened species and risks to low flow are identified in FSC (2005). Fisheries Scientific Committee. Final recommendation. Aquatic ecological community in the natural drainage system of the lowland catchment of the Lachlan River.

Table 27. Predicted environment effects of the installation of a weir at Whealbah (lower Lachlan) using long-term historical past climate and dry future climate modelling

	Long-term historical past climate	Dry future climate
Metric	**Average (Min–Max)**	**Average (Min–Max)**
Number of years with greater or equal to one zero flow spell in 130 years	-0.6 (-8.7 to 0.7)	0.4 (-0.4 to 3.2)
Average duration of zero flow spells (days)	3 (-72 to 315)	0.3 (-11.8 to 31.4)
Number of zero events per 130 years	17 (-75 to 754)	4 (-14 to 119)
Very low flow rate (ML/day) measured as the 95th percentile discharge of daily flows	-19 (-100 to 7)	-6 (-90 to 25)
Low flow rate (ML/day), measured as the 90th percentile discharge of daily flows	-11 (-67 to 5)	-7 (-74 to 21)
Median annual low flow days	-3 (-16 to 8)	-5 (-32 to 2)
Median days below low flow	12 (-21 to 94)	13 (-40 to 153)
Low flow standard deviation	2 (-13 to 34)	-3 (-14 to 2)
Low flow days below the 75th percentile	22 (-23 to 150)	27 (-50 to 264)
Base flow rate (ML/day), measured as the 80th percentile discharge of daily flows	-7 (-57 to 13)	-7 (-46 to 6)
Mean annual discharge (ML/year)	-0.9 (-5.1 to 1.5)	-1 (-9 to 2)
Fresh flow rate (ML/day), measured as discharge of daily flows	-3 (-25 to 2)	-6 (-39 to 8)
Average number of freshes per year	0 (-0.1 to 0.7)	0.1 (0 to 1.1)
Average duration of freshes (number of days)	2 (-21 to 53)	2 (-29 to 77)
High flows – 2.5-year Annual Return Interval	0.6 (-0.6 to 6.7)	-2 (-24 to 4)
High flows – 5-year Average Recurrence Interval (ARI) flow rate (ML/day)	1 (-0.5 to 7.8)	0.8 (-0.5 to 10.1)
Very high flows – 10-year ARI flow rate (ML/day)	0.4 (-0.5 to 2.8)	2 (0 to 24)
Monthly flow coefficient of variation	3 (-1 to 17)	-0.1 (-4.2 to 5.7)
Daily flow coefficient of variation	4 (-2 to 28)	1 (-3 to 18)
Weekly flow coefficient of variation	3 (-1 to 25)	0.7 (-3.7 to 15.1)

Note: The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios. Cells are colour coded as per the shading in Table 14.

NEW Option: New weir in the Belubula regulated river

Purpose	The new weir would seek to improve system operations and reliability for water licence holders in the Belubula.
Description	This option involves the construction of a new 3 GL re-regulating weir on the Belubula River to allow for re-regulation of water released from Carcoar dam.
Results	Not viable due to uncertain benefits and high potential for net negative impacts for the region. A new weir on the Belubula River, with additional high security entitlements, results in increases in average economic outcomes to permanent crop producers during the long-term historical past climate and historical climate datasets. Under these climate scenarios, long-term take by high security licenses increases by nearly 1 GL/year with a resultant average total increase over 40 years of $30 million and $50 million for long-term historical past climate and historical climates respectively. Under the dry future climate dataset the average economic impact of the option for permanent crop producers is negative, indicating that a dry climate is unlikely to be able to support the quantity of high security entitlement created. Under this option some reduction of general security entitlements is required which is reflected in the average reduction in economic producer surplus of annual crop producers which shows minor reductions in all climate datasets. Additionally, across all climate datasets town water security is estimated to be lower on average, with the worst impact occurring under the dry future climate dataset. Under this drier climate dataset the average increase in the economic cost of town water supply shortfalls is estimated to be $8.7 million over a 40-year period.
Limitations	Addition of 10,000 ML high security entitlement at the Weir brings Belubula General Security Entitlement (GSE) back to about Base Case diversions and performance. Note that there is an incremental impact on Lachlan general security entitlement diversions. The estimated cost of this option contains a high degree of uncertainty. It is likely that the cost of the infrastructure would significantly increase in the event of further site-specific considerations and costings based on a progressed design. No site specific environmental or cultural heritage considerations, including any potential impact on Cliefden Caves, have been considered in this cost estimate. Additionally, any grouting costs due to the potential for high infiltration rates in the system, including at the proposed weir, have not been included. Impacts to supplementary licences have not been considered within the Belubula catchment. This omission is unlikely to have an impact on the outcomes presented.

A summary of hydrological and rapid cost benefit assessment results for the new option: new weir in the Belubula regulated river are shown below (Table 28 and Table 29 and Table 30). These changes are compared to the base case (i.e. without the option).

Table 28. New option: new weir in the Belubula regulated river – Hydrological results – changes in the Belubula catchment

Climate dataset	Change in long-term average water take under licences (GL/year)		Surface water supply shortfalls (% of unrestricted demand that cannot be met)	Change in mean manual flow at Helensholme (ML/year)
	General security	High security		
Historical (130-years of instrumental data)	No change	Increases from 1,034 ML/year to 10,597 ML/year	No change	Reduces from 141,857 ML/year to 133,862 ML/year
Long-term historical past climate (10,000-year dataset)	Reduces from 1,690 ML/year to 1,616 ML/year	Increases from 994 ML/year to 10,078 ML/year	No change (25.8% of days in restrictions)	Reduces from 152,159 ML/year to 144,594 ML/year
Dry future climate (10,000-year dataset)	Reduces from 734 ML/year to 719 ML/year	Increases from 731 ML/year to 7,720 ML/year	No change (43.3% of days in restrictions)	Reduces from 71,444 ML/year to 65,663 ML/year

Table 29. New option: new weir in the Belubula regulated river – Hydrological results – changes in the Lachlan catchment

Climate dataset	Change in long-term average water take under licences (GL/year)		Surface water supply shortfalls (% of unrestricted demand that cannot be met)	Change in % of time system storage <300 GL (25% Full Supply Level)	Change in total simulated end of system flow (GL/year)
	General security	High security			
Historical (130-years of instrumental data)	Reduces from 154.9 GL/year to 152.8 GL/year	No change	Increases from 0.7% to 1.1%	Increases from 9.8% to 10.3%	Reduces from 183.9 GL/year to 181.6 GL/year
Long-term historical past climate (10,000-year dataset)	Reduces from 151.4 GL/year to 149.3 GL/year	Reduces from 10.8 GL/year to 10.7 GL/year	Increases from 1.0% to 1.1%	Increases from 19.2% to 20.2%	Reduces from 198.3 GL/year to 196.3 GL/year
Dry future climate (10,000-year dataset)	Reduces from 102.4 GL/year to 100.2 GL/year	No change	Increases from 14.6% to 15.2%	Increases from 51.6% to 52.7%	Reduces from 91.2 GL/year to 90.0 GL/year

Table 30. New option: new weir in the Belubula regulated river – Hydrological results – changes in the Lachlan catchment

Climate dataset	Average Change in Economic Outcomes ($ million, over 40 years)			Net Present Cost ($, million)	Average Net Present Value ($, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical (130-years of instrumental data)	-0.4 (-2.5%)	-1.2 (-0.2%)	54.3 (107.4%)	70.6	-17.7	< 1.0
Long-term historical past climate (10,000-year dataset)	-1.1 (-5%)	-36 (-6%)	34.3 (75%)	70.6	-38.2	< 1.0
Dry future climate (10,000-year dataset)	-8.7 (-3.6%)	-33 (-7.5%)	-35.3 (-239.8%)	70.6	-119.5	< 0

Ecological assessment – new weir in the Belubula regulated river at Needles Gap

This option demonstrated a range of ecological significant impacts on the Belubula River. The model showed extreme impacts on the frequency of zero flow events and a moderate impact on the frequency of base flows under the long-term historical past climate scenario. The option also led to a (on-average across gauges) major improvement in base flows and minor improvements in high flows and daily coefficient of variation (Table 31). The extreme impacts on zero flow frequency were driven by the large changes on 4 of the 5 gauges on the Belubula River. Three gauges – Needles, Lyndon near Canowindra, and Bells – all experienced increases over 2,000% which was due to the base case only having fractions of days with zero flows that increased to 13 days (Bells), 11 days (Lyndon) and one day (Needles). In contrast, the Belubula River at Carcoar Flow decreased from 21 days to 2 days. This pattern was repeated for the number of years with zero flow events which went from around one in 50 years to around one in 3 years. Once again, Belubula River at Carcoar Flow trended in the opposite direction and decreased from one in 4 years to one in 40 years.

There was also a minor impact on (or reduction in) the size of (80th percentile) base flows. The effects were concentrated on the Belubula River with greatest impact at Helensholme (EOS) and at downstream of Carcoar Dam.

The weir was also associated with a major improvement in the size (ML/day) of very low (95th percentile) flows. This was largely due to the 550% increase at the Belubula River at Carcoar from 0.2 ML/day to 1.3 ML/day. This suggests more regular release of very low flows from Carcoar Dam would be enabled under this option, which is supported by the much-reduced frequency of zero flows at the same location. Three other gauges on the Belubula River all experienced impacts on the size of very low flows, ranging from 53% (Bells) to -14% (Needles).

The dry future climate modelling revealed a similar pattern of extreme impacts on zero flows. Although the effects on low flow were partially reversed with an extreme improvement in low flow discharge there remained an extreme impact on the frequency of time below (90th percentile) low flows. The extreme improvement in low flow discharge was driven by an increase from 0.1 ML/day to 1.2 ML/day at Belubula River at Carcoar. The zero-flow impact was driven by changes in 3 Belubula River gauges which included changes from one day to 13 days (Needles) 25 days (Lyndon) and 30 days (Bells). There were also minor improvements in base flow and fresh flows.

The Surface Water Risk Assessment[181] for this valley identified the Belubula River as at medium risk of achieving zero flow requirements, and at high risk for all other environmental flow components (base flow to the highest magnitude overbank flows). Accordingly, the river stopped flowing below Canowindra in 2009, floodplain vegetation vigour diminishes across flood to drought sequences, and dieback of riparian trees is more evident in lower river sections.[182] These studies collectively indicate that high risks include the effect of the new dam, as well as limited tributary input immediately downstream of Carcoar Dam and, further downstream, surface and groundwater irrigation take that constrains the capacity to deliver both baseflow and high magnitude flow events in the Belubula River. As such, risks to environmental water requirements will increase with the installation of the weir at Needles Gap.

Under these conditions long-lived species may decline and struggle to recover before the next dry event more frequently because of these effects of low flows, but also reduced upstream recolonisation from potential upstream refuges such as at Junctions Reef. This would affect larger threatened species such as Macquarie Perch and Murray Cod. Smaller flow-dependent species such as Southern Pygmy Perch which rely on still, vegetated waters, and the Booroolong Frog which requires damp riparian habitat are also at greater risk from local extinction during lower flows due to loss of habitat and refuge from predators.[183, 184] Declines in low and very low flows are also likely to reduce water quality given that the Belubula River flows through cleared agricultural land which exposes the system to nutrient and sediment inputs and greater exposure to high temperatures. This includes a pre-existing high risk for within-stream total phosphorus, which increases the risk of algal blooms.[185]

As with the Whealbah weir, this assessment is not able to fully determine the effect of impeded movement of aquatic organisms, and transportation of organic material and nutrients which are also critical to stream function caused by an instream structure. These impacts have been well documented for many years,[186] and partial mitigation of these effects can be enabled through construction that allows fish passage.

181. Department of Planning, Industry and Environment 2018, *Risk assessment for the Lachlan water resource plan area*, NSW Department of Industry.
182. Driver et al 2004, *Determination of low flow requirements for an upland Murray–Darling Basin River; the Belubula River*, Proceedings of the 7th Australian Stream Management Conference, Townsville, Queensland.
183. Lintermans, M. and Cottingham P. eds., 2007, *Fish out of water – lessons for managing native fish during drought,* Final Report of the Drought Expert Panel. Murray–Darling Basin Commission, Canberra.
184. These species are known to occur in the system. See Department of Primary Industries 2013, *Water Sharing Plan for the Belubula Regulated River Water Source – Background document*, first published: February 2013, NSW Department of Primary Industries, NSW Office of Water.
185. See White, G. C., Smalls, I. C., & Bek, P. A 1994, *Carcoar wetland – A Wetland System for River Nutrient Removal*, Water Science and Technology, 29(4), pp 169-176, and Department of Planning, Industry and Environment 2020, *Water quality technical report for the Lachlan surface water resource plan area (SW10)*, NSW Department of Planning, Industry and Environment.
186. E.g., see Walker, K. F 1985, *A review of the ecological effects of river regulation in Australia, Perspectives in southern hemisphere limnology*, pp 111-129, and Bunn, S. E., & Arthington, A. H 2002, *Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity*, Environmental management, 30(4), pp 492-507.

Table 31. Predicted environment effects of new weir in the Belubula regulated river at Needles Gap using long-term historical past climate and dry future climate modelling

	Long-term historical past climate	Dry future climate
Metric	**Average (Min–Max)**	**Average (Min–Max)**
Number of years with greater or equal to one zero flow spell in 130 years	-0.1 (-4 to 6.7)	-0.3 (-6.3 to 10)
Average duration of zero flow spells (days)	968 (-91 to 21004)	166 (-81 to 3371)
Number of zero events per 130 years	199 (-89 to 3663)	52 (-77 to 905)
Very low flow rate (ML/day) measured as the 95th percentile discharge of daily flows	21 (-53 to 550)	-13 (-96 to 4)
Low flow rate (ML/day), measured as the 90th percentile discharge of daily flows	-3 (-55 to 8)	40 (-66 to 1100)
Median annual low flow days	-2 (-30 to 1)	-3 (-19 to 0)
Median days below low flow	0.4 (-20.7 to 6.9)	187 (-100 to 2900)
Low flow standard deviation	-1 (-29 to 14)	0.1 (-41.7 to 14.7)
Low flow days below the 75th percentile	0.2 (-30.8 to 20)	-4 (-50 to 2)
Base flow rate (ML/day), measured as the 80th percentile discharge of daily flows	-7 (-100 to 12)	7 (-8 to 104)
Mean annual discharge (ML/year)	-0.4 (-3.2 to 0.1)	-0.8 (-7.4 to 0.1)
Fresh flow rate (ML/day), measured as discharge of daily flows	-2 (-53 to 3)	-5 (-71 to 2)
Average number of freshes per year	0 (-0.5 to 0.4)	-0.1 (-0.5 to 0.1)
Average duration of freshes (number of days)	0.7 (-1.5 to 11.6)	1 (-47 to 34)
High flows – 2.5-year Annual Return Interval	3 (-2 to 93)	2 (-3 to 60)
High flows – 5-year Average Recurrence Interval (ARI) flow rate (ML/day)	3 (-1 to 86)	2 (-3 to 40)
Very high flows – 10-year ARI flow rate (ML/day)	1 (-1 to 14)	3 (-2 to 88)
Monthly flow coefficient of variation	2 (-1 to 16)	0.9 (-12.2 to 15.3)
Daily flow coefficient of variation	3 (-2 to 33)	2 (0 to 14)
Weekly flow coefficient of variation	2 (-2 to 19)	0.8 (-14.6 to 11.1)

Note: The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios. Cells are colour coded as per the shading in Table 14.

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