Draft Western Regional Water Strategy

Consultation Paper

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Cover image Image courtesy of Destination NSW. Menindee Lakes, Menindee.

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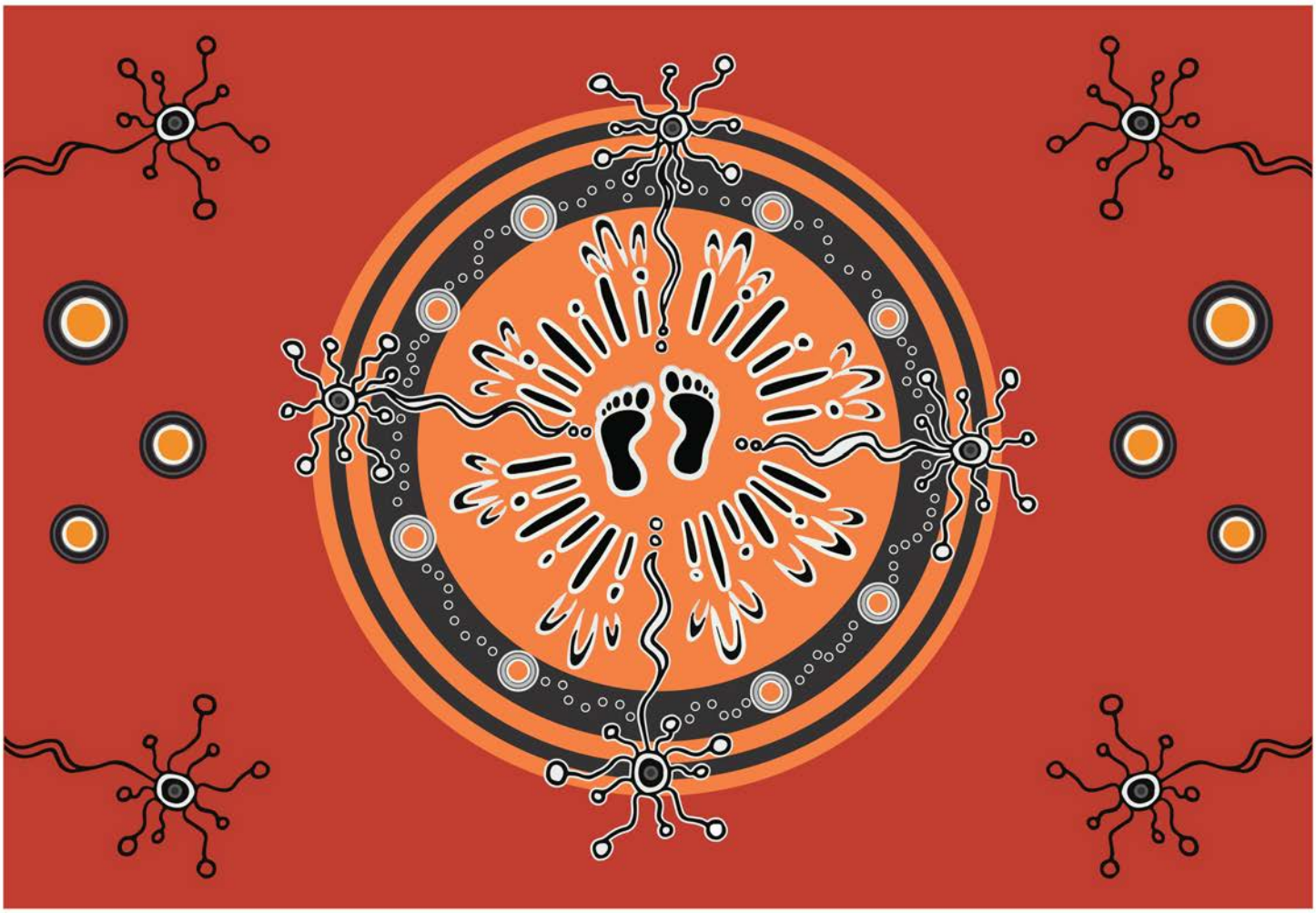


Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and 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 in which Aboriginal people are included socially, culturally and economically.

We acknowledge that the people of the Barkandji, Budjiti, Gomeroi/Kamilaroi, Guwamu (Kooma), Kunja, Malyangapa, Maraura, Murrawarri, Muthi Muthi, Ngemba, Ngiyampaa, Ualarai/Euahlayi, Wangaaypuwan, Wayilwan, Wilyakali, Wongaibon and Wongkumara Nations hold a significant connection to the lands in which the Western Regional Water Strategy falls upon.

The Western region holds areas of great spiritual, cultural and economic importance to Aboriginal people and the NSW Government recognises the connection of the water to the people of these nations. We recognise the intrinsic connection of Traditional Owners to Country and acknowledge their contribution to the management of the landscape and natural resources in the Western region.

NSW Department of Planning and Environment understands the need for consultation with Traditional Owners and the inclusion of their knowledge, values and uses in water management and planning to ensure our water resources are shared fairly, responsibly and sustainably.

NSW Department of Planning and Environment is committed to continue future relationships and building strong partnerships with Aboriginal people. We thank the Elders, representatives of the Aboriginal Nations and Aboriginal community members who provided their knowledge throughout the regional water strategy development process.

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 droughts. Our towns, industries, and natural and cultural assets all rely on water, and the way we manage it deeply affects the lives and livelihoods of the people of NSW. Water is our most precious resource.

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 data and 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 Western region is the largest land area of NSW, home to 36,000 people and includes the communities of Broken Hill, Cobar and Bourke.

Farmers use the land to graze sheep, goats or cattle, providing jobs and contributing to the region's $2.3 billion per year economy. Water drives agricultural land use, supports towns and ensures a healthy local environment, which in the Western region includes the Menindee Lakes system, a vital nursery ground for native fish species. The region is also home to floodplains, rivers, lakes, wetlands and groundwater sources which play a central role in supporting threatened and endangered species.

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

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

Aboriginal people have continuously lived in the Western region for more than 45,000 years. The region lies within the traditional lands of 17 First Nations. 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 Western region.

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 dry periods.

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 climactic circumstances.

We engaged leading academics, including experts from the University of Adelaide, to undertake paleoclimate-informed rainfall and evaporation modelling. This climate modelling is based on a deliberately conservative 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.

We know the Western region faces significant challenges going forward. Over 90 per cent of the inflows into the Barwon–Darling system come from the tributaries in NSW and QLD. This means that water in the region relies on the climate and how water is managed in upstream catchments.

The Western Regional Water Strategy will put forward the best mix of solutions to address these challenges and support environmental, social and economic outcomes. We will assess all options, including infrastructure, water recycling, improved water efficiency and policy and regulatory and operational changes.

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

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

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

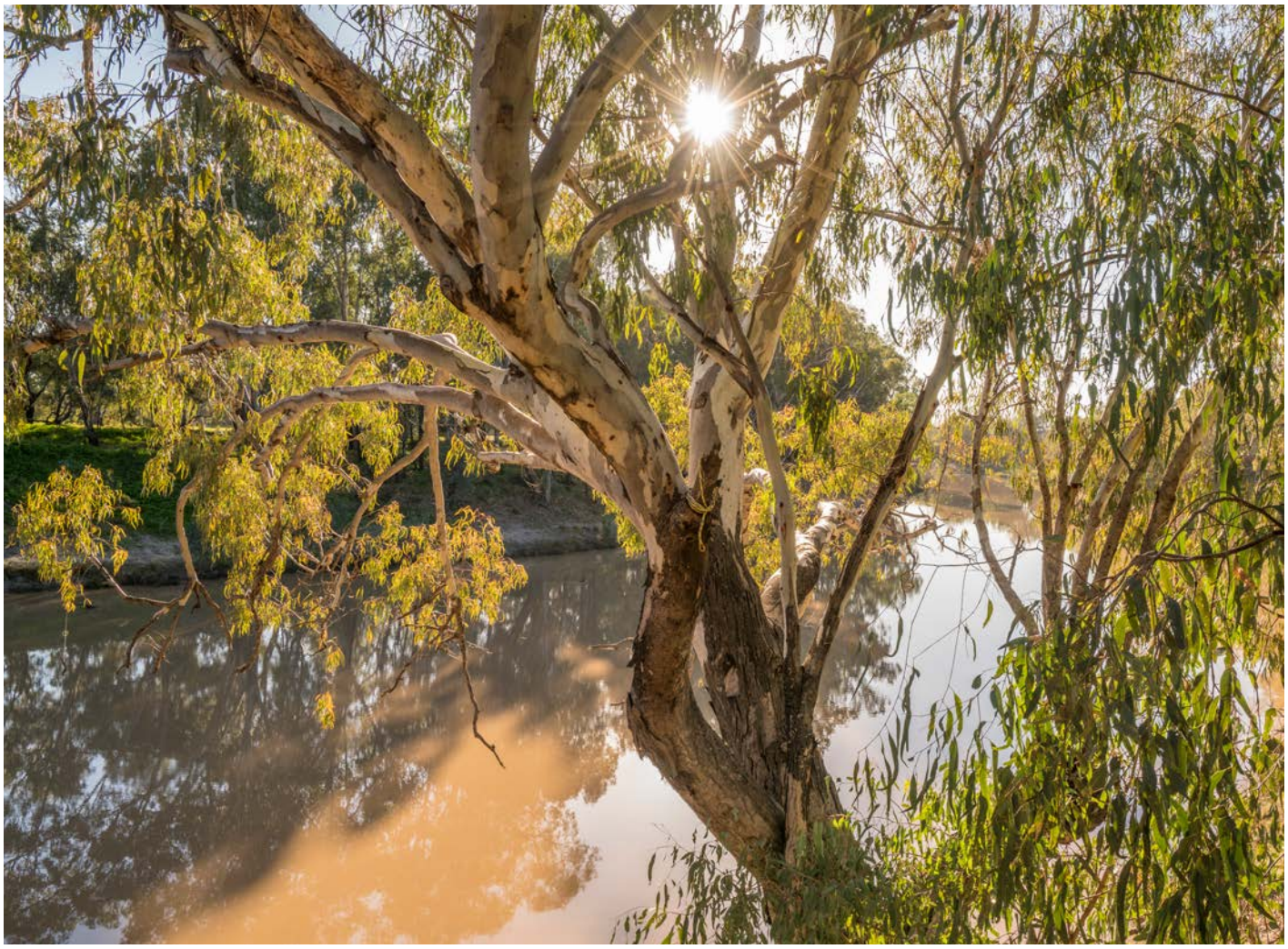


Image courtesy of Destination NSW. Darling River, Bourke.

Contents

Snapshot

The Western region

Aboriginal Nations:
The Western region (as defined for the regional water strategies program) is located within the traditional lands of the following Aboriginal Nations: Barkandji, Budjiti, Gomeroi/Kamilaroi, Guwamu (Kooma), Kunja, Malyangapa, Maraura, Murrawarri, Muthi Muthi, Ngemba, Ngiyampaa, Ualarai/Euahlayi, Wangaaypuwan, Wayilwan, Wilyakali, Wongaibon and Wongkumara

Water is deeply entwined with Aboriginal culture and Aboriginal people's connection to Country

36,671
population

275,556
km^2 area
about one-third of NSW

Key regional centres include:
Broken Hill and Cobar

Towns:
Bourke, Brewarrina, Collarenebri, Menindee, Pooncarie, Lightning Ridge, Tibooburra, Walgett and Wilcannia

Climate:
Semi-arid to arid with mild winters, hot summers and high evaporation rates

Main rivers:
Barwon, Darling-Baaka, Intersecting streams, Culgoa, Narran, Warrego and Paroo

Over 90% of water flowing in the Barwon–Darling comes from upstream catchments

Major water storages:
The main river systems are unregulated until the Menindee Lakes Scheme which has a storage capacity of 1,731 GL

Evaporation from Menindee Lakes is significant, due to the semi-arid climate, the shallow depth and the large surface area of the lakes

Water for the environment:
Approximately 66% of surface water licence shares in the region, or 372 GL of water entitlements, are managed by state and federal environmental water holders. Of these shares, 324 GL are held in the regulated Lower Darling and includes 250 GL of supplementary water entitlements

Groundwater sources:
There are many sources of groundwater, although fresh groundwater is limited, and many sources need to be treated to meet drinking water guidelines

Groundwater sources are significant for supporting a range of ecologically valuable ecosystems

Key environmental assets:
The Barwon–Darling is a critical ecological link between the northern and southern Murray–Darling Basin and is classified as an aquatic endangered ecological community

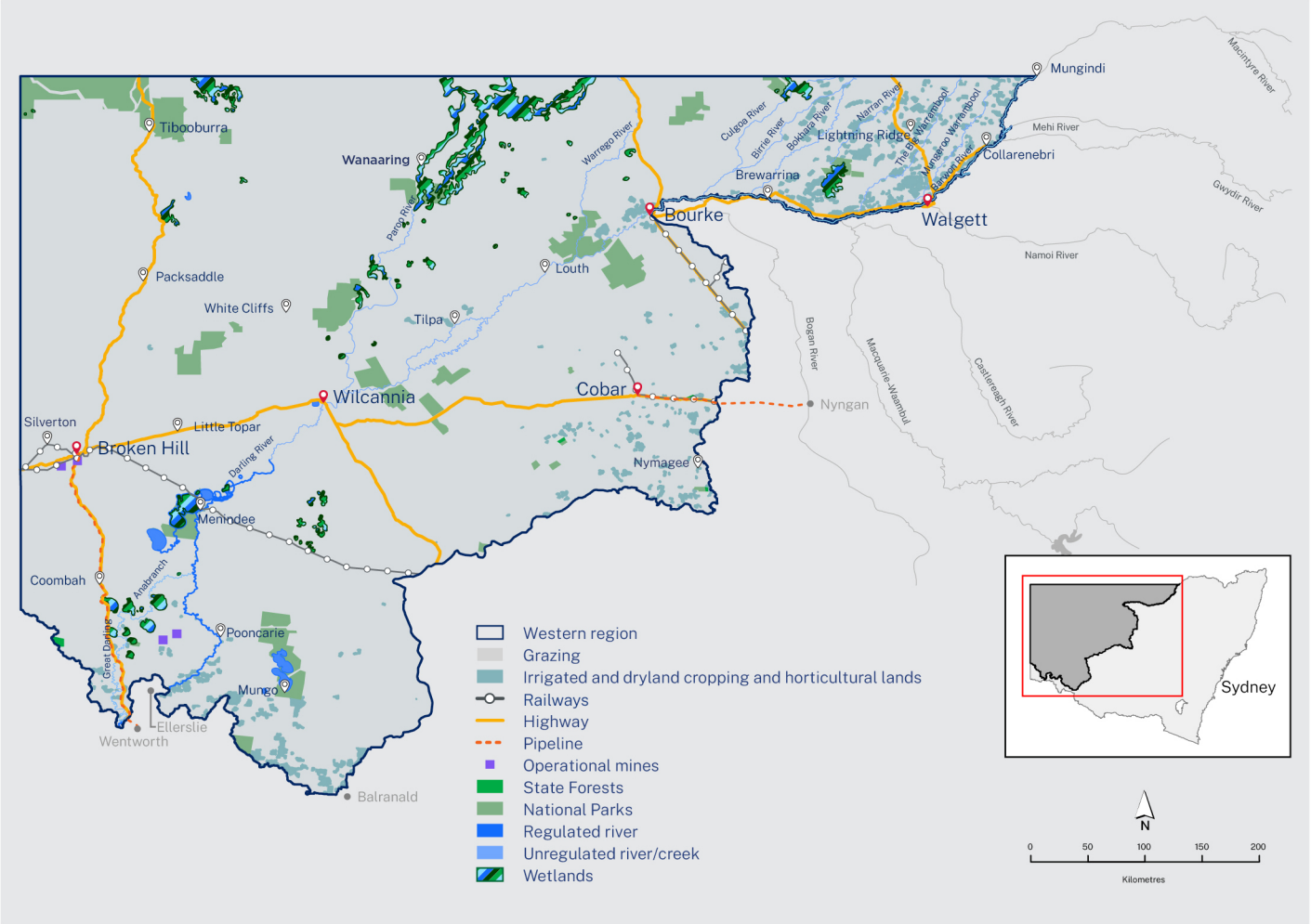
The region supports several endangered ecological communities and nationally significant wetlands: Narran Lakes, Paroo River Wetlands, Kinchega National Park, Toorale and Willandra Lakes and the Great Artesian Basin Mound Spring Clusters

Gross regional product: **$2.3 billion**

Dominant agriculture land use is rangeland grazing of sheep, goats or cattle. Some irrigated cotton production occurs in the upper catchments, concentrated on the alluvial floodplains near Collarenebri and Bourke

Industry in the region is diversifying, with renewable energy projects expanding, tourism increasing and ongoing exploration for mining and gas commodities

Figure 1. Map of the Western region



Definitions

We use the following definitions in the Western Regional Water Strategy:

Water security refers to the acceptable chance of having sufficient town water supplies to meet basic needs. This requires community and government to have a shared understanding of a 'fail event' (for example, no drinking water or restrictions below a defined level for longer than a defined period, or unacceptable water quality), the likelihood of this occurring and the costs communities and governments are willing to pay to reduce these risks.

The NSW Government's guidance around an appropriate security of supply for sizing town water supply headworks is the 5/10/10 rule. Under this approach:

- the total time spent in drought restrictions should be no more than 5% of the time
- restrictions should not need to be applied in more than 10% of years
- when they are applied there should be an average reduction of 10% in water usage.

This allows full demand to be met in most years and also allows for water restrictions to be implemented infrequently to conserve supplies.

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

Resilient water resources means that these resources (and the towns and communities that rely on them) are able to withstand extreme events, such as drought and flood, and/or adapt and respond to changes caused by extreme events.

Introduction

1

Image courtesy of Destination NSW. Barwon River, Brewarrina.

What are regional water strategies?

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.

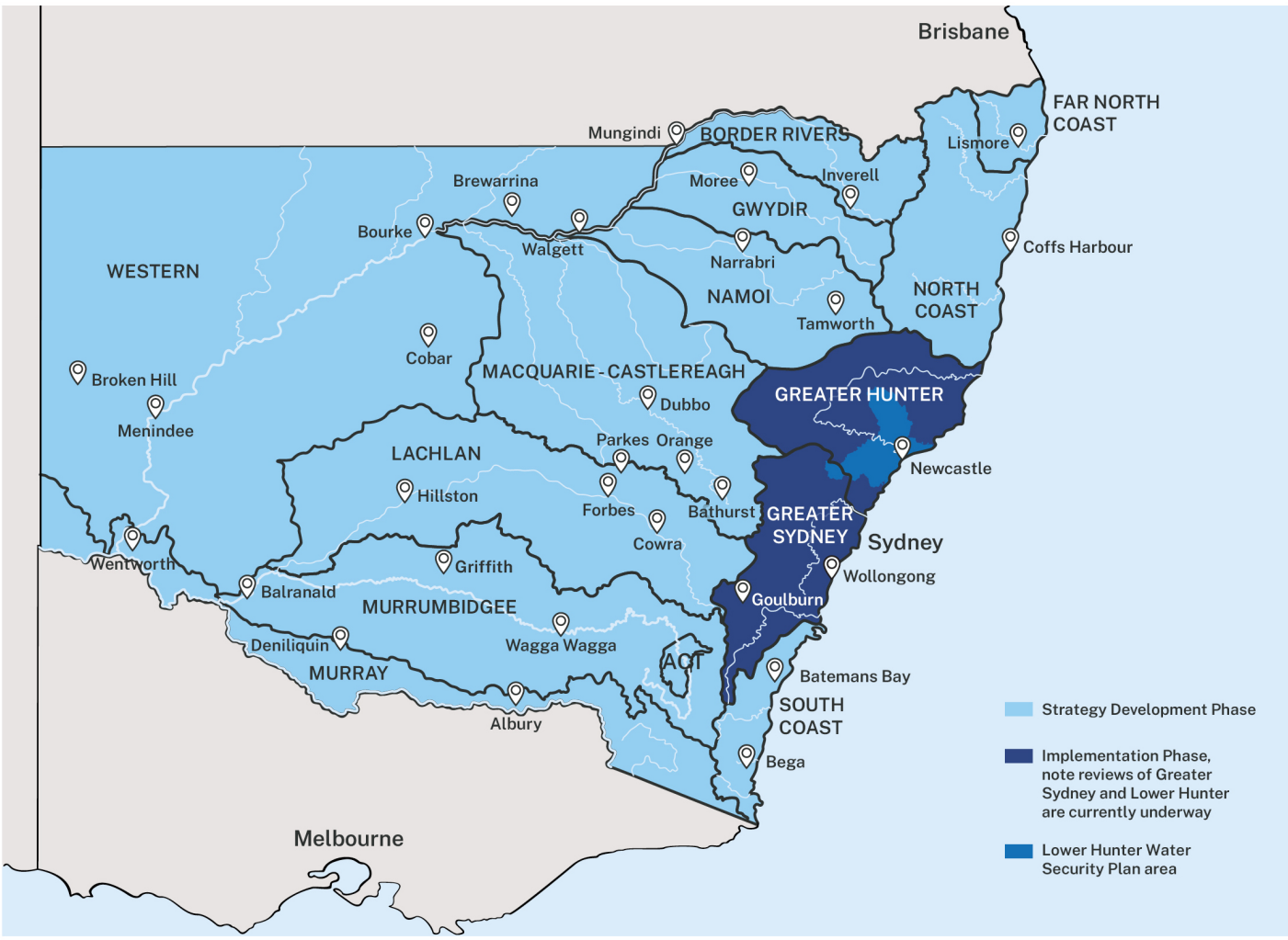
Across NSW, valuable and essential water resources are under pressure. A more variable climate, as well as changing industries and populations, mean we face difficult decisions and choices about how to balance the different demands for this vital resource and manage water efficiently and sustainably into the future.

The Western Regional Water Strategy is one of 14 strategies – 12 regional water strategies, a Greater Sydney Water Strategy and a Lower Hunter Water Security Plan (Figure 2) – the Department of Planning and Environment is developing in partnership with water service providers, local councils, Aboriginal peak bodies, communities and other stakeholders across NSW.

The strategy aims to provide choices to 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.

The Draft Western Regional Water Strategy identifies the key water related challenges for the region and options that could be implemented to meet these challenges and maximise opportunities across the region.

Figure 2. Map of NSW Regional Water Strategy regions



Objectives of regional water strategies

Regional water strategies will set out a long-term 'roadmap' of actions to deliver 5 key objectives (Figure 3). Options selected for inclusion in the final strategy for each region will need to address at least one of these objectives.

Figure 3. Regional water strategies: objectives

Deliver and manage water for local communities

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

Enable economic prosperity

Improve water access reliability for regional industries.

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

Including Aboriginal heritage assets.

Protect and enhance the environment

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

Affordability

Identify least cost policy and infrastructure options.

Our aim is for each strategy to have a comprehensive, balanced package of options that delivers on all the regional water strategy objectives and aligns with the priority actions of the NSW Water Strategy.

During extreme events, such as drought, our focus is on securing water for critical human needs. At these times, under section 60 of the *Water Management Act 2000*, critical human needs are the first priority, and the environment is the second priority. Outside of these extreme events, we have greater flexibility to deliver across all the objectives. It is also important to note that when formulating water sharing plans, the NSW Government must take all reasonable steps to prioritise the protection of water sources and their dependent ecosystems.[1]

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

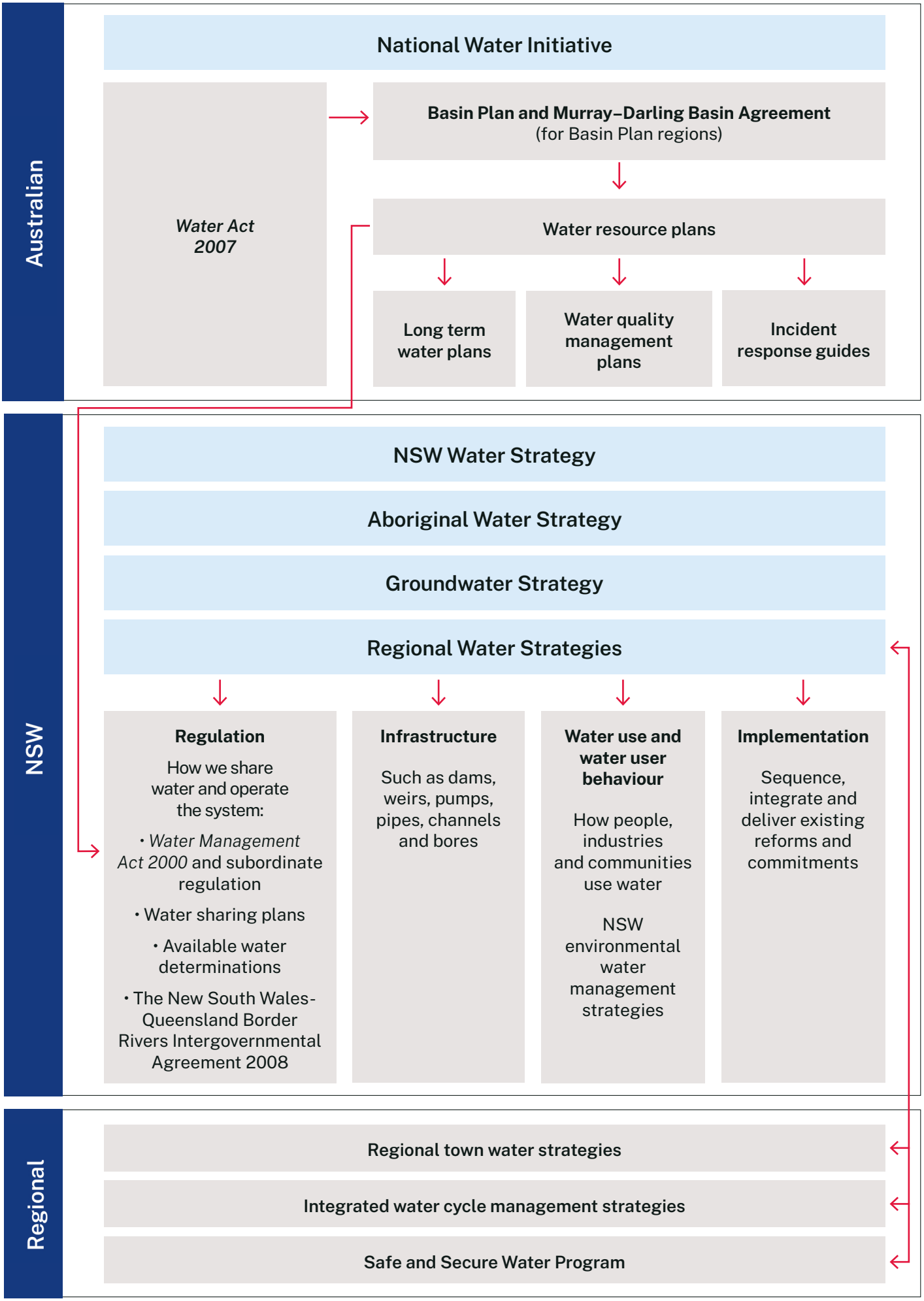
1. Subsections 9(1)(b), 5(3)(a) and 5(3)(b) of the NSW *Water Management Act 2000*.

How do regional water strategies fit with other water strategies?

Each regional water strategy across the state sits within a broader policy and planning context, including a range of policies and plans that guide the management of water resources in NSW (Figure 4).

Image courtesy of Michael Scotland. Barwon River, Collarenebri.

Figure 4. NSW water policy and planning context



The strategic planning framework for water management in NSW includes the NSW Water Strategy, which is underpinned by the 14 regional and 2 metropolitan water strategies. The NSW Water Strategy was developed in parallel with these strategies and guides the strategic, state-level actions that we need to take. 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 5).

As part of delivering the NSW Water Strategy, the NSW Government will deliver other statewide strategies including:

- the Aboriginal Water Strategy – co-designed with Aboriginal people to identify a program of measures to deliver on First Nation's water rights and interests in water management
- a 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 councils
- a new state-wide Water Efficiency Framework and Program – to reinvigorate water use efficiency programs in our cities, towns and regional centres.

The NSW Water Strategy and the Western Regional Water Strategy also complement other whole-of-government strategies, including the 20-Year Economic Vision for Regional NSW, the State Infrastructure Strategy and the Far West Regional Plan.

Image courtesy of Wentworth Shire Council. Lower Darling River at Wentworth.

Figure 5. State and regional water strategies: priorities and objectives

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

How we have developed the Western Regional Water Strategy

The approach for the Western Regional Water Strategy recognises that communities in the region have been engaging with government over many years to identify options and proposals to help address current and future water-related risks. The Western Regional Water Strategy builds on the strong foundation provided by this feedback, research and analyses.

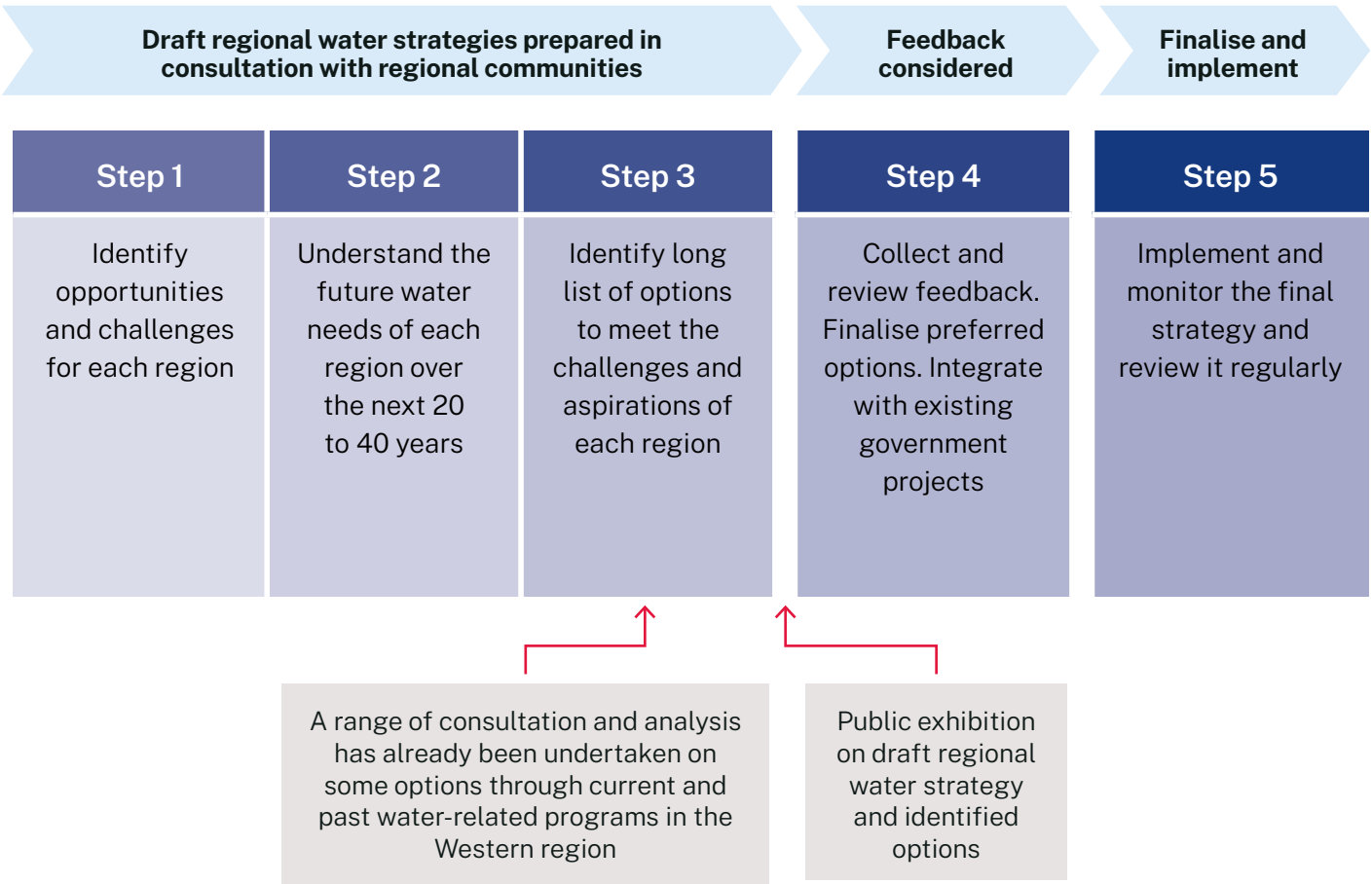
In other regional water strategy regions across NSW, a draft strategy has been released with a long list of options for public comment before detailed analysis is undertaken to shortlist options. We are taking a different approach for the Western region because consultation and analysis across a range of issues and options have already been undertaken through:

- the Western Weirs Program[2] and Wilcannia Weir business cases
- the Better Baaka Program and the previous Menindee Lakes Sustainable Diversion Limit Adjustment Mechanism (SDLAM) Project
- the Connectivity Stakeholder Reference Group.

This means that enough analysis has been undertaken to support a number of options on the long list being progressed through to the short list without any further delay. Attachment B identifies where sufficient analysis has been undertaken to enable options to be shortlisted.

The Draft Western Regional Water Strategy brings together this information to identify the challenges in the region that need to be tackled first and the measures that will best support the region over the next 20 to 40 years.

Figure 6. Approach to developing the Western Regional Water Strategy



2. Recommendations from the Western Weirs Strategic Business Case are being taken forward as part of the Better Baaka Program.

What has informed the Draft Western Regional Water Strategy?

We have used the best evidence and most recent data, taken from a wide range of sources, to inform regional water strategies across NSW and to ensure that ideas and options are investigated fully for each region. Regional water strategies are also supported by extensive community consultation and build on the foundation provided by existing NSW Government commitments and reforms to improve water security and reliability in our regions.

Improved climate modelling and data

Until now, water management in NSW has been based on historical data and observations going back to the 1890s. This has provided a limited understanding of extreme events.

The NSW Government has invested in new climate datasets and modelling to develop a more sophisticated understanding of past and future climatic conditions. These improved datasets integrate recorded historical data with paleoclimate data[3] to give a modelling tool that generates 10,000 years of synthetic climate data. When combined with other sources of climate data such as climate change projections, we can better understand natural climate variability, including the likelihood of wetter and drier periods, and risks to future water availability in each region.

Improved modelling means that we may be able to move away from making decisions based heavily on single 'worst-case' scenarios drawn from a relatively short climatic record, to a more accurate understanding of the frequency and duration of past wet and dry periods. This should help us to better mitigate water-related risks and assess the possible benefits of medium-and long-term solutions.

This updated climate information has been used in developing the Western Regional Water Strategy and will help to assess and compare the effectiveness of the options. It will also support all water users in making more informed decisions and better plan and prepare for climate risks.[4]

The section on *Climate in the Western region* sets out the results from the analysis of the new climate data for the Western region. We will continue to use the best and latest evidence about the future climate to develop solutions to address the challenges associated with protecting and enhancing environmental assets, Aboriginal water interests, towns and industries in a more variable climate and during extreme events.

Existing studies

A significant amount of work has been undertaken to understand the risks affecting water resource management in regional NSW.[5] The Draft Western Regional Water Strategy has been informed by a range of studies, along with information provided by organisations and stakeholder groups across the region.

This has included catchment studies, water security reports and existing water allocation and drought planning, as well as regional development, infrastructure and environmental strategies prepared by NSW Government departments and agencies. We have also considered:

- specific studies undertaken for the Western Weirs and Wilcannia Weir business cases
- WaterNSW's *20-year Infrastructure Options Study for Rural Valleys*
- reviews, assessments and studies relating to the Barwon–Darling River
- the *Independent Assessment of Social and Economic Conditions in the Murray–Darling Basin*, commissioned by the Australian Government
- the Australian Competition and Consumer Commission's inquiry into markets for tradeable water rights in the Murray–Darling Basin.

We have also been guided by NSW's commitments under the Murray–Darling Basin Plan when developing the options to ensure that these commitments are met.

This information has been used to prepare a comprehensive background paper on the region's water resources and water users (see Attachment A).

3. Data reconstructed from before instrumental records began, using sources such as tree rings, cave deposits and coral growth.
4. More information about these new climate datasets and how they are being used in our river system models is in the *Regional Water Strategies Guide,* www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies
5. More information is in the *Regional Water Strategies Guide,* www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies

Building on existing commitments and reforms

The NSW Government has made significant commitments to address the risks associated with water in regional NSW and set our regions up for the future.

The Government is delivering significant state-wide water reforms. These include improving water and sewage services for Aboriginal communities, improving compliance and transparency around water use and access, and implementing robust metering laws to make sure that 95% of the potential water taken in NSW is accurately measured and monitored.[6] In 2020, the NSW Government also completed the delivery and commenced implementation of all of the environmental water reforms that arose from the Water Reform Taskforce, that was set up following the *Independent investigation into NSW water management and compliance* report. These include implementing:

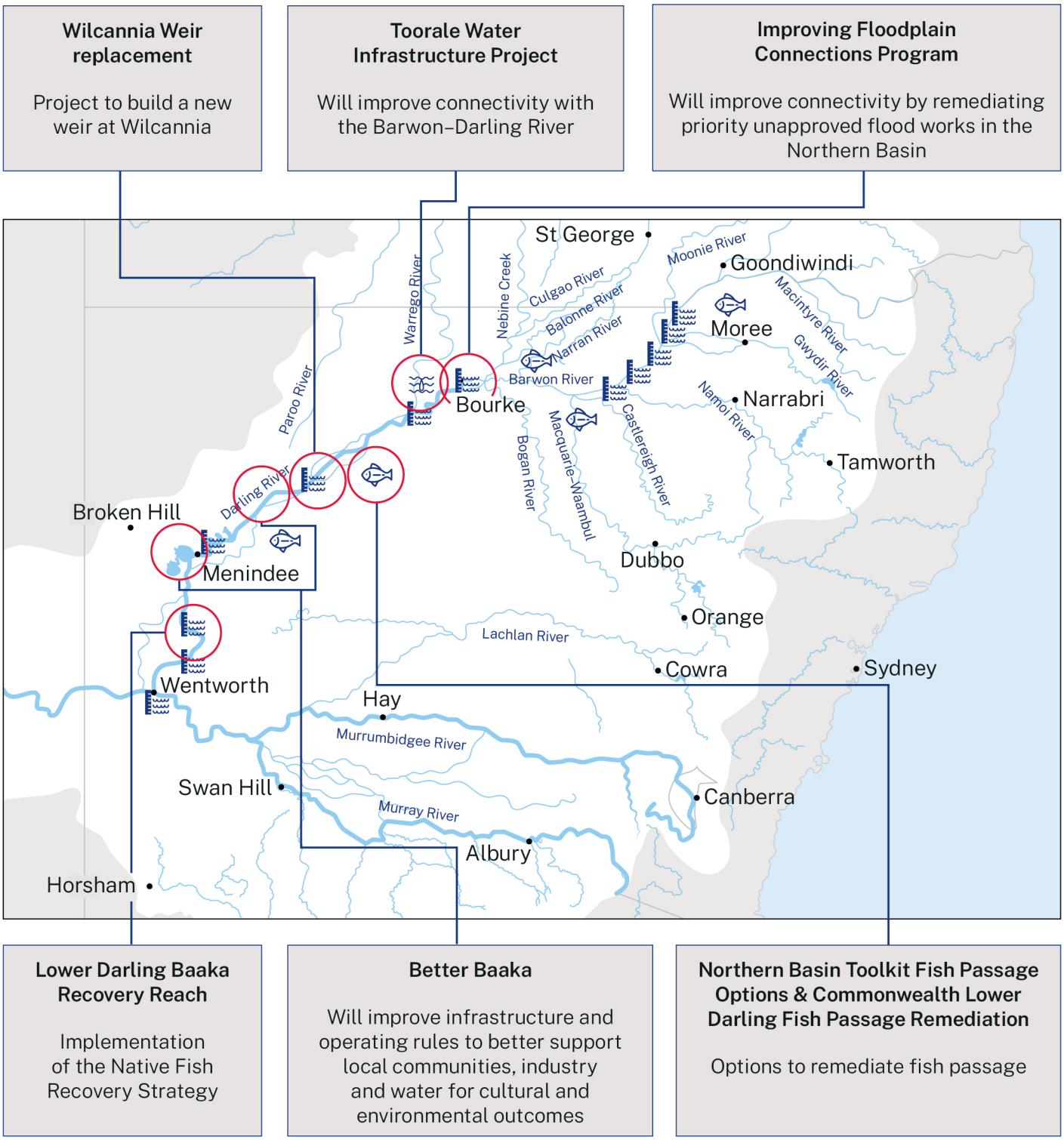
- individual daily extraction components in the Barwon–Darling
- the resumption of flows rule in the Barwon–Darling
- active management to protect held environmental water in the Barwon–Darling, lower Macquarie, and lower Gwydir.

A number of projects are underway in the Western region to improve water management (Figure 7). During the recent drought, the NSW Government also assisted Western region councils to undertake emergency works to address water security issues.

Image courtesy of Annette Corlis. Paroo River, Wilcannia.

6. The NSW and Australian governments have committed $23.6 million and $12.5 million respectively to the metering program to ensure that meters are upgraded effectively. This includes rebates for water users who switch to telemetry-based systems.

Figure 7. Committed Darling Basin projects



We have improved protections for environmental water in the Northern NSW Murray–Darling Basin, are supporting the health of native fish populations, better managing river flows and implementing recommendations made by the Independent Panel Assessment of the Management of the 2020 Northern Basin First Flush Event.

The Western Regional Water Strategy builds on these commitments and reforms and seeks to enhance and leverage them where possible, while also addressing any outstanding gaps.

Box 1. Working together to improve how we manage water

Having a whole-of-government approach will help us to integrate water and land management and ensure we can take full advantage of the opportunities that are arising in the Western region. Some of the water-related projects underway in the Western region are outlined below.

Western Weirs – The NSW Government previously committed $4.2 million from the Restart NSW Water Security for Regions Program to the Western Weirs Project. The project has developed a business case to improve town water security for communities reliant on surface water from the Barwon–Darling and Lower Darling rivers. The business case assessed the capacity of town weirs to provide water for far west towns and recommended options that included raising weirs and constructing new gated weirs, removing weirs and structures that provide no benefit to the system and changes to water sharing rules. The business case also recommended further investigating alternatives to weirs, such as groundwater and managed aquifer recharge, off-river storage, recycled water and bulk water supply pipelines. Relevant recommendations from the business case are being progressed through the Better Baaka Program.

Northern Basin Toolkit – This $180 million, Australian Government-funded project aims to restore the ecological health of the Northern Basin. Toolkit projects in the Western region include the Reconnecting the Northern Basin Project, which is constructing fishways and undertaking fish friendly rehabilitation works in the Barwon–Darling and Border Rivers, and the Fish Friendly Water Extraction Project, which is installing fish-friendly screens on irrigation pumps in the Barwon–Darling and Gwydir valleys.

Better Baaka – The NSW Government is investigating options to improve connectivity, environmental, cultural and community outcomes for the Darling-Baaka River system. A range of measures has been identified, including works to enhance Cawndilla Creek, weir modifications and renewals, upgrading Wilcannia Weir and reallocating 15 GL of water in the Intersecting Streams to the environment.

Lower Darling–Baaka Recovery Reach – Developed in response to the significant fish deaths in the Lower Darling–Baaka near Menindee throughout 2018–2020, the Australian and NSW governments are working together to implement the Native Fish Recovery Strategy, which is guiding investment in native fish and river health. The Lower Darling–Baaka Recovery Reach is focusing on fish community monitoring, aquatic habitat mapping, providing input into planning of flow events and a program of on-ground actions to protect and improve native fish habitat.

Extensive community consultation

Over the last few years, the NSW Government has been consulting with stakeholders and communities on a range of water-related issues, including water resource plans, metering reforms, environmental water management, the Sustainable Diversion Limit Adjustment Mechanism Program, the Better Baaka Program, floodplain harvesting, connectivity and drought. Through these engagements, we have heard many ideas about how to be better prepared for future droughts and floods, and a more variable climate.

We have also heard that community members would like to take action now rather than continuing to discuss options. We have taken this on board in the re-design of our approach to the Western Regional Water Strategy and have fast-tracked the analysis of certain options in this strategy so they can be implemented as soon as possible.

Due to the COVID-19 pandemic, we have had to redesign our engagement program, replacing some face-to-face consultation with virtual, online and contactless methods. We have continued to talk with local councils, targeted stakeholder groups and Aboriginal communities about their thoughts on what the Western Regional Water Strategy needs to cover.[7]

Attachment C provides further information about the outcomes of meetings and discussions with local councils, local water utilities, joint organisations, targeted stakeholders and Aboriginal communities.

7. Much of this consultation has been aligned closely with the Western Weirs and Better Baaka programs.

During consultation with local councils, Aboriginal communities, the Connectivity Stakeholder Reference Group and Better Baaka stakeholders we heard:

Connectivity	Aboriginal knowledge and connection to Country
While connectivity is important to all stakeholders, there are different views about how to achieve improved connectivity and what is acceptable. Many stakeholders believe there has been a reduction in connectivity, and that the more recent extended dry periods have never occurred in the past, and certainly not during living memory. Some stakeholders suggested there needs to be more water flowing into the Menindee Lakes and the Lower Darling. Other stakeholders suggested there are physical constraints to delivery of water along long dry river systems and there are challenges around ensuring connectivity during extreme droughts.	The river is the centre of cultural life for Aboriginal people. Water supports the health and wellbeing of communities. Throughout time Aboriginal people have been the custodians of water, protecting and managing the water and the environment for people downstream. Connectivity and end-of-system flows are important for Aboriginal people. Aboriginal nations feel like they are not being heard. Meaningful consultation with Aboriginal communities is required to build trust and a positive working relationship. This takes time and involves going onto Country and talking with communities face-to-face.

Environment and ecosystem health	Town water security and infrastructure
There are concerns about the impact that a loss of connectivity between river systems has on the overall health of these systems, and the stress that it places on the environment. Aboriginal people are concerned that the amount of water taken for irrigation means that not enough water is set aside for the environment.	Towns along the river see themselves as 'river communities' and so securing and protecting surface water is a priority for them. New infrastructure, such as weirs, is needed to assist with town water supply and recreational activities. There are additional demands on town water supplies during drought due to the need to provide water to residents not connected to town water supplies. Approaches to water reuse need to be innovative, flexible and affordable to meet the needs of different water users in small communities.

Water quality	Economic development
There are widespread concerns about the quality of water in the river. For Aboriginal people, poor water quality impacts on being able to make use of the river for cultural and recreational reasons. For river communities, poor water quality impacts on its suitability for domestic use – for washing and drinking along with recreational activities such as swimming and fishing. Councils and water utilities have told us that large variations in surface water quality presents significant water treatment issues.	Future economic prosperity in the Western region will require improved water security and reliability. Communities in the Unincorporated Area have important visitor economies but do not have water 'on tap'. Water security will help attract more visitors and tourism.

What is the purpose of this consultation paper?

This consultation paper sets out the key water security challenges we have identified for the region based on evidence and feedback we have heard from the community, as well as the options that could help to tackle these challenges.

Like all parts of Australia, the Western region faces a more variable and changing climate. We need to prepare now for the transition to a scenario where we do more with less water, make smarter decisions about our water use and management armed with better knowledge and information, and protect our most critical water uses.

As shown in Figure 8, our vision is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous Western region. We have identified 6 challenges that are immediate priorities for the region. Addressing these challenges will help us achieve the vision and objectives we have set for the region. We have identified options for inclusion in the Western Regional Water Strategy and Figure 8 also indicates where more detailed information about these options is provided in this consultation paper. We are interested in your views on whether these challenges and options need to be prioritised.

Image courtesy of Michael Scotland. Barwon River, Mungindi.

Figure 8. Proposed water security challenges and priorities for the Western region

Vision

Healthy, reliable and resilient water resources for a liveable and prosperous Western region.

Regional Water Strategy 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 meeting our visions and objectives

- Declining water security for towns and small communities
- Insecure water supplies affect the viability of businesses
- Aboriginal people's water rights have not been delivered
- Declining health of natural systems
- Reduced connectivity impacts critical needs
- Managing impacts of poor water quality

Options for the Western Regional Water Strategy

Improving water security for towns and industries	Delivering on Aboriginal people's water rights and improving access to water	Protecting and enhancing natural systems	Managing the impacts of poor water quality	Making water information more accessible and meaningful	Improving connectivity across the Northern Basin
Pages 82-85	**Pages 86-88**	**Pages 89-93**	**Pages 94-94**	**Pages 96-98**	**Pages 99-115**

This paper is accompanied by:

- Attachment A, which includes further detail on the Western region, its water resources and water-related challenges
- Attachment B, which sets out the long list of options
- Attachment C, which summarises what he have heard from targeted consultation so far
- Attachment D, which includes detail on the review of the North-West Flow Plan
- Attachment E, which provides a rationale for the critical dry conditions triggers.

The Draft Western Regional Water Strategy is also accompanied by an explanatory guide that outlines the broader context for the development of regional water strategies across NSW.

The strategy is being developed alongside amendments to the Barwon–Darling Water Sharing Plan (WSP), which will set the rules for sharing water in the Barwon–Darling. This means that a number of options for the Western region will be progressed in the short term through the amended WSP. This includes the licensing, measurement, and regulation of floodplain harvesting within legal limits.

To give water users, stakeholders and communities a clear understanding of how future water options align and interact – and to ensure that we identify integrated and complementary options that deliver the best outcomes for the region – we are consulting jointly on the Draft Western Regional Water Strategy, the amended Barwon–Darling Water Sharing Plan and the proposed enduring floodplain harvesting rules. In addition to this consultation paper, a number of other documents are also on public exhibition and should be read in conjunction with this paper, as shown in Figure 9.

Figure 9. Public consultation on water programs in the Western region

Western Regional Water Strategy	Overarching water strategy for the region Long term 20 to 40 years	On public exhibition **Draft Western Regional Water Strategy, with attachments (this consultation paper)**
Amended Barwon–Darling Water Sharing Plan	Rules for sharing water in the Barwon–Darling Immediate term 10 years	On public exhibition **Proposed changes to Barwon–Darling Water Sharing Plan, with supporting papers**
Floodplain harvesting	Licensing and regulation of floodplain harvesting Implemented in Barwon–Darling as WSP rules	On public exhibition **Proposed enduring floodplain harvesting rules package, with modelling and environmental reports**

Joint consultation

- Central webpage
- Public webinars
- Public information sessions
- Face-to-face meetings
- Targeted Aboriginal community sessions
- Targeted peak group session

We want to hear from you

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

We are seeking your feedback on the Draft Western Regional Water Strategy. We want your views on whether we have adequately identified the priority challenges in the region, and the options to help address these challenges. Your feedback will help us to finalise the strategy and implementation plan.

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

- based on the best evidence
- designed to respond to the Western 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.

The Western region

2

Image courtesy of Destination NSW. Menindee Lake, Menindee.

The Western region is vast, flat and low-lying, making up about one-third of the land mass of NSW and covering 275,556 km^2 (Figure 1). The region is bounded by the Queensland border to the north, the South Australian border to the west and the Border Rivers, Gwydir, Namoi, Macquarie–Castlereagh, Lachlan, Murrumbidgee and Murray catchments to the east and south.

The Western region is located within the traditional lands of 17 First Nations who have remained caretakers of the region for over 60,000 years. The region is rich in Aboriginal culture and heritage and many significant Aboriginal cultural and heritage sites are also recognised as important water-dependent environmental assets, including Baiame's Ngunnhu (Brewarrina fish traps), Paroo River Wetlands and Narran Lake Nature Reserve.

While covering such an extensive area, the region is home to a small and dispersed population of about 36,700 people – or 0.6% of the state's population.[8] It has an average population density of just 0.2 persons per square kilometre, the lowest of all the NSW water strategy regions.

Most people live in the regional centres of Broken Hill (17,600), Cobar (4,600) and Bourke (2,600). These regional centres – and other towns such as Mungindi, Walgett, Lightning Ridge, Brewarrina, Tibooburra, and Menindee – are important employment and service hubs for surrounding communities.

The rest of the population lives in smaller towns, villages and localities spread across the region. Small towns located along the Barwon–Darling River include Collarenebri, Louth, Wilcannia, Menindee and Pooncarie. Towns located away from the river include Goodooga, Lightning Ridge, Tibooburra, Wanaaring and White Cliffs.

The main industries in the region are mining, agriculture, health care and social assistance. The dominant agriculture land use is rangeland grazing of sheep, goats or cattle. Some irrigated cotton production occurs in the upper catchments, concentrated on the alluvial floodplains near Collarenebri and Bourke. Industry in the region is diversifying, with agriculture continuing to adapt to new technologies and a highly variable climate. Renewable energy projects are expanding, tourism is increasing and there is ongoing exploration for mining and gas commodities.

Image courtesy of Department of Planning and Environment – Environment and Heritage. Western Floodplain, Toorale.

8. REMPLAN, Department of Planning Industry and Environment

Water in the Western region

3

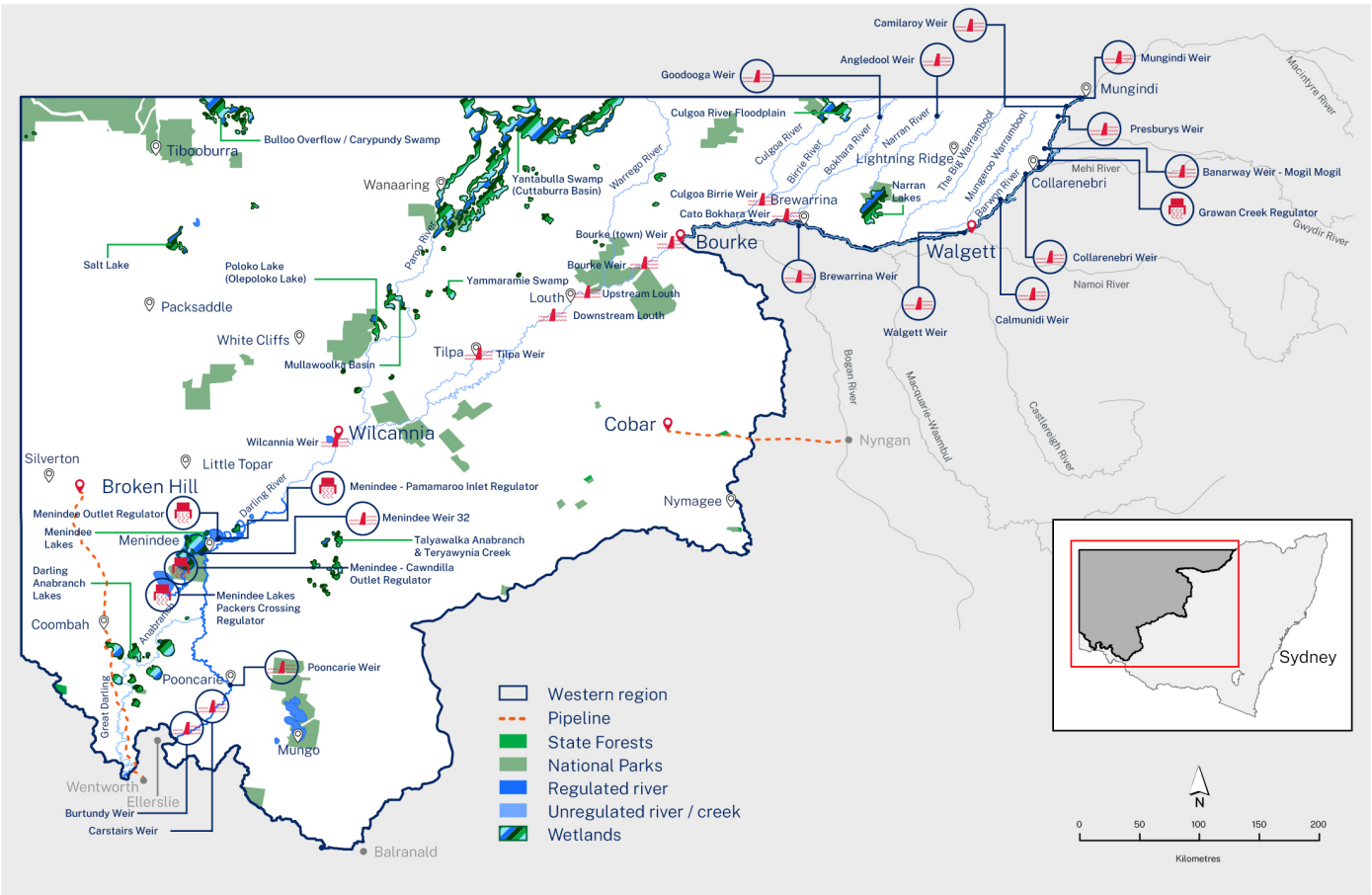
Image courtesy of Destination NSW. Menindee Lakes, Menindee

Water is a significant feature of the Western region's semi-arid environment, with multiple sources of interconnected rivers, creeks, lakes, groundwater aquifers and wetlands. Water is critical to the spiritual health of Aboriginal communities, the environment, the social fabric and liveability of the Western region, and its economic prosperity.

The region's towns, communities and industries use water from:

- the Barwon–Darling River
- Menindee Lakes and the Lower Darling
- the Intersecting Streams (which originate in Queensland)
- groundwater resources
- arid catchments in the north-west that do not form part of the Murray–Darling Basin.

Figure 10. The Western region: key surface water resources and infrastructure



The Barwon–Darling River system is the main water source in the region and connects the northern and southern parts of the Murray–Darling Basin. It starts upstream of Mungindi and flows 1,900 km until it reaches the Murray River at Wentworth. The system has 3 sections:

1. Barwon River, which stretches from the confluence of the Weir and Macintyre rivers about 25 km upstream of Mungindi, south to the Culgoa River near Bourke
2. unregulated portion of the Darling River, which flows from the confluence of Culgoa River near Bourke to the Menindee Lakes in the south
3. regulated portion of the Darling River (known as the Lower Darling River), which continues from Menindee Lakes to the Murray River in the south.

The Barwon–Darling remains unregulated until it reaches Menindee Lakes, and is one of the most significant unregulated river systems in NSW. The Menindee Lakes regulates the water flowing along the Lower Darling. Unlike most inland catchments in NSW, the Barwon–Darling River upstream of Menindee does not have a large headwater storage that regulates flows along the length of the river, and over 90% of the inflows in the region are generated in upstream catchments most of which are regulated.

This means that towns, water users and the environment rely on inflows from the north that are impacted by water extraction, the operation of headwater dams, and the climate, including its effect on soil moisture and flooding, in upstream tributaries.

What do we mean by regulated and unregulated rivers?

Unregulated rivers or streams are not fully controlled by releases from a dam or through the use of weirs and gated structures. However, in some catchments there are town water supply dams that control flows downstream.

Water users on unregulated rivers are reliant on climatic conditions and rainfall and can only access water when the river has reached a certain level.

Regulated rivers or streams are where flow is controlled via one or more major man-made structures (e.g. dams and weirs). Within a regulated river system, licence holders can order water which is released from the dam and then taken from the river under their water access licence.

Annual rainfall in the region is generally low, with mild winters, hot summers, high evaporation rates, long periods of low or no flows interspersed with small-to-medium and high-flow events. These conditions mean that agricultural industries, town weirs and environmental assets along the unregulated rivers rely on the irregular small-to-medium and high-flow events to survive and prosper.

The predominant water use in the unregulated Barwon–Darling River in average years is for irrigated crops centred around Bourke and Mogil Mogil. In the Lower Darling, the water is predominately held by environmental water holders, with productive use centred around grazing. Local water utility licences in the Barwon–Darling River and Lower Darling are around 3% of total water licences in the region.

Table 1. Barwon–Darling and Lower Darling river licences (2021/2022)

Lower Darling regulated river		Barwon–Darling unregulated river	
Entitlements	**Proportion of shares compared to total share pool (%)**	**Entitlements**	**Proportion of shares compared to total share pool (%)**
Supplementary	74	Unregulated River – C class	23
General security	24	Unregulated River – B class	68
High security	2	Unregulated River – A class	5
Local water utility*	<1	Local water utility	3
Domestic and stock	<1	Domestic and stock	<1

*Essential Water, the water utility for Broken Hill, sources water from the Murray River through a pipeline and so it is not included in the total percentage.

The Barwon–Darling plays a critical role in the Murray–Darling Basin, providing the ecological link between the northern and southern basins, and is one of the most important ecological corridors across the Basin. The majority of the river is classified as an aquatic endangered ecological community.[9] The river supports a range of threatened species such as Murray Cod and Silver Perch, key recreational fish species including Golden Perch, as well as internationally important wetlands.

Ensuring there is enough water in the Barwon–Darling system and the Lower Darling River for critical needs during summer can be a challenge. High evaporation and the length of the river system mean that it can take from one to 4 months for water to flow from the northern valleys to Menindee Lakes.

The Menindee Lakes storage system consists of 4 main lakes: Wetherell, Pamamaroo, Menindee and Cawndilla (Figure 11). The lakes are a critical ecological system for fish breeding and bird life and also hold important cultural values and significance for Aboriginal people.

The Menindee Lakes system is the only large public water storage in the Western region with the infrastructure owned and operated by the NSW Government. The water can also be shared to meet Murray River demands when the volume rises above 640 GL, and until it drops below 480 GL in accordance with the Murray–Darling Basin Agreement.

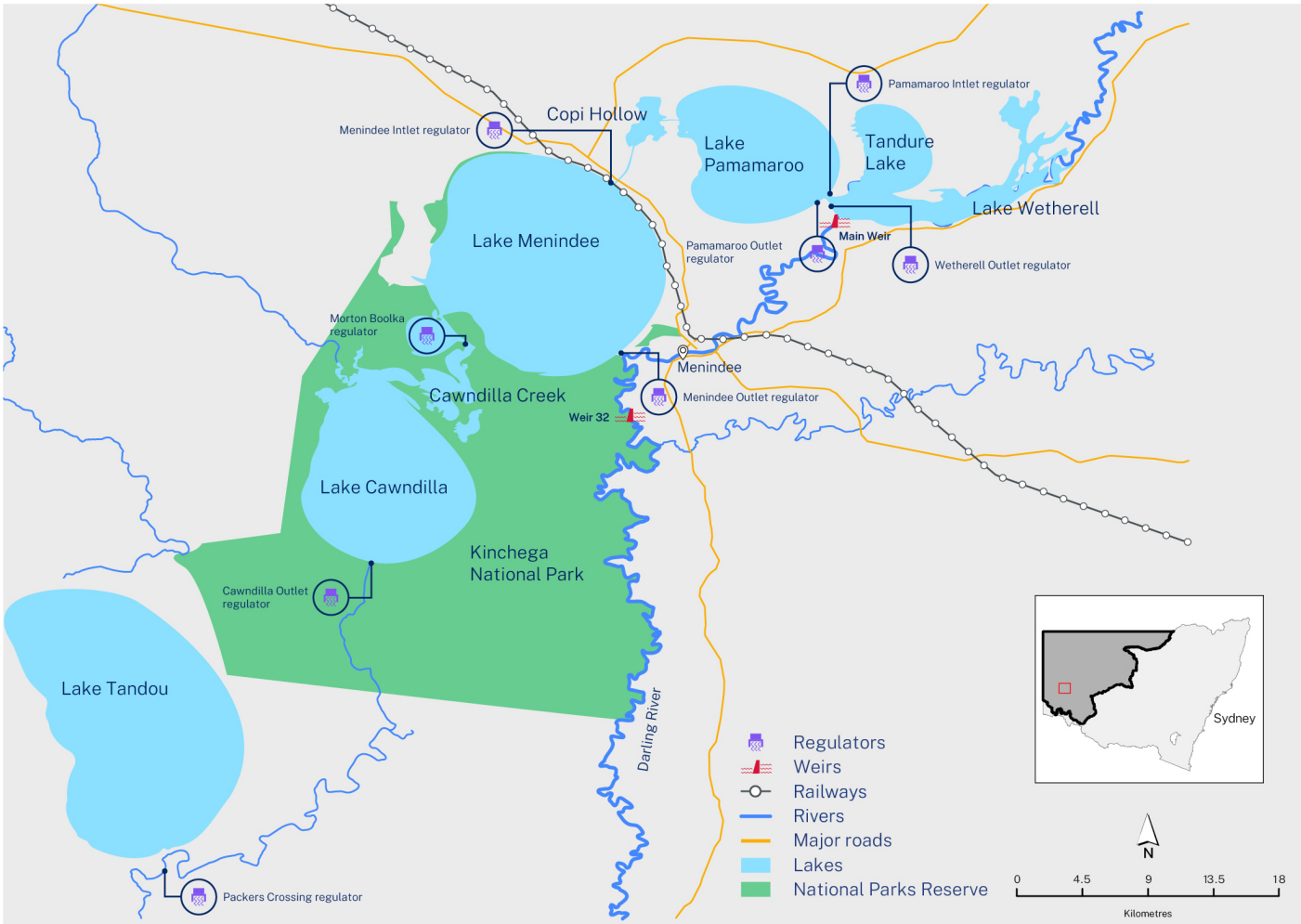
Flows into the lakes often occur in large pulses, following flooding rain in the upper catchments. Large floods usually occur after late summer rains in QLD or late winter rains in NSW tributaries.

Evaporation from Menindee Lakes is significant, due to the semi-arid climate, the shallow depth (average 7 m) and the large surface area of the lakes.[10] Losses can be as high as 700 GL/year,[11] or about 40% of the storage capacity when the lakes are full.

Image courtesy of Carla Frankel. Menindee Lakes system.

9. Listing endangered ecological communities is a form of landscape or systems level protection. These communities provide vital wildlife corridors and habitat refuges for many plant and animal species, including threatened species and other Australian plants and animals that are in decline. Endangered ecological communities are those listed in 'Schedule I' of the *Threatened Species Conservation Act 1995* or Schedule 4 of the *Fisheries Management Act 1994*.
10. WaterNSW, *Menindee Lakes Facts and History*, www.waternsw.com.au/supply/visit/menindee-lakes
11. MDBA 2019, *Menindee Lakes: The Facts*, www.mdba.gov.au/water-management/infrastructure/menindee-lakes/management

Figure 11. Map of the Menindee Lakes system

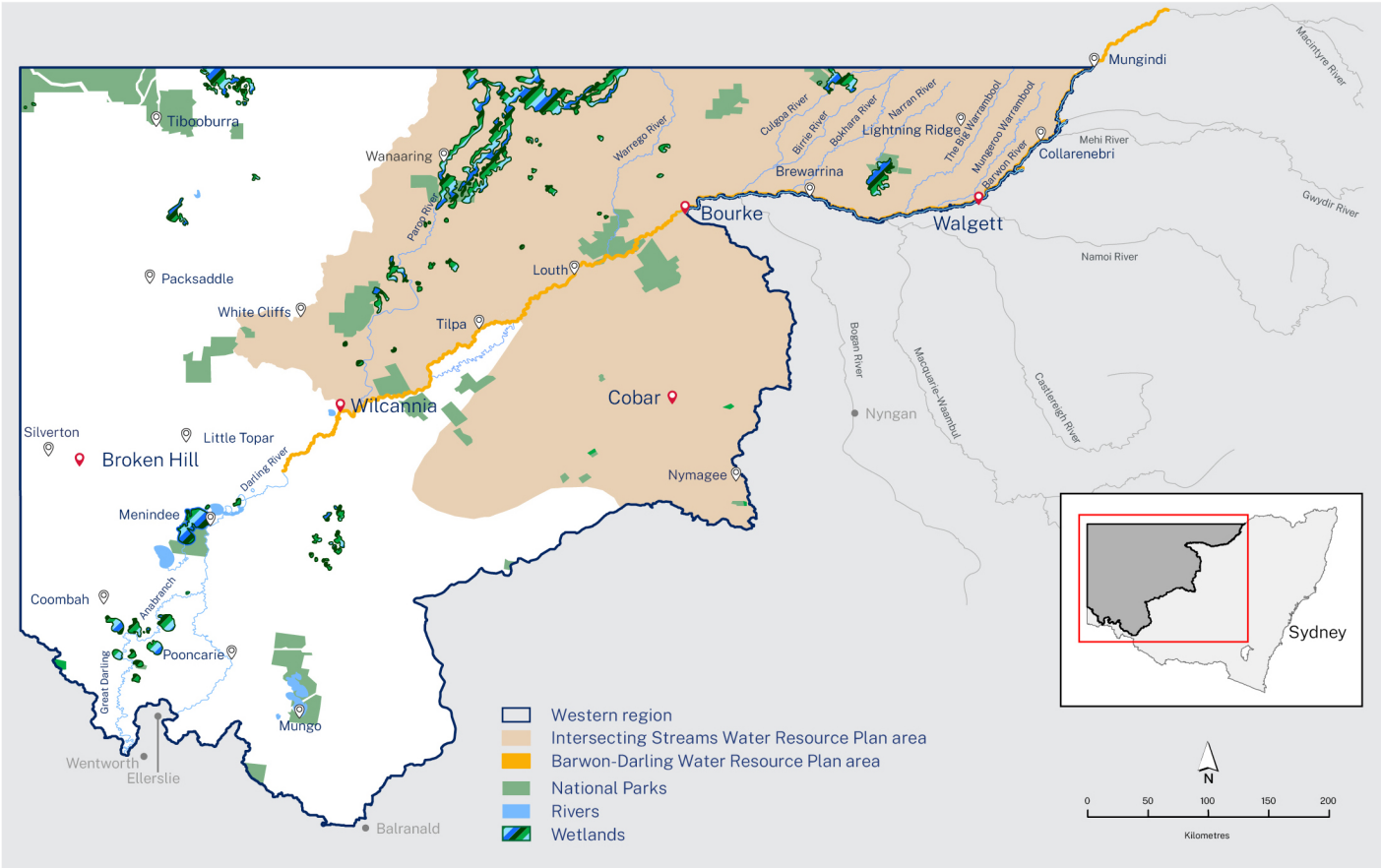


The Intersecting Streams system includes the Narran, Bokhara, Culgoa, Warrego and Paroo rivers, which flow south across the QLD–NSW border and into the Barwon River (Figure 12). The system contains many tributaries, distributaries and anabranches and an extensive network of ephemeral wetlands and hypersaline lakes. The system is unique and has some of the largest natural free-flowing and high environmental value systems in the Murray–Darling Basin.

Stream flows are highly variable between seasons and across catchments, with sporadic flooding associated with cyclonic rain. Between wet periods, most streams become a series of unconnected waterholes, lakes and wetlands. With the exception of the Narran River, the Intersecting Streams connect to the Barwon–Darling River during wet periods and make an important flow contribution to that system.

Extraction of water in the Intersecting Streams is mainly for stock and domestic purposes and is a very small component of total water use in the region.

Figure 12. The Intersecting Streams network of rivers



Groundwater is water below the land surface. Groundwater slowly moves between gaps in sediments and in the cracks (or fractures) of rocks. Groundwater is contained in aquifers – underground geological formations with the capacity to store and yield groundwater – that are 'recharged' from surface water, such as rivers and creeks, seeping into the ground and replenishing the groundwater.

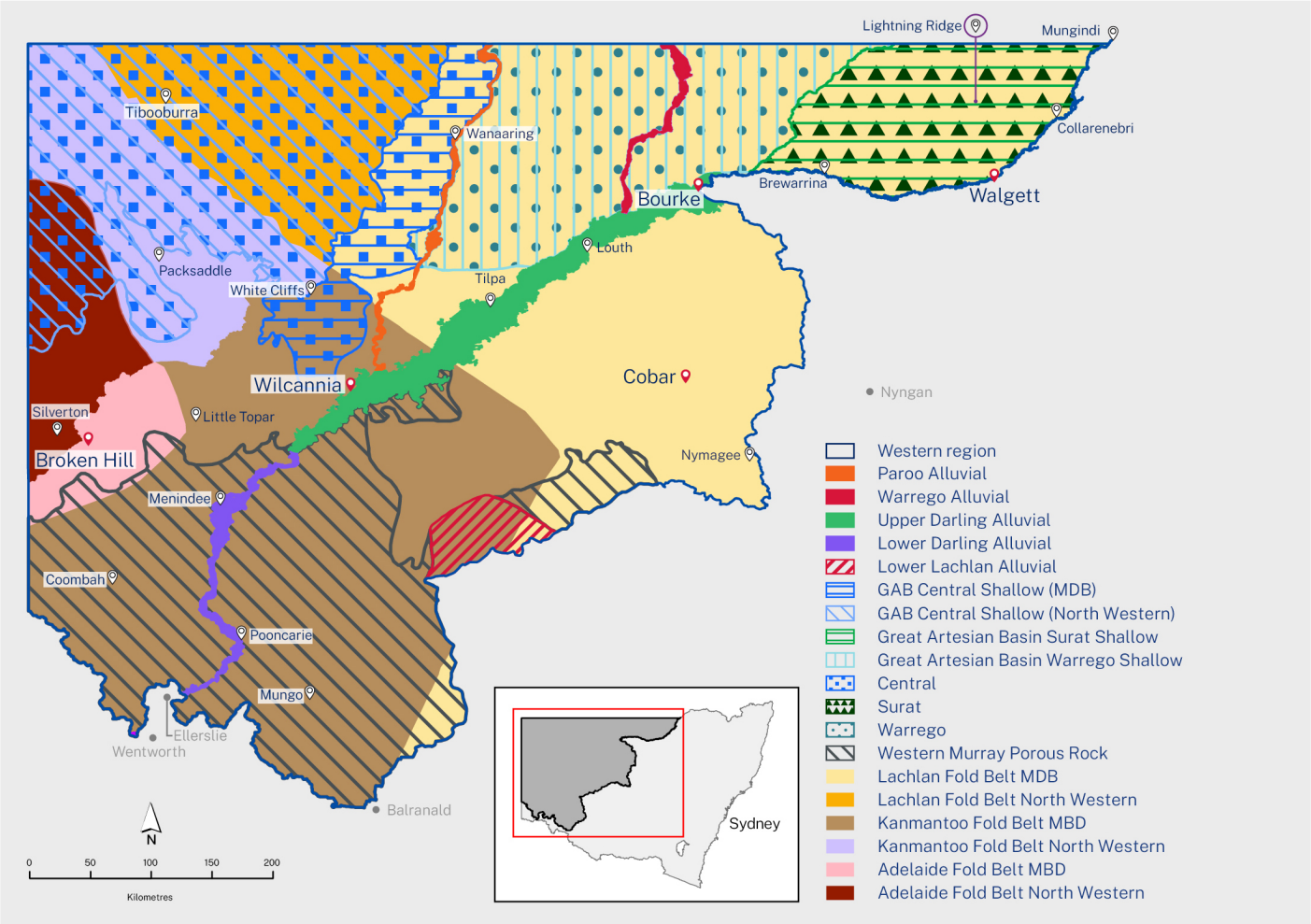
There are many sources of groundwater across the Western region found in different geological layers (Figure 13):

- The topmost layers are sediments deposited by rivers or creeks. The shallow alluvial groundwater sources include the Paroo Alluvial Groundwater Source, Warrego Alluvial Groundwater Source, the Upper Darling Alluvial Groundwater Source and the Lower Darling Alluvial Groundwater Source.
- The next layer is the Great Artesian Basin, the largest artesian groundwater basin in the world. Sources are located in the northern section of the region and include the Central Shallow, Warrego Shallow, Surat Shallow, Central Groundwater Source, Warrego Groundwater Source and Surat Groundwater Source. The southern end of the Western region includes the Western Murray Porous Rock source which overlies the fractured rocks.
- The bottom layer of fractured rocks consists of the Lachlan Fold Belt, Kanmantoo Fold Belt, and the Adelaide Fold Belt.

Fresh groundwater is limited and all shallow groundwater sources need to be treated to meet drinking water guidelines. As a result, overall groundwater use in the Western region is low, but it remains a vital supplementary water supply in the region for towns and industry.

Groundwater also supports a variety of fauna and flora communities. These groundwater dependent ecosystems provide critical ecological services, such as habitats, and have inherent environmental value. Important ecosystems are the Menindee wetlands, which are partly maintained by alluvial groundwater, and the unique Great Artesian Basin mound springs in the Paroo River Wetlands.

Figure 13. Groundwater resources in the Western region



Four arid catchments in the region's north-west – the Lake Bancannia, Lake Frome, Cooper Creek and Bulloo River catchments – are all internal drainage basins with no outlet to the sea nor adjoining river systems. Access to reliable water supplies in this part of the region is an ongoing challenge for industry and towns.

Private on-farm storages are an important water resource for the region. These storages capture rainfall runoff or store water extracted from the region's rivers, streams and aquifers. On-farm storages also capture water flowing across floodplains. Floodplain harvesting in the Western region occurs within the Barwon–Darling Valley Floodplain during flood events, and accounts for an estimated 10-15% of the total amount of water taken from surface water resources (on a long-term average across the Western region). Many agricultural businesses rely on water from floodplain harvesting, which has grown significantly over the last 20 years.

Small volumes of water are recycled by local water utilities in Broken Hill and Cobar. Recycled water remains an underused resource in the region despite its potential to diversify water supplies and buffer water availability from the impacts of droughts.

Attachment A contains more detail about the Western region's water resources.

Image courtesy of Michael Scotland. Barwon River, Mungindi.

Climate in the Western region

4

Image courtesy of Destination NSW. Darling River, Bourke.

Climate snapshot

The Western region experiences arid, dry conditions and a highly variable climate, with low rainfall, very high evaporation rates and lengthy dry periods.

- Droughts can be persistent, occurring on average once in every 8 to 10 years. The Barwon–Darling River often stops flowing during dry periods.
- The recent drought has been the worst 3-year drought on record and resulted in the lowest inflows into the Barwon–Darling on record and the longest case-to-flow period on record: 364 days at Walgett. Menindee Lakes reached critically low water levels and towns faced water shortages.
- Evaporation in the region is very high. Monthly evaporation rates can be more than 8 times the average rainfall and Menindee Lakes can lose up to 40% of its water in a year due to evaporation.
- The number of hot days (a maximum temperature higher than 35°C) ranges from 30 to 40 days per year in the south to over 70 days in the north-west.

Hydrological models updated with the latest climate change data suggest that a future climate could be even more variable.

- Our new modelling suggests that under a worst-case, dry climate change scenario there could be:
  - seasonal shifts in inflow patterns, higher evaporation, more hot days and an increase in fire-weather conditions
  - more times when the northern NSW valleys do not connect with the Barwon–Darling, with up to 40% less inflows into the Barwon–Darling on average under a worst-case dry climate change scenario when compared to our long-term historical climate
  - increased probability of the most recent drought (2017–2020) reoccurring. Under a worst-case climate change scenario, there could be no inflows into Menindee Lakes for 3 years or more.
- While large impacts are not expected in the short term, and the likelihood of the worst-case scenario eventuating is small, these new projections show that just relying on observed historical records to make future water management decisions may no longer be the best course of action. We need to have plans in place to be prepared and resilient if there are future changes in the climate.

Flooding is an important feature of the Western region.

- Floods are a vital, natural process that support the region's ecological and agricultural productivity.
- Even under dry climate change scenarios, we may see more extreme floods with higher flows of water than we have experienced in the past.
- Significant increases in summer and autumn rainfall could lead to corresponding increases in the frequency and magnitude of flooding.

Image courtesy of Sally Anderson-Day. Barwon River, Brewarrina.

What we know about the climate in the Western region

Most of the Western region is semi-arid, except for the far north-west corner, which lies in the arid zone. The region has a highly variable climate, characterised by high summer temperatures, mild winters, low rainfall and very high evaporation rates (Figure 14 and Figure 15).

Figure 14. Current climate in the Western region

Extreme summer temperatures

- 30-40 hot days per year in the southern part of the region
- 70 hot days per year in the northern part of the region
- The 3 highest recorded temperatures in NSW to 2021 were at Menindee (49.7°C), Walgett (49.1°C) and Brewarrina (48.9°C)

Low winter temperatures

- The average minimum temperature is 4–6°C for most of the region

Low and erratic rainfall

Average annual rainfall:

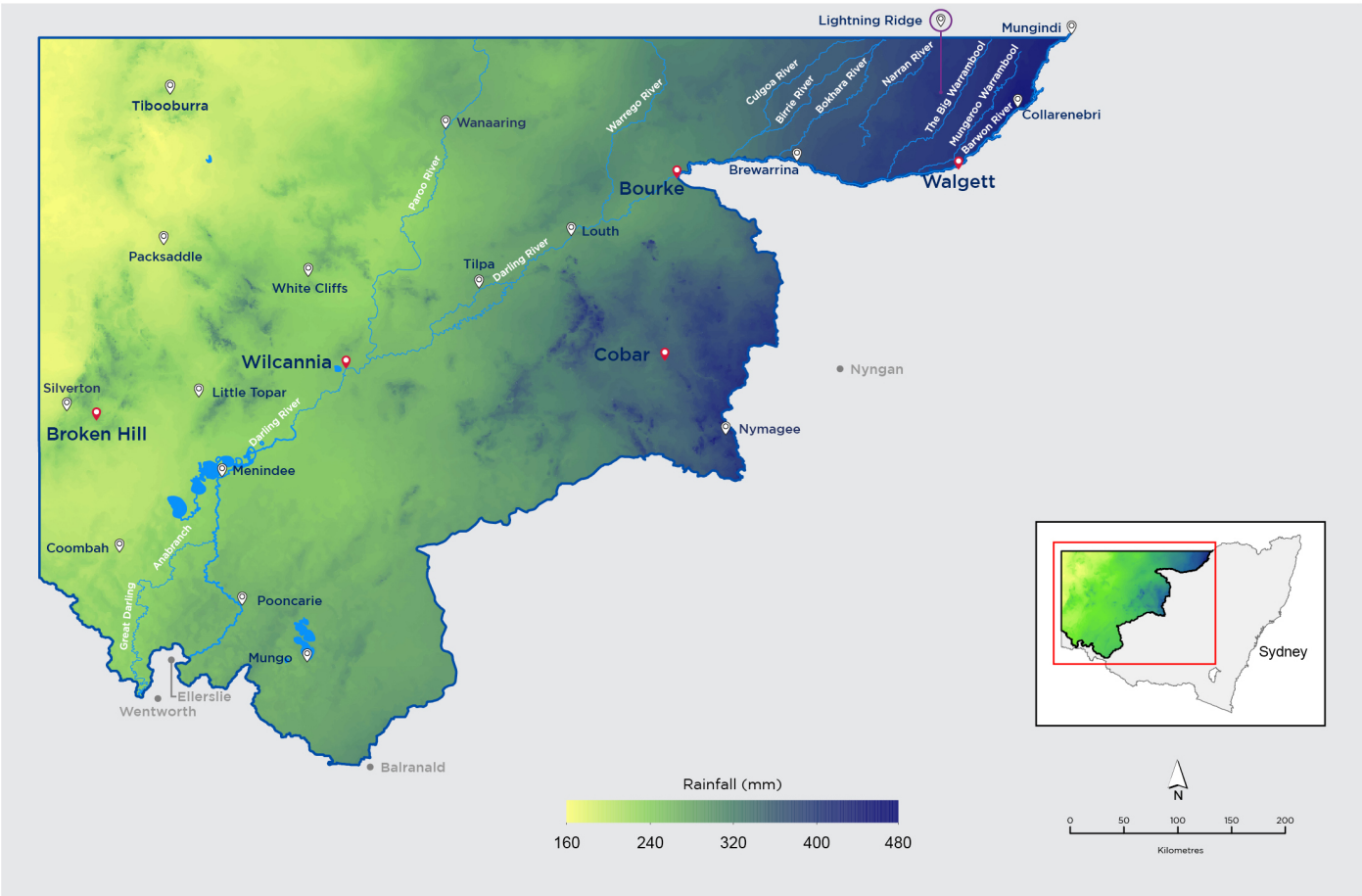
- 150 mm in the north-west corner
- 290 mm in the south-west
- 450 mm in the north-east

Very high evaporation

- 2,400 mm/year in the north-west
- 1,800 mm/year in the south-east

Note: The average monthly evaporation rate at Bourke is more than 8 times the average rainfall in some months. At Menindee, summer evaporation rates are more than 6 times average monthly rainfall.

Figure 15. Observed average annual rainfall in the Western region (2000–2020)



The region has wet and dry periods that can last decades

Our observed historic climate records from the last 130 years indicate that the region has had lengthy dry and wet periods:

- the 1900s to 1940s was a comparatively dry period
- the 1950s to 1990s was a comparatively wet period
- the Millennium Drought (2001–2009), followed by the recent 2017 to 2020 drought saw a return to a mostly dry period for the first 2 decades of this century.

Most of the recorded short droughts (one to 5 years) and decadal droughts (10 years) occurred during dry periods in the region's climate (Figure 16 and Figure 17). This pattern is the same for the Border Rivers, Gwydir, Namoi and Macquarie–Castlereagh catchments, which are key contributors to water flowing into the Barwon–Darling.

Figure 16. Lowest 5-year rainfall periods from the historical record in the Barwon–Darling River catchment (1889–2020)

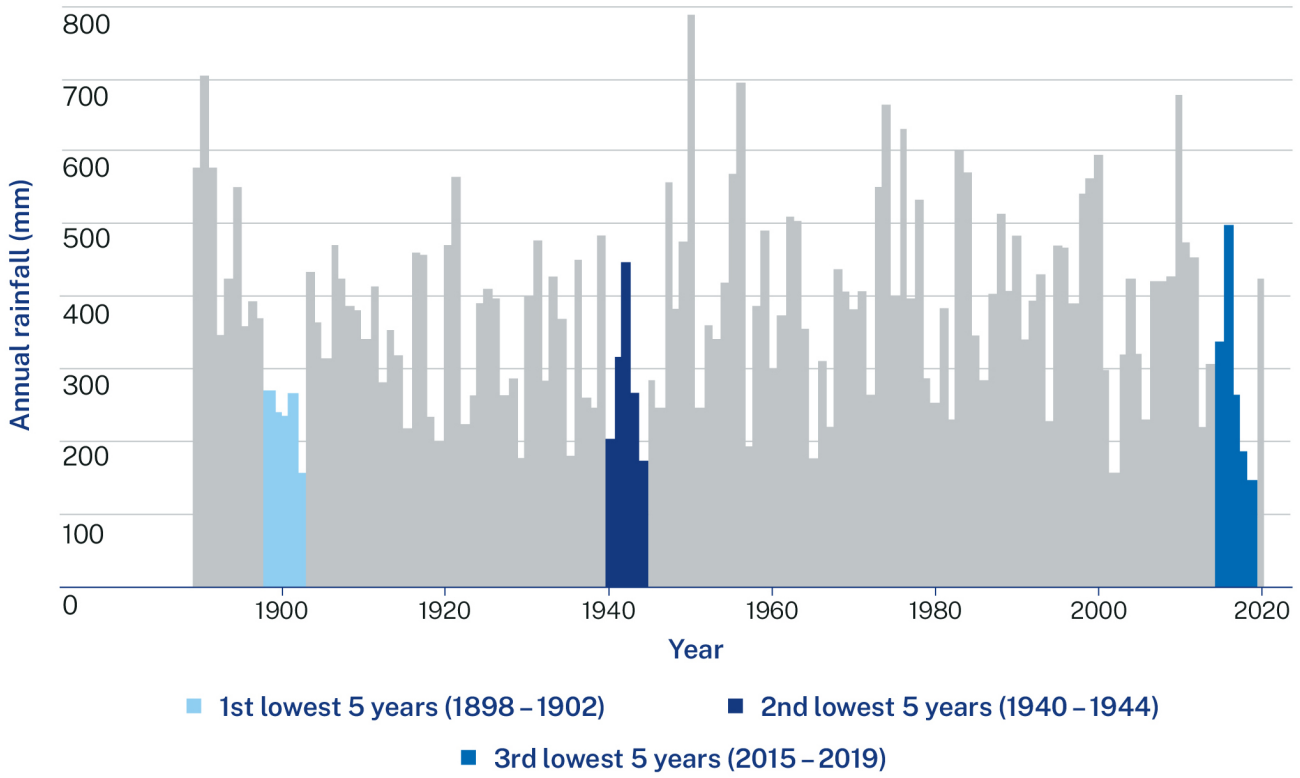
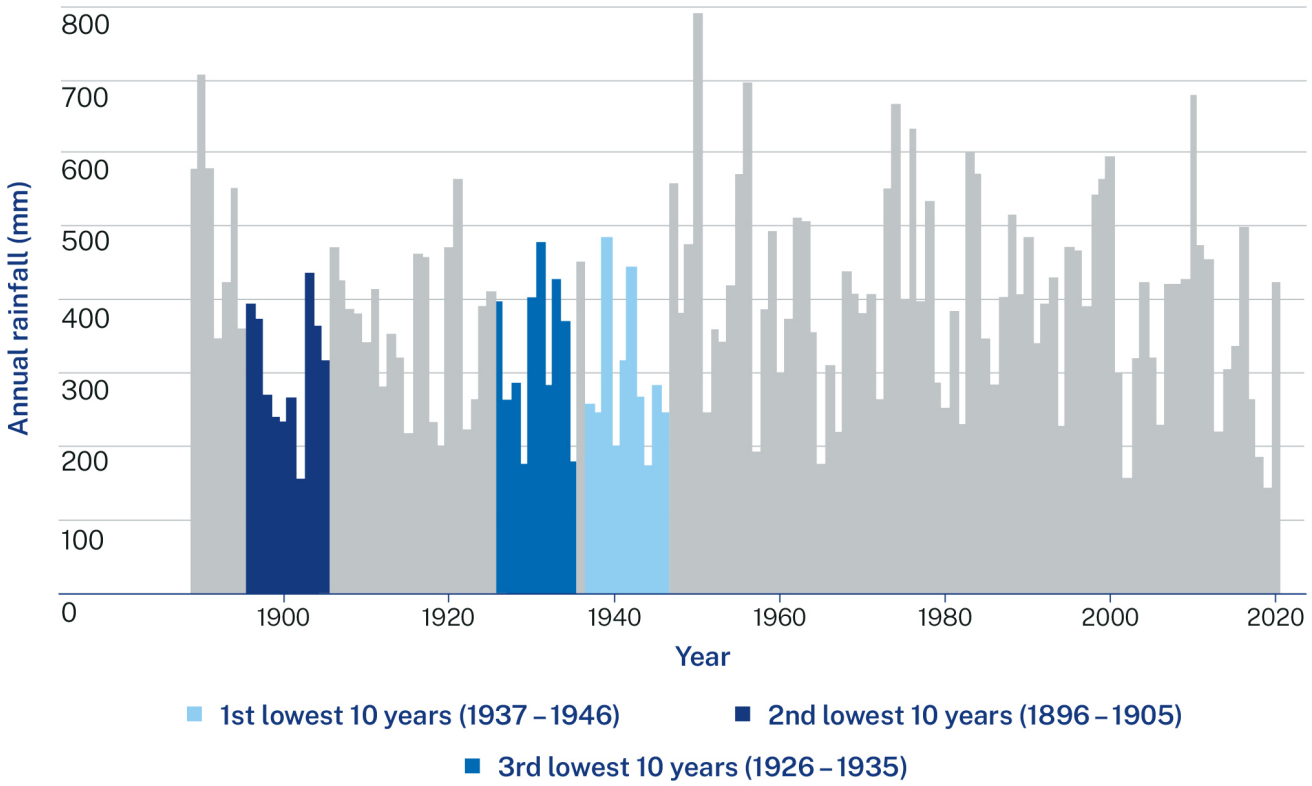


Figure 17. Lowest 10-year rainfall periods from the historical record in the Barwon–Darling River catchment (1889–2020)



The river has stopped flowing during dry periods

The Barwon–Darling naturally has periods of low flows or cease-to-flow events.

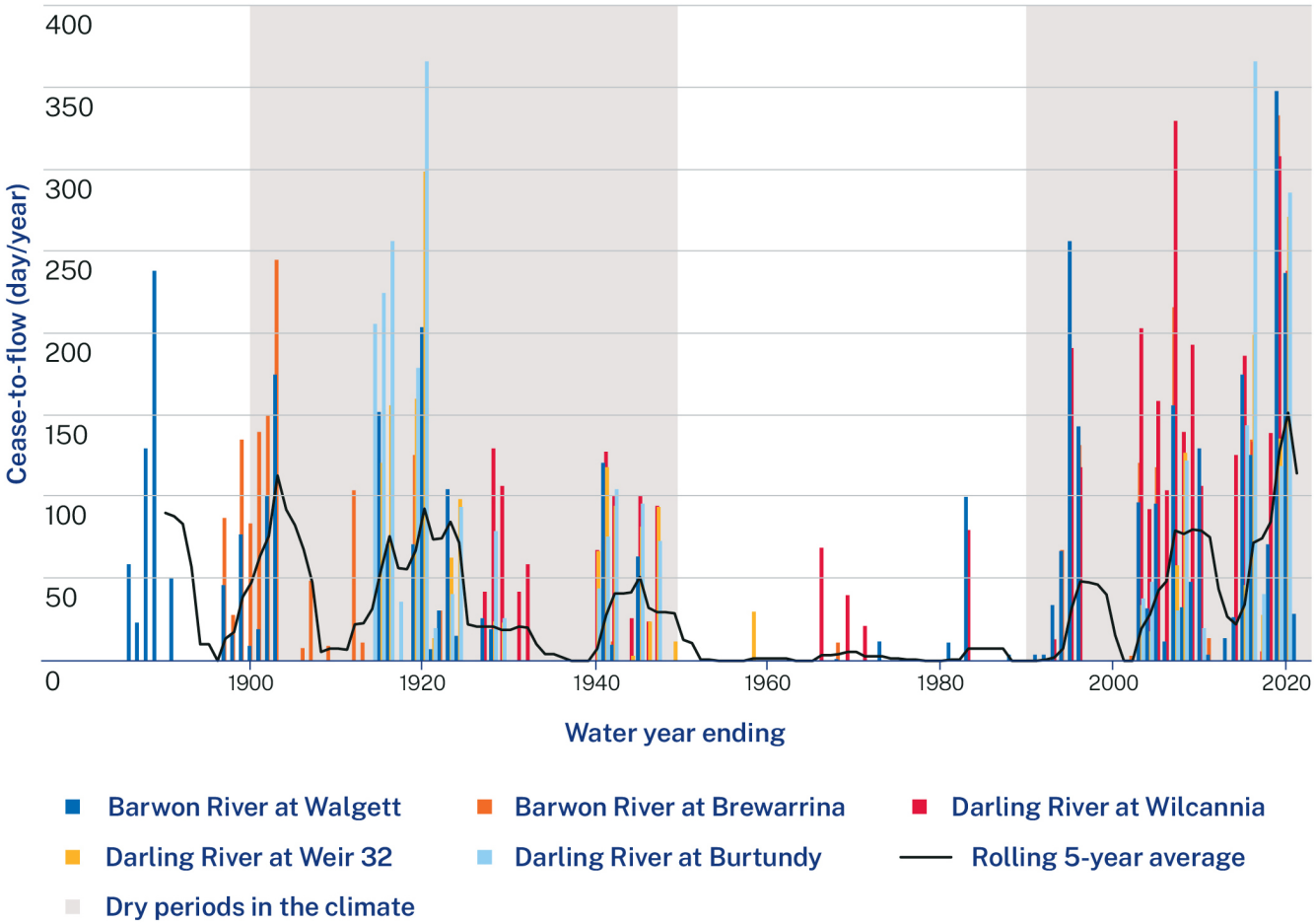
Our historical data from the last 130 years tells us that the Barwon–Darling River has stopped flowing a number of times, with extended cease-to-flow periods occurring more often during dry cycles. Figure 18 shows the number of days in each year since the early 1900s that the river has stopped flowing. This observed data shows that extended dry periods and cease-to-flow events have occurred at various times, including before 1940 when there was little water infrastructure and extraction in the Northern Basin. For example, before 1940, the longest periods the river stopped flowing were:

- Walgett: 270 days in 1902
- Brewarrina: 296 days in 1902
- Wilcannia: 130 days in 1927
- Weir 32/Menindee Town: 236 days in 1919–1920.

In comparison, the river stopped flowing for 364 days at Walgett in the last drought.

Extended dry periods, particularly if the dry periods happen in close succession with minimal flows in between, can have significant impacts on communities, cultural needs and the environment, across the region.

Figure 18. Number of cease-to-flow days per year in the Barwon–Darling River



Box 2. Historical reports about the region's climate

In July 1974, the report *Water resources of the Darling Valley within New South Wales, survey of 32 NSW river valleys; Report No.27 – July 1974* was published. It indicated that drought conditions were reported by the explorer Charles Sturt in 1828 and 1845 when he journeyed through the area. Records from 1895 and 1902 tell us that during this drought, sheep numbers in the Darling Valley were decimated due to lack of feed and many properties had no water for their stock to drink. During this period, there was a documented destructive drought with 362 days of no flow recorded at both Wilcannia and Menindee from January 1902 to January 1903.

In other parts of the state, water was carted long distances. For example, during the 1902 drought, water was carted into Nyngan and Cobar on trains. These reports are available at www.industry.nsw.gov.au/water/science/data/historical-data

The recent drought has been the worst 3-year drought on record

Droughts occur, on average, once 8 to 10 years in the Western region. However, due to its vast area, the impacts of any drought are not necessarily the same across the whole region. Droughts can span multiple years, and each drought differs in its severity, spatial extent and seasonality.

The most severe droughts have included:

- the most recent drought (2017-2020)
- Millennium drought (2001–2009)
- World War II drought (1937–1945)
- Federation drought (1895–1903).

The most recent drought has been the worst 3-year drought on record[12] and had significant impacts across the region (Table 2).

Image courtesy of Water Infrastructure NSW. Copi Hollow, Menindee.

12. Bureau of Meteorology 2020, *Annual climate statement 2019*, accessed from, www.bom.gov.au/climate/current/annual/aus/

Table 2. Impacts of 2017–2020 drought across the region

Lowest inflows on record and loss of connectivity	No significant inflow from upstream catchments between mid-2018 and early 2020 in the Barwon–Darling. Total river flows at Wilcannia in 2018 (12 GL) and 2019 (3 GL) were a fraction of the long-term average (2,247 GL). Licensed environmental water was released from the Border Rivers and Gwydir systems to top up refuge habitats and provide some connecting flows in the Barwon–Darling.
Record cease-to-flow events	364 days of no flows at Walgett, the longest period on record.
Very high evaporation rates	Either the highest on record or significantly above average across the region.[13]
Menindee Lakes were basically empty	No significant inflows into Menindee Lakes from 2017 to early 2020. The lakes were at less than 2% of capacity for over 12 months and releases could not be made.
Critically low town and stock water supplies	Water was carted for Pooncarie, Wilcannia and White Cliffs and to landholders around Menindee and Pooncarie. There was not enough surface water to sustain Bourke and Brewarrina, so both towns turned to bore water. Towns, and domestic and stock users in the Lower Darling were restricted to 50% allocation in 2019/20 and temporary weirs were installed in the Lower Darling in 2018 to pool the remaining water.
Zero and low water allocations	A temporary water restriction was issued in December 2018 (repealed 30 March 2020) for the Lower Darling to protect water for town water supply, stock and domestic use, and permanent plantings. General security licence holders did not receive any water allocations in 2018/19 and most of 2019/20. Water for high security licence holders in the Lower Darling was restricted to a 30% allocation in 2019/20.
Declines in groundwater	Groundwater levels declined due to low rainfall, decreased stream recharge and increased pumping for consumptive use.
Significant fish deaths	Over one million fish are estimated to have died in 3 incidences in the Lower Darling.
Poor water quality	Low flows and hot weather conditions contributed to blue-green algae and low oxygen levels in rivers and pools. Poor water quality impacted ecosystem health and led to the need for water carting for stock and domestic supplies.
Loss of connectivity	Low or no natural flows in the upper tributaries of the Namoi, Macquarie, Gwydir and Border Rivers resulted in no or little flows to the end of these river systems and into the Barwon–Darling.

Significantly, no towns ran out of water during the recent drought. This was due to concerted efforts by the community, local water utilities and government to reduce demand for water, conserve remaining river supplies for critical human needs and establish alternative back-up sources of groundwater.

13. Bureau of Meteorology 2019, *Special climate statement 70 update* – drought conditions in Australia and impact on water resources in the Murray–Darling Basin, Canberra, www.bom.gov.au/climate/current/statements/scs70a.pdf

A better understanding of natural climate variability and future climate change

Our new climate datasets and improved modelling have given us a better understanding and more realistic picture of the natural variability of the Western region's climate. These improvements have allowed us to analyse changes to flows and water availability over a much wider range of climate conditions than was possible with only 130 years of observed historical data.

The new climate modelling focuses on surface water availability. A future scope of works for climate modelling will be to understand how different climate scenarios may impact on groundwater and water quality, which is not currently shown in any climate models.

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

The wet and dry cycles and the patterns of rainfall that we have seen in the last 130 years are not unusual when compared to our modelling of the long-term climate beyond the observed records. There have been more extreme dry and wet conditions in the long-term past than we have seen in the last 130 years. If the region's future climate is like its past climate – before observed records began – we could experience a climate that can have more variability in rainfall, particularly during summer and winter, more variability in inflows into Menindee Lakes and potentially more extreme droughts.

Our modelling also includes recognised climate change projections. These suggest that if a worst-case dry climate change scenario eventuates, there may be an increase in extreme weather events with more severe droughts. The wet years could result in higher flows than we have seen in the past and in the dry years, there could be more extended droughts. Figure 19 and Figure 20 show the potential changes in the climate that could eventuate under a worst-case dry climate scenario.[14, 15]

14. The modelling for the Western region is drawn from the NSW and ACT Regional Climate Modelling (NARCliM) Project, www.climatechange.environment.nsw.gov.au/projections-map?region=far-west#downloads. Further information about how these forecasts have been used in combination with the new climate datasets is in the *Regional Water Strategies Guide*, www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies
15. Office of Environment and Heritage 2014, *Far West Climate Change Snapshot*, accessed from, www.climatechange.environment.nsw.gov.au/projections-map?region=far-west#downloads

Figure 19. Changes under a worst-case dry climate scenario

Higher evapotranspiration

Potential evapotranspiration could increase by up to 5% by 2070 compared to levels between 1990 and 2009, with the largest increases in winter and spring (Figure 20).

Higher minimum and maximum temperatures

Minimum and maximum temperatures are expected to increase by an average of 0.7°C now (2020 to 2039) and 2.1°C in the future (2060 to 2079).

More hot days (temperatures over 35°C)

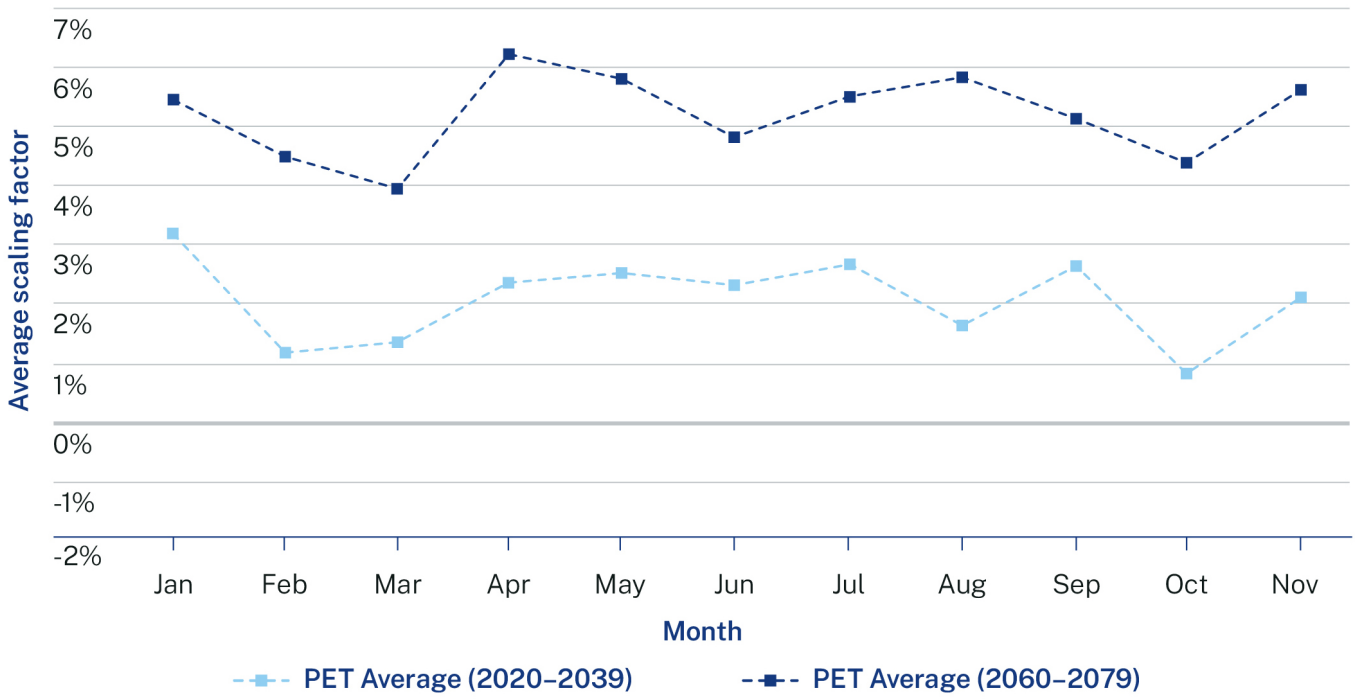
While more hot days are expected across the entire region, the greatest increase is predicted for the region's north-west plains, which will likely experience an additional 10 to 20 hot days each year in the near future and an additional 40 or more hot days each year by 2070.

Fire weather conditions

Average fire weather is projected to increase in summer and spring.

We are not expecting to see climate change impacts of these magnitudes in the short term. However, these results indicate that it may no longer be the best course of action to simply rely on observed historical records or a single 'drought of record' to make water management decisions. We have an opportunity to put plans in place to make sure we are prepared and resilient if there are future changes in the climate.

Figure 20. Short- and long-term climate change (NARCliM) projections for average monthly evapotranspiration in the Western region, compared to the baseline period 1990–2009



Note: This figure is derived from NARCliM 1.0 future climate change projections and represents catchment average monthly changes for the short term (2020–2039) and long term (2060–2079), compared to the baseline period of 1990–2009. The baseline period is represented as 0% on the scaling factor.

Box 3: Using climate change projections in water modelling

The NSW Government's NARCliM (climate change) datasets include a range of different future climate scenarios. We have used the most conservative result from NARCliM in our modelling – the scenario that represents the greatest reduction in average monthly rainfall.

While the results of the other scenarios in the current version of NARCliM are arguably equally appropriate and probable, we intend to stress test the water system and understand the worst-case climate scenario for strategic water planning. This will test the resilience of options proposed in the regional water strategies, particularly options that go towards securing water for critical human needs.

A dry climate change scenario could result in fewer inflows into the Barwon–Darling River from NSW and QLD tributaries

Over 90% of the flows into the Barwon–Darling River come from upstream valleys. Our new climate change modelling suggests there could be less inflow from these valleys, resulting in more times when the northern rivers do not connect with the Barwon–Darling. For example, over the past 130 years, end of system flows in the Namoi River have stopped approximately 20% of the time. If our future climate is similar to our long-term historical climate, end of system flows between the catchments are unlikely to change significantly. However, under a worst-case dry climate change scenario, there could be:

- no end-of-system flows to the Barwon–Darling from the Namoi for 40% of the time
- less water flowing into the Barwon–Darling from tributaries in NSW and QLD
- 42% lower median annual inflows when compared to our long term historical climate projections.[16]

These dry climate change scenarios may not occur. And if they do occur, we don't expect to see the full impacts for another 40 years. However, analysing these bookend scenarios helps us understand the extreme and allows us to test how well different options can perform under different climate scenarios.

There is a small probability that we could see droughts significantly worse than the most recent one

The most recent drought saw 3 years of low inflows into the Barwon–Darling and Menindee Lakes, which significantly stressed Western region communities and the environment. These low inflows were a major contributor to the 2018–2019 fish deaths in the Lower Darling. Our new datasets and modelling suggest that the probability of low inflows like those experienced during 2017 to 2020 drought occurring again is:

- less than 1% if the future climate is similar to our long-term historic climate projections
- less than 4% of the time if the worst-case dry climate change scenario occurs.

There is a small probability that we could see droughts even worse than the most recent drought. At the most extreme scenario, the minimum inflows into the Barwon–Darling from the NSW and QLD tributaries over a 36-month period under a dry climate change scenario could be a fraction of what we have experienced over the last 3 years (Figure 21) and there could be no inflows into Menindee Lakes for 3 years (Figure 22). Under this scenario, there is also a possibility there could be significant increases in the frequency of cease-to-flow events.

Increases in cease-to-flow events may be most prevalent in the northern river sections, especially around Brewarrina.

Image courtesy of Water Infrastructure NSW. Copi Hollow Pelicans, Menindee.

16. We have looked at a 10,000-year dataset. Within that 10,000-year data set there are a range of 130-year subsets which have different average inflows sequences that range for 43% less on average compared to our long term historical climate projections, to double the average annual inflows when compared to the historical climate projections.

Figure 21. 36-month minimum inflows into the Barwon–Darling River from the NSW and QLD tributaries

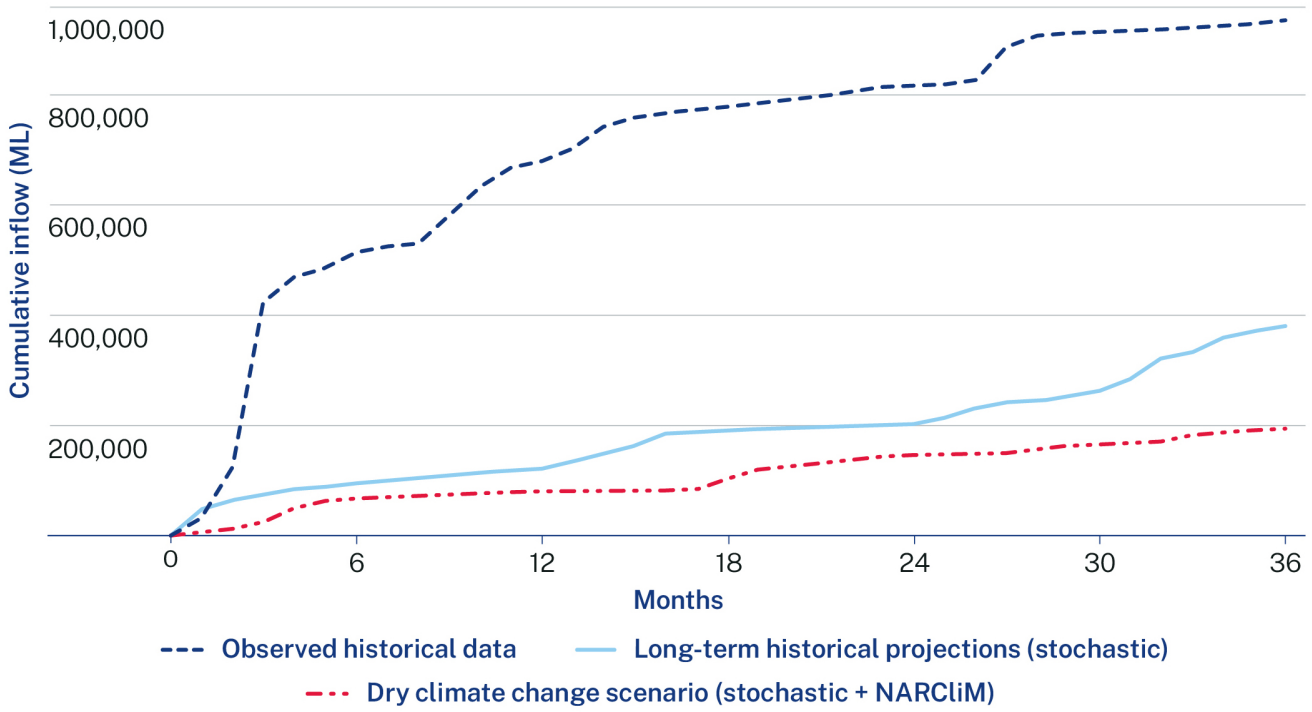
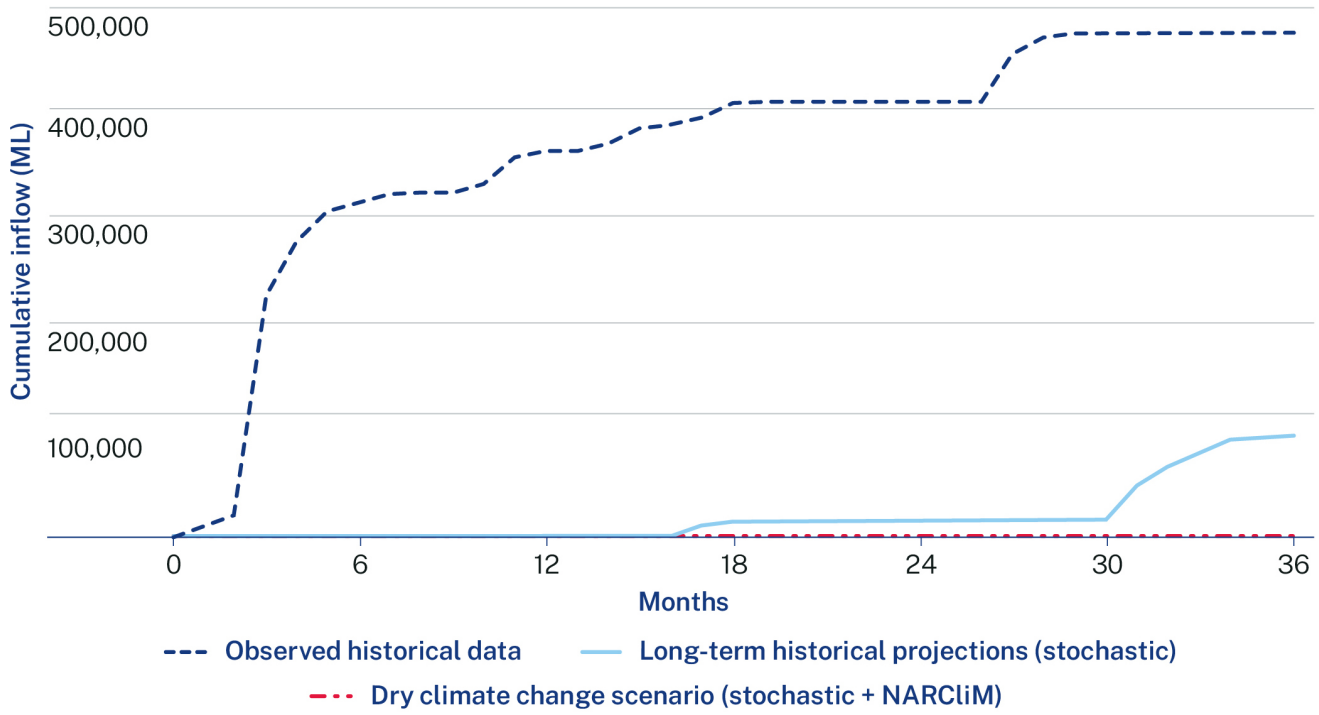


Figure 22. 36-month minimum inflows into the Menindee Lakes



The probability of these scenarios occurring is very small – one event in a 10,000-year dataset – and they may not eventuate. Using the most extreme climate change scenario may not be the most appropriate data upon which to base our future water decisions. However, by analysing these extremes we can begin to stress test the system and begin a conversation within the community about how we can plan for accepted levels of risk and extreme droughts, and what we need to do to ensure we can provide water for critical human needs.

The seasonality of inflows to the Barwon–Darling River may change

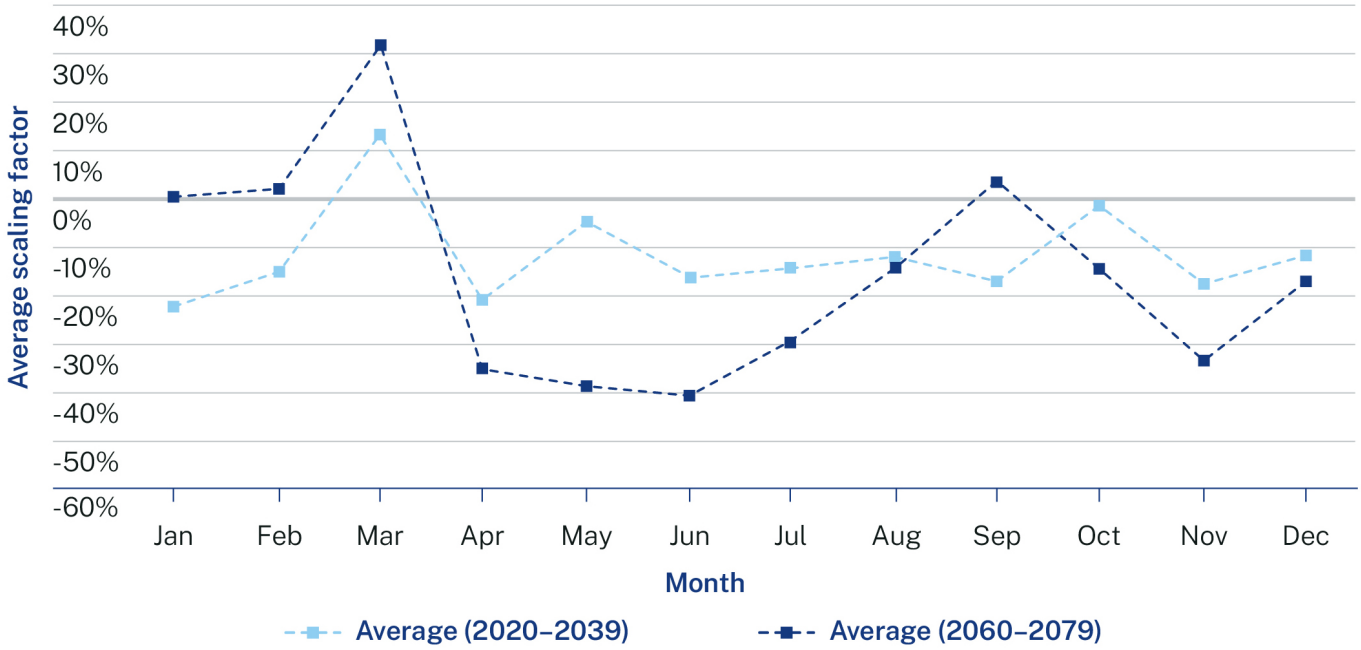
Our climate change model also shows potential changes to the seasonality of inflows into the Barwon–Darling River from both the NSW and QLD tributaries (Figure 24). Historically, the Barwon–Darling receives inflows in autumn and again in late winter. However, under a dry climate change scenario, average rainfall is projected to decrease in most months except February to April (Figure 23), leading to a change in inflows in the river.

The Barwon–Darling may receive larger late summer inflows followed by very low inflows for the rest of the year.

Rainfall is also likely to be more sporadic with short, sharp and heavy rainfall events. Changes in rainfall patterns have implications for cropping practices and releases of environmental water in upstream catchments.

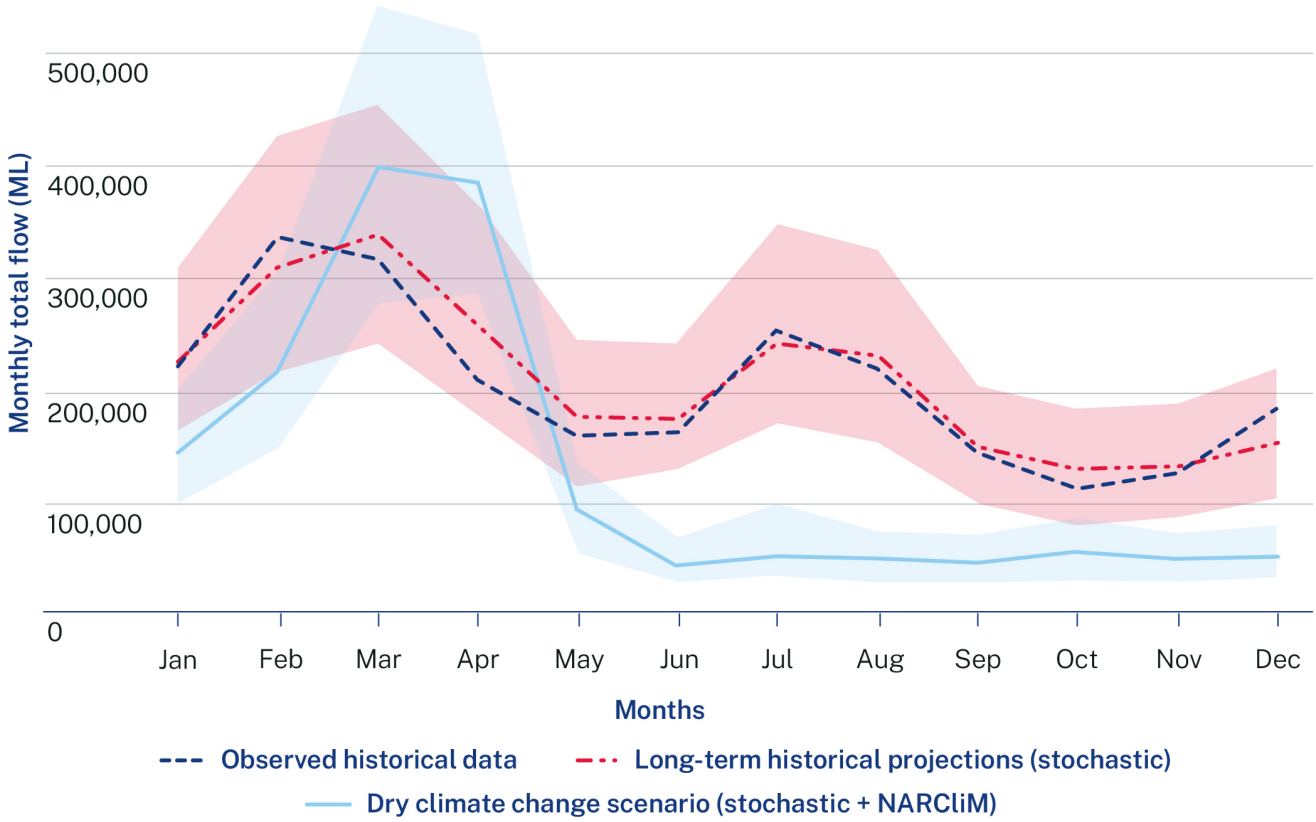
These changes in rainfall and inflow patterns would have implications for industries, town water supplies and the plants, animals and ecosystems that rely on variable flows.

Figure 23. Short and long-term climate change (NARCliM) projections for average monthly rainfall in the Western region, compared to the baseline period 1990–2009



Note: This figure is derived from NARCliM 1.0 future climate change projections and represents catchment average monthly changes for the short term (2020–2039) and long term (2060–2079), compared to the baseline period of 1990–2009. The baseline period is represented as 0% on the scaling factor.

Figure 24. Long-term average of total monthly flows from QLD and NSW into the Barwon River under different climate scenarios



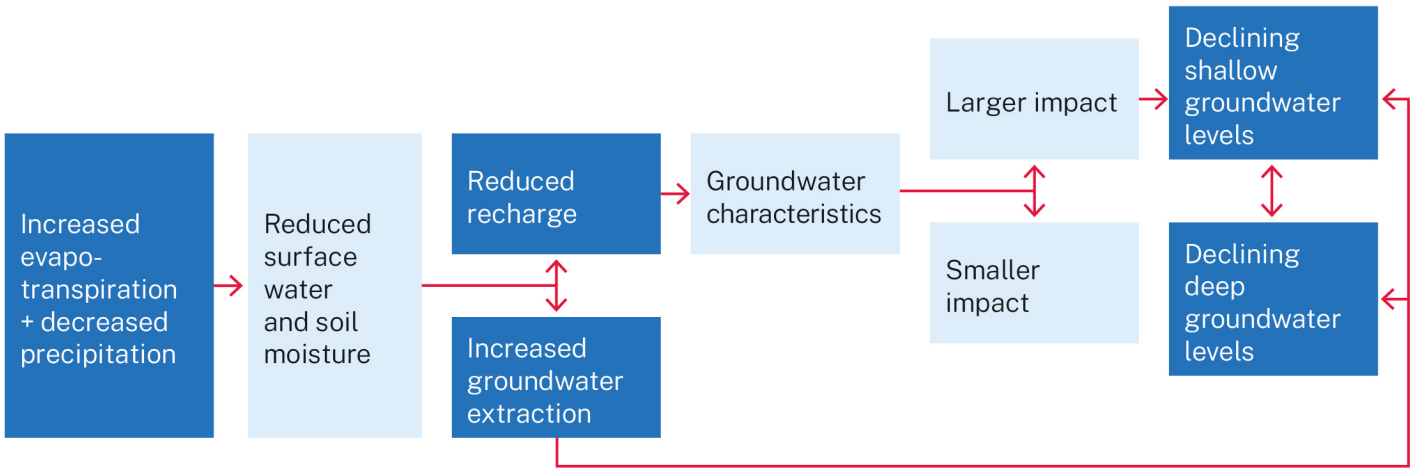
Climate modelling also indicates that we may need to move away from treating droughts as natural disasters that require emergency responses and focus on supporting Aboriginal people, communities, industries and the environment by planning for the expectation of extreme dry conditions over the long term. Some of the most significant factors in building resilience to dry conditions are good climate information, monitoring and risk management, and vulnerability and impact assessments.

A note of caution: The scenarios in these models will not necessarily eventuate. They are potential scenarios and there is always a level of uncertainty with this type of modelling, which needs to be accounted for in water decision making and planning. In some instances, this may mean managing risks to water security by being prepared and resilient, rather than relying on firm predictions and hard numbers.

Climate variability has impacts on the region's groundwater

During periods of higher rainfall there is more water infiltrating through the ground and riverbeds to refill (or recharge) the aquifers. More rainfall also means that surface water is more abundant so towns and water users may rely less on groundwater.[17] The relationship between rainfall, recharge, surface water availability and reliance on groundwater is generally reversed during drier conditions (illustrated in Figure 25). There are communities, such as Lightning Ridge and communities in the Unincorporated Area of NSW, and industries – such as some mines – that rely solely on groundwater, irrespective of the prevalent climate conditions. Often, these users do not have access to river water.

Figure 25. Factors affecting groundwater recharge and levels during extreme dry periods



The degree to which climate variability affects groundwater depends on how connected the aquifer is to the surface, the size of the aquifer storage and its uses. Overall, groundwater sources that have limited connectivity to the surface and a high storage are not very sensitive to changes in climate – for example, the deep Great Artesian Basin groundwater sources like Surat and Warrego and fractured rocks like the Kanmantoo Murray–Darling Basin Fold Belt. Shallow groundwater sources that are connected to surface water are more sensitive to the direct effects of climate change – like the Upper and Lower Darling Alluvium.

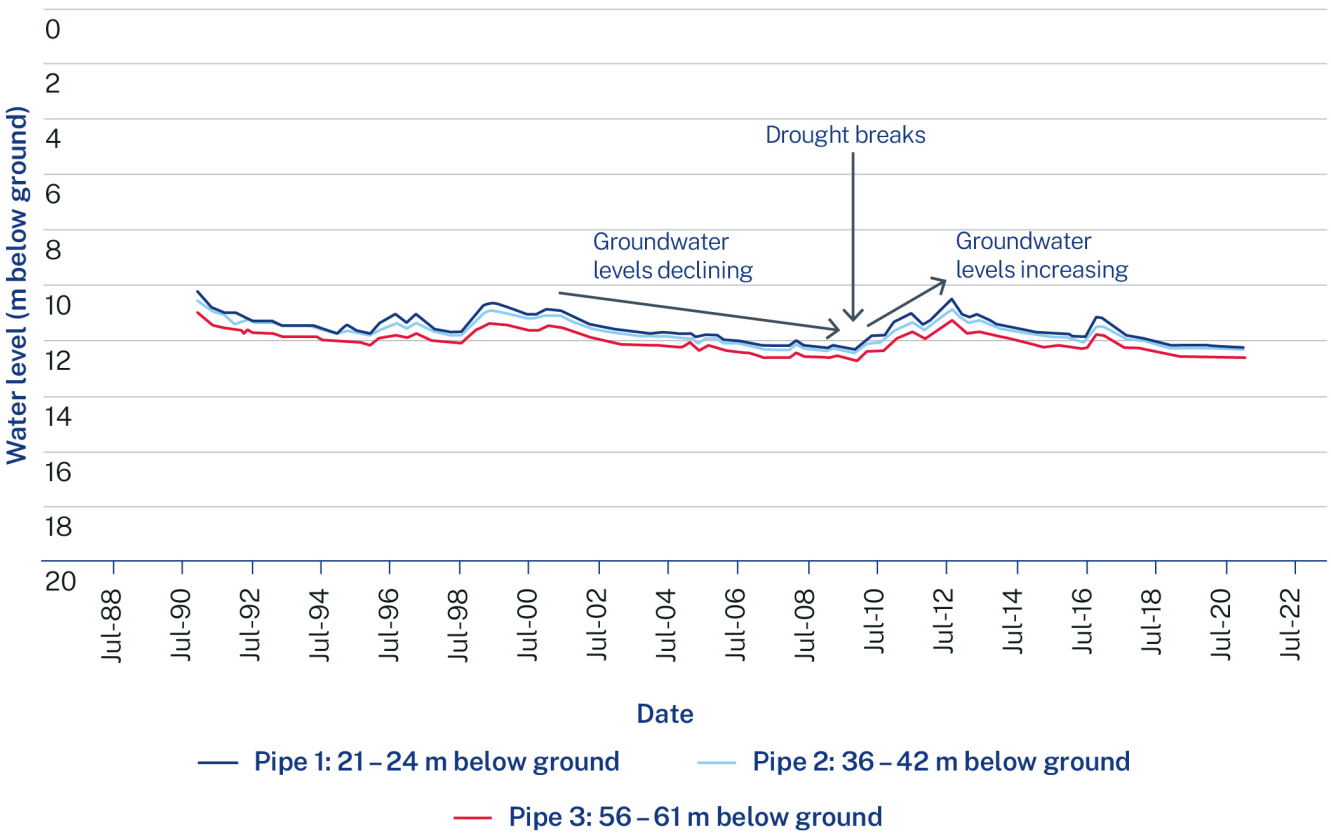
The Upper and Lower Darling Alluvium are directly affected by climate variability. These sources have narrow and shallow aquifers that are connected with the Darling River. Around Bourke, groundwater levels are shallow, and saline water from the aquifer discharges into the Darling River. Further downstream between Louth and Wilcannia, water from the river flows into the underlying aquifers. This trend is reversed around Wentworth, where groundwater flows into the Darling and Murray Rivers.

Groundwater levels in monitoring bores along the Upper and Lower Darling Alluvium generally reflect the climate and river conditions. Groundwater extraction is consistently low, so there are no seasonal drawdown trends as in other highly used groundwater sources. Figure 26 shows that groundwater levels at a monitoring bore between Louth and Tilpa declined around 2 m from the late 1990s until the end of the Millennium Drought in 2010. From 2010 until 2012, groundwater levels recovered to pre-drought conditions. Overall, this is not a significant groundwater decline.

The Sustainable Yields Project carried out by CSIRO[18] looked at future climate change and development scenarios. The study found that although recharge to the Upper and Lower Darling Alluvium could decrease in response to a dry future climate scenario, overall there would be a greater impact from increased development of the groundwater resource. Greater groundwater extraction would also reduce streamflow.

17. For those water users that hold both surface water and groundwater entitlements
18. CSIRO 2008, *Water availability in the Barwon–Darling, A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project*, publications.csiro.au/publications/publication/PIchangeme:1928

Figure 26. Hydrograph for Upper Darling Alluvium between Louth and Tilpa showing groundwater levels before, during and after the Millennium Drought



Box 4: Groundwater opportunities

Treated groundwater provides a significant opportunity for the Western region. Investing in technology and research to understand how treated groundwater can support towns, landholders and industries could help to secure water supplies for communities in the face of a drier climate with less water available in the region's rivers and streams.

Continuing to improve our understanding of groundwater will enable better-informed decisions about its management and use. Gaining knowledge about groundwater availability in the Western region and providing this information to towns and industries could significantly improve water resource planning and management during drought. It could also help communities to make informed decisions about which water sources to access at different times.

While NSW has a robust groundwater management framework in place, opportunities still exist to continue to improve how we manage groundwater resources. Groundwater options investigated as part of the Draft Western Regional Water Strategy include actions to improve our understanding of the region's groundwater sources, manage groundwater salinity, increase secure and reliable access to groundwater for towns and better protect groundwater dependent ecosystems.

Floods are a feature of the past, and the future

Floods are a vital, natural process that support the region's ecological and agricultural productivity, improve water flowing across the landscape into wetlands, floodplains and billabongs, and recharge groundwater resources.

Floods enable fish and other aquatic animals to access critical floodplain habitats to complete important life stages – for example, the Menindee Lakes system is an important nursery ground for native fish. Iconic fish species such as silver perch and golden perch breed and disperse during high flows, with floods also resulting in higher recruitment and survival by seasonal breeders like Murray Cod and freshwater catfish. Flooding also provides breeding opportunities for water birds.

The Western region contains significant wetlands that require intermittent flooding for their long-term productivity and survival. When inundated, Poopelloe Lake, Talyawalka Creek and Pelican Lake within the Talyawalka–Teryaweynya system, as well as the Darling River floodplain near Louth, can provide vegetation and habitat that supports 20,000 or more waterbirds.[19]

Aboriginal communities value floodplains as an important source of food, tools and medicine, which are plentiful during and following flood events. Places and objects on the floodplain that contribute to Aboriginal customary law, traditions, history and current practices often require flooding, or their value to Aboriginal people is dependent upon flooding. Floodplain flora and fauna that depend on flooding contribute to the social and ceremonial aspects of Aboriginal life – for example, as living scarred trees or as totem species.[20]

Flooding in the Western region also supports the tourism industry. Large numbers of holidaymakers and photographers come to the area to see the lakes and wetlands filled, and the wildlife that the floods bring.

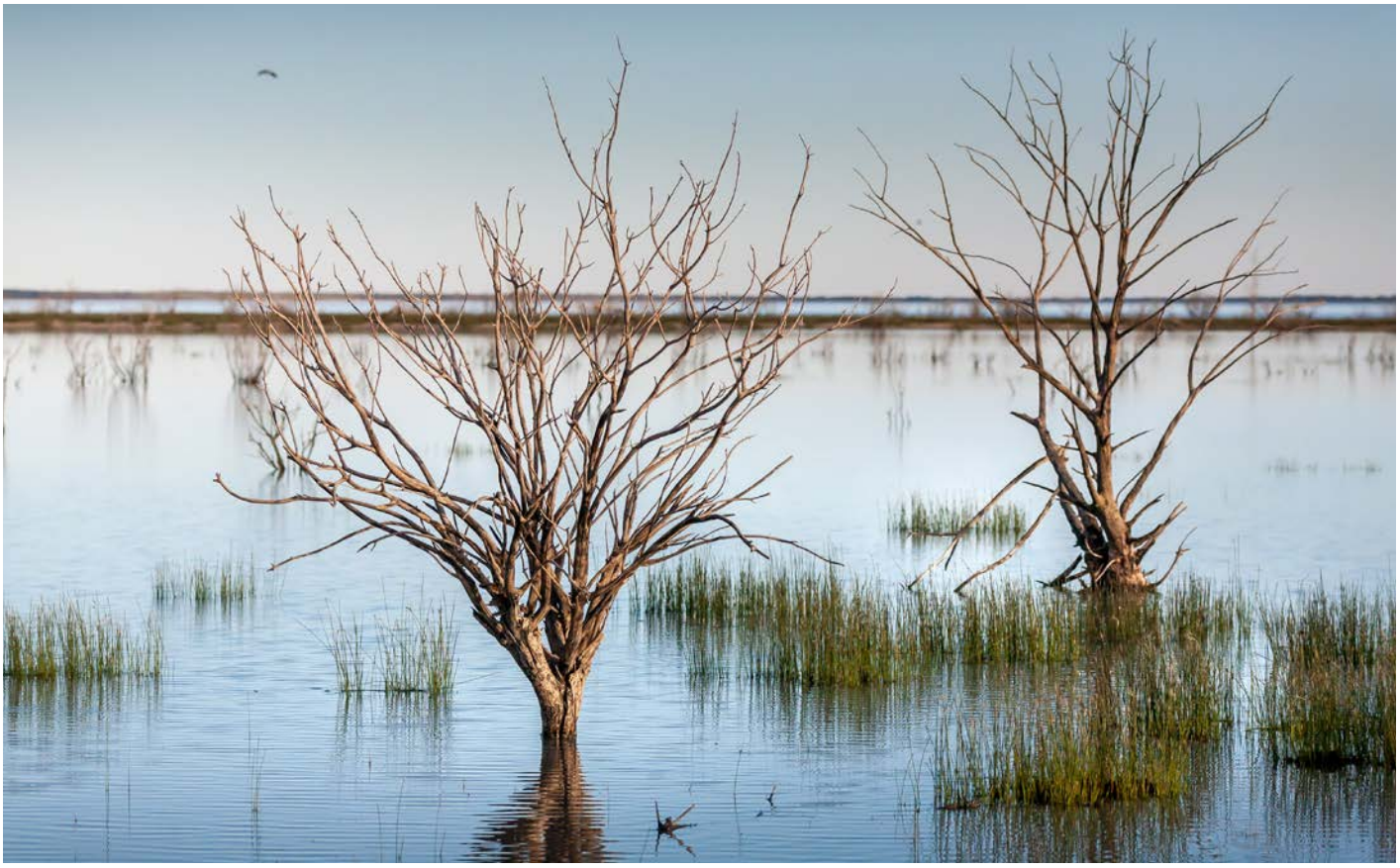


Image courtesy of iStock. Menindee Lake.

19. Murray–Darling Basin Authority 2016, *Assessment of environmental water requirements*, www.mdba.gov.au/sites/default/files/pubs/NBR-environmental-water-requirements-Barwon-Darling.pdf
20. NSW Department of Industry 2015, *Rural floodplain management plans, Technical manual for plans developed under the Water Management Act 2000*, accessed from, www.industry.nsw.gov.au/water/plans-programs/plans/valleys

Conversely, floods can have adverse impacts on people and businesses – damaging infrastructure, creating safety risks and causing financial and economic loss. Poor catchment management and land management, vegetation clearing and altered flow patterns on floodplains exacerbate the negative impacts of floods. Floods that occur following extended dry periods can also cause:

- land degradation and soil erosion
- damage to river-bank vegetation due to rapid wetting of the banks
- flushing of dead organic matter into streams, which in some instances can cause low oxygen (hypoxic) 'blackwater' events that pose a risk to fish species.

The flooding regime in the Barwon–Darling is highly variable, as high flows can arise from multiple sources. While flooding mainly occurs from tributary inflow it can also be caused by localised rainfall events. Summer storms, particularly in upstream tributaries, can cause flooding and erosion, and winter flooding can also occur when soils remain saturated after summer rains. The duration of floods ranges from a few hours to several months, with some areas of the floodplain – such as deep billabongs – remaining inundated for several years.

The flow regime is dominated by periods of low or no flows and small pulses, with major floods periodically interrupting these dry periods. The region has experienced significant flood events over the past 130 years of record, notably in 1890, 1950, 1955 and 2016.[21] The rainfall associated with the March 2021 inland NSW floods was the highest on record in some locations. Large rainfall events were recorded at Tibooburra, as well as at locations in some upstream tributaries, such as Moree, Pallamallawa, Warialda, Inverell and Ashford.

The 2021 flooding and above-average rainfall in the upstream tributaries provided welcome inflows in the Barwon–Darling river system and Menindee Lakes, allowing all the lakes to fill in September 2021 and water to be released into the Great Darling Anabranch for the first time since 2017.

Our hydrological models have been developed to understand long-term inflows into rivers and extraction from rivers. While the models have not been specifically designed for flood analysis, they can give some indication about the trends of flood behaviour with climate change. It is important to note that climate change projections for annual rainfall include both drier and wetter scenarios and that we have modelled a dry climate change scenario for the regional water strategies. Even under these dry climate change scenarios, we may see more extreme floods with higher flows of water than we have experienced in the past. A changing climate is likely to result in more extreme dry and wet events. Under a wetter climate change scenario, the flooding projections would look quite different. Significant increases in summer and autumn rainfall could lead to corresponding increases in the frequency and magnitude of flooding.

We need better data and information on floods in the Western region, including how floodplains are connected, how groundwater reserves are replenished and the flood risk of towns and villages. Flood studies that analyse the characteristics and movements of floods will help to protect rural properties and vital infrastructure and enhance our understanding of the implications of flooding for environmental and cultural assets.

The Western Regional Water Strategy provides an opportunity to identify how we can harness the benefits of floods while minimising their damage to private and public assets in the region. It is also an opportunity to assess gaps in the current flood management framework, distinction between actions required for water security and those required for major flood management, and the delineation of responsibilities between the state and local governments.

21. Bourke Shire Council 2013, *Bourke Shire Local Flood Plan 2013*, www.ses.nsw.gov.au/media/2352/bourke-shire-lfp-feb-2013-endorsed-updated-august-2017.pdf; Bureau of Meteorology 2017, *Special climate statement 58 – Record September rains continue wet period in much of Australia*, Canberra, www.bom.gov.au/climate/current/statements/scs58.pdf

Image courtesy of Michael Scotland. Riverbank, Bourke.

Key challenges

5

Image courtesy of Carla Frankel. Darling River, Wentworth.

Taking action: our 6 priority challenges

We have identified 6 challenges that are immediate priorities for the region:

- **Declining water security for towns and small communities** – High evaporation rates and extended droughts mean many towns in the region do not have a secure supply of water. These water security risks could increase under a dry climate change scenario.
- **Insecure water supplies affect the viability of businesses** – Important regional industries, such as mining, agriculture and tourism, rely on water to survive. Multi-year droughts impact the region's industries and economy. A dry climate change scenario could increase the frequency of dry periods, adversely affecting employment and business prosperity in the region.
- **Aboriginal people have lost access to water** – Historical dispossession of land and water licences that are allocated to land parcels have continued to constrain Aboriginal people's access to water, restricting their ability to care for Country, practice and teach culture, and use traditional knowledge to care for and manage waterways.
- **Declining health of natural systems** – Regulation of upstream catchments, water extraction and land use change has modified how water moves naturally through the landscape, affecting the health of the river system and resulting in the loss of native vegetation and wetlands, and a decline in the condition of fish communities and waterbird habitat. These effects, and risks to ecosystems, are likely to be exacerbated under future climate change.
- **Reduced connectivity impacts critical needs** – Over 90% of flows in the Barwon–Darling system come from upstream valleys, meaning water in the region is influenced by the climate, water management and extractions in those catchments. Maintaining connectivity in a changed flow regime, including during droughts is especially challenging. When most of the northern and western NSW catchments are experiencing a very dry period, it can be virtually impossible to deliver water for critical needs along the length of the system.
- **Poor water quality** – Poor water quality has been a long-term concern for the region. Poor water quality affects aquatic organisms, is a risk to human health and stock, impacts the amenity of waterways and affects Aboriginal people's ability to practice culture on or near waterways.

We would like to hear from you about whether you think these are the key challenges that should be targeted for the Western region.

Image courtesy of Destination NSW. Townscape, Bourke.

Challenge: Declining water security for towns and small communities

The Barwon–Darling River has a naturally variable flow pattern that includes extended periods of low or no flows and periods of high flows and floods. A more variable or drier climate and changes to hydrology could result in more frequent, and longer, low flow and cease-to-flow periods. This will increase water security risks for towns and water-dependent industries.

Extended droughts will increase water security risks for towns and landholders

Many towns along the Barwon–Darling and Lower Darling rivers rely on surface water from a series of small weirs, supplemented in some cases by groundwater of variable quality and quantity. Due to the small storage volumes, low average annual rainfall and high evaporation rates, these weirs rely on irregular inflows to replenish water supplies for local communities.

Town weir pools typically supply most towns for approximately 6-9 months. Extended no-flow periods and very high evaporation rates in summer can result in a rapid depletion of water in town weir pools, placing stress on town water supplies and affecting the quality of the water in the town weir pools. For example, during the last drought, water levels in Bourke Weir fell by approximately 2 m in 7 months (a 60% drop in weir capacity), placing water security for the town at risk.

Approximately 16% of people in the region source water for their own drinking and domestic use from roof water harvesting in rainwater tanks, harvesting runoff within their properties into farm dams and accessing unregulated rivers and groundwater aquifers. During droughts, these households need to rely on groundwater or water carted from nearby towns, placing an increased demand on town water supplies. Supplying water to the region's small and highly dispersed communities can be expensive and challenging.

Maintaining water security for towns is also crucial for maintaining the liveability of communities, attracting people to the region and supporting a growing tourism industry.

While recent investments in water supply and groundwater have helped improve water security for a number of towns in the region including Broken Hill, most towns do not have a secure water supply (Table 3).

Image courtesy of Destination NSW. The Paddle Vessel Jandra Cruises, North Bourke.

Table 3. Summary of town water security assessment conducted as part of the Western Weirs Strategic Business Case[22]

Town water supply – weir	Emergency/backup groundwater supply	Secure town water supply
Angledool	Yes	No
Bourke	Yes	No
Brewarrina	Yes	Yes
Collarenebri	Yes	No
Gongolgon	No	No
Goodooga	Yes	No
Louth	Yes	No
Menindee & Sunset Strip	Yes	Yes
Pooncarie	Yes	No
Tilpa	Yes	No
Walgett*	Yes	N/A
Wilcannia*	Yes	N/A

*Walgett Weir has already been raised and a new Wilcannia Weir is to be built, so these weirs were not further considered by the Western Weirs Project.

A more variable or drier future climate could result in extended dry periods with longer no flow periods and poor water quality in town weirs, including elevated levels of salinity and blue-green algae. For towns and Aboriginal communities, the potential for more frequent and longer dry periods will mean less secure water supplies unless actions are taken to invest in diversified water sources – including climate-independent sources – and change how we manage major storages. This risk will be greatest for towns that rely on water from unregulated rivers.

22. This analysis was based on a secure yield assessment that compared the secure yield for each town water supply against the 30-year unrestricted dry year demand for the town. The 30-year unrestricted dry year demand was estimated in accordance with the Department of Planning and Environment – Water's February 2019 integrated water cycle management checklist. The dry year demand used is an estimate of the 2020 unrestricted dry year demand. It does not account for potential residential or non-residential growth or climate change. Climate change was considered in the assessment. It was assumed that the secure yield under a historic climate would be reduced by 35% (being the average of 8 secure yield studies undertaken for inland supply systems, where the reduction in secure yield ranged from 20% to 50%).

Groundwater availability and quality varies

A more variable or drier future climate could result in a greater reliance on groundwater for towns with emergency or backup bores. Some councils have also indicated an interest in exploring opportunities for additional treatment of groundwater to support drinking water for towns where groundwater quality is poor. While groundwater may be a solution for some communities, its use comes with a number of challenges.

While there are many sources of groundwater across the region, its availability and quality varies according to location and geology. Potable groundwater is limited, and all shallow groundwater sources need to be treated to meet drinking water guidelines. The water from artesian bores is often at high temperatures, which can also make it challenging for towns to use this groundwater.

Groundwater salinity is a major challenge in the region and salt interception schemes are in place to help manage the risks of saline groundwater discharging into surface water ecosystems. Increased use of bores that access fresh water can result in saline water from deeper in the alluvium flowing into the bore. A better understanding of the size of these shallow pockets of fresh groundwater and how they change over time in response to surface water flows and floods will be needed to improve water security for towns and other users.

Towns and local water utilities have limited access to data on groundwater sources availability, quality and extraction and the potential effects of climate change on these sources. The data may not be accessible or available to water users in a format that is useful to their needs. This makes it difficult to make effective decisions based on an evidence-based assessment of risk, particularly during drought periods.

Improving our monitoring of low use groundwater sources, such as the Western Murray Porous Rock Groundwater Source, will also be important in developing a better understanding of water quality in these sources and determining how best to support any growth in their use.

Image courtesy of Sally Anderson-Day. Barwon River, Brewarrina.

Challenge: Insecure water supplies affect the viability of businesses

Multi-year droughts impact the region's water-dependent industries and economy. Ongoing changes to climate could increase drought frequency and severity.

Water underpins the regional economy

The Western region is home to a range of industries. The primary employer is the healthcare and social assistance sector, with employment mainly occurring in larger centres like Broken Hill and Cobar (Figure 27). Mining, agriculture and tourism are also important industries, with mining providing the largest economic output for the region (Figure 28).

The mining and agricultural sectors directly employ around 25% of all workers and underpin other town-based businesses. Tourism employed over 900 workers in 2016.

Due to the predominantly semi-arid climate, the main agricultural land use in the region is extensive grazing of rangelands by sheep, goats and cattle. Crops tend to be annual or seasonal and irrigated cotton production occurs in the upper catchments, concentrated on the alluvial floodplains near Collarenebri and Bourke. Although irrigated agriculture accounts for a very small proportion of agricultural land use in the region, it provides a significant proportion of agricultural income. In 2017–18, the gross value of irrigated agricultural production in the Western natural resource management region was $298.8 million, which represented 46% of the gross value of agricultural production in the management region.

Mining operations include the:

- Ginkgo and Snapper mineral sands operations near Pooncarie
- Broken Hill Operations, Perilya and Pinnacles Mines near Broken Hill
- CSA, Endeavour, Peak Gold (Newgold) and Gera Gold Project at Cobar.

These sectors rely on access to water, which means that regional economic output can vary significantly in response to climate conditions and mining commodity fluctuations. Having a reliable water supply and making the most efficient use of available water will become even more important to the sustained success of these sectors under a more variable climate.

Similarly, tourism in the region is often linked to water availability. In 2021, record numbers of visitors went to the region to see Menindee Lakes full for the first time in years. Many small townships provide an important role supporting tourism in the Western region by providing rest and re-supply opportunities; however, very few towns in the Western region have adequate water security. For example, communities in the Unincorporated Area have important visitor economies but do not have a reticulated water supply.

We know from history, and the most recent drought experience, that water availability influences employment and business growth in the Western region. For example, the Millennium Drought had an adverse impact on agribusiness across the region and we heard from people in the Unincorporated Area that tourism levels dropped during the most recent drought. Conversely high flows in the Barwon–Darling River and the filling of the Menindee Lakes brings in tourism to the region.

Improving water security and reliability is crucial for attracting people and businesses to the region and supporting the growing tourism industry.

Figure 27. Employment in key industries in the Western region (2016)

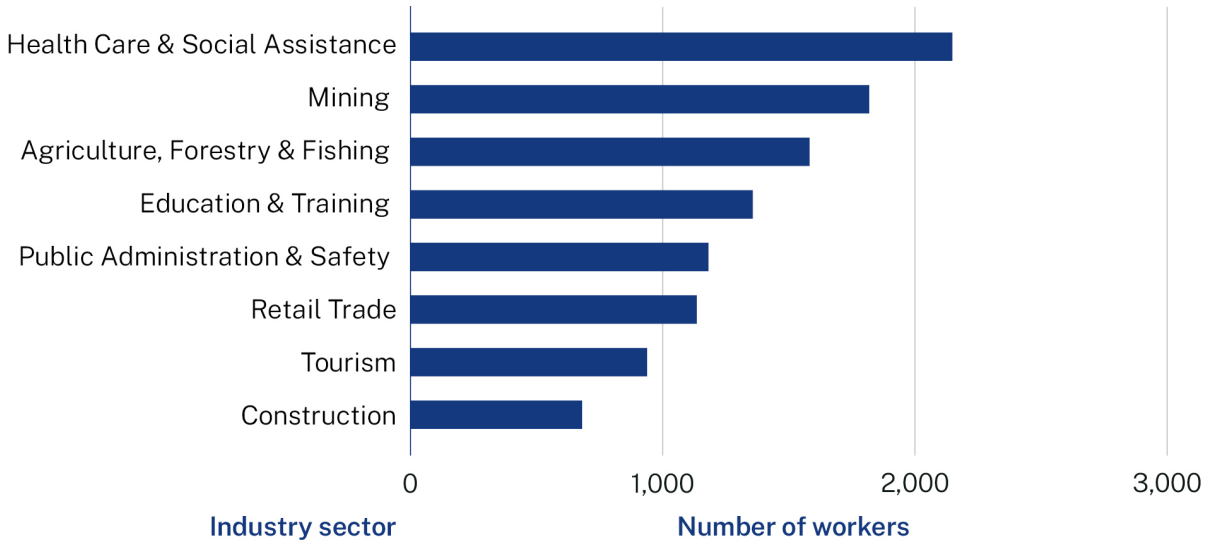
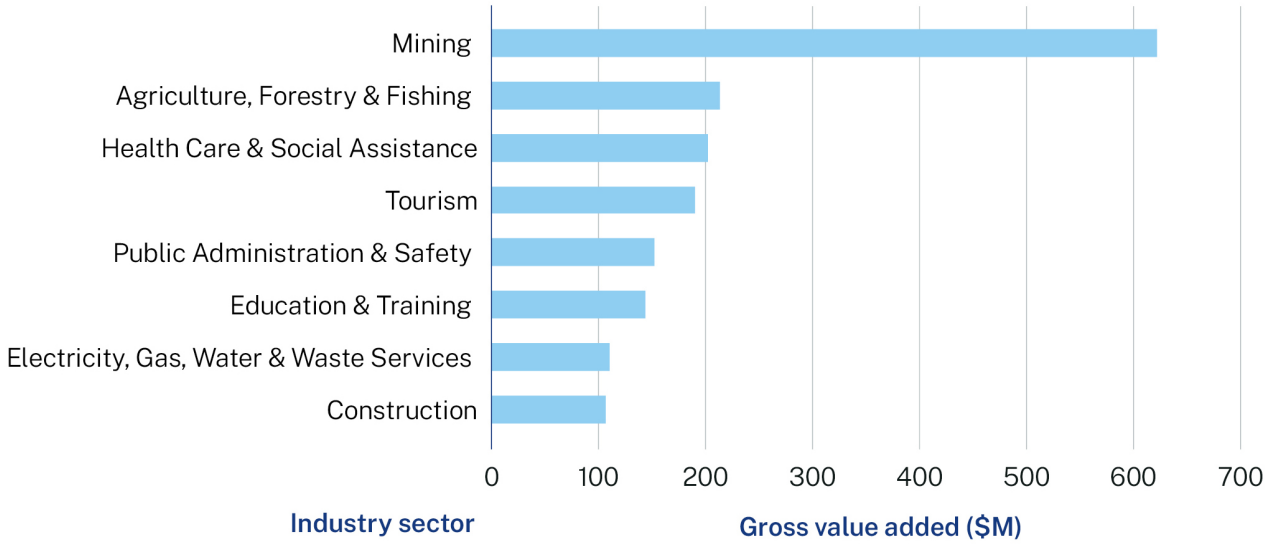


Figure 28. Economic outputs of key industries in the Western region (2018/2019)



Surface water is unreliable and groundwater use is limited by water quality

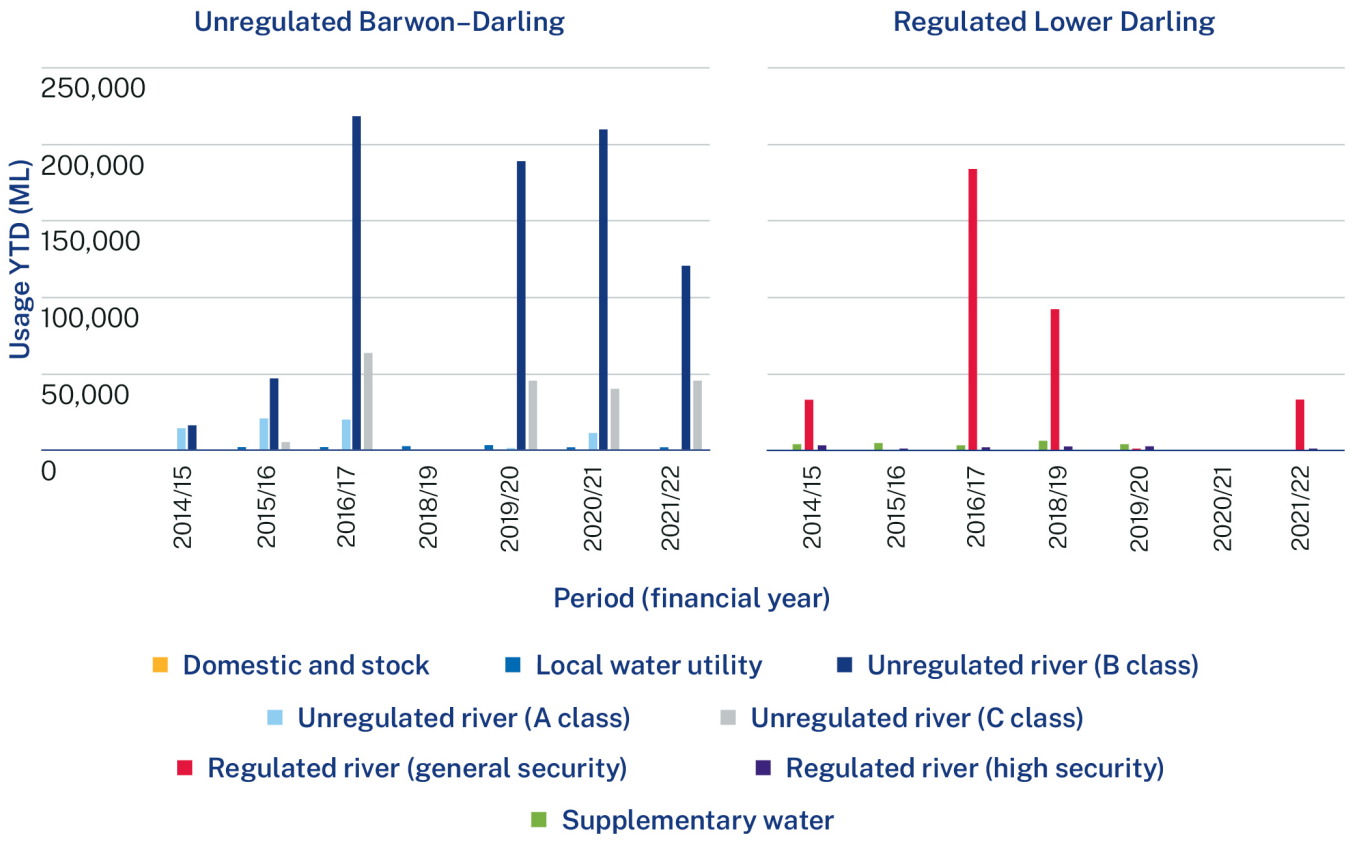
Most of the water taken in the Western region by industry is from the Barwon–Darling unregulated river and the Lower Darling regulated river (see Figure 29).

In the Barwon–Darling unregulated river, over 188 GL of entitlements are licensed for unregulated river access (A, B and C class) licences, the majority of which are held by cropping farmers concentrated around Bourke. Approximately 350 GL of licensed entitlement is held in the Lower Darling, predominantly by the NSW and Commonwealth environmental water holders.

The timing of when water can be taken depends on the amount of water flowing in the rivers and the storage level of Menindee Lakes. The actual amount of water used by these licence holders changes each year depending on available flows in the river.

Reliance on unregulated river flows and a regulated river in a highly variable climate makes industries highly vulnerable to drought and means industries rely on those few years of high flow events to sustain their operations. Years of low flows and extended droughts can have a significant impact on industry and impose hardship on communities, with the impacts of reduced production extending to other parts of the economy. We heard from councils that access to reliable potable water supply is also important to increasing visitor numbers to the region.

Figure 29. Water taken under different categories of water licences in the unregulated Barwon–Darling River and regulated Lower Darling rivers between 2014/15 and 2021/22



Source: NSW Water Register, waterregister.waternsw.com.au/water-register-frame

Groundwater use is low across the Western region compared to some other regions and is often constrained by water quality. Groundwater quality in the region naturally varies between and within groundwater sources. There are a number of water quality challenges:

- **Salinity is a key challenge in the Western region** and limits the use of groundwater in sources such as the Western Rock Porous groundwater. Shallow groundwater can cause land salinisation or saline groundwater flowing into rivers. Salt interception schemes are in place at Bourke and Wentworth to reduce the volume of saline groundwater flowing from the alluvium into the Darling and Murray rivers.
- Groundwater from the deep **Great Artesian Basin has high concentrations of sodium**, making it unsuitable for irrigation, and exceeds the Australian Drinking Water Guidelines' aesthetic values for sodium in most areas in the Surat, Warrego and Central Groundwater Sources.
- The **temperature of bore water** from the Great Artesian Basin can exceed 50°C in the Central Groundwater Source. Water at these temperatures require cooling before being used for drinking water or for agricultural purposes.
- **Fluoride concentrations** of more than 6 times the Australian Drinking Water Guidelines can be found in groundwater along the boundary between the Warrego and Central Groundwater Sources.

Managing groundwater salinity and promoting groundwater desalination for industry and towns can help to address future water security challenges.

Given the expected continuing demands on groundwater, enhancing our understanding of the interaction between surface water and groundwater resources in the Western region will help to improve our management of connected water sources. We need to understand where a change in groundwater use can influence flows to rivers and vice versa. We also need to understand how a changing climate is impacting the replenishment of groundwater resources. More broadly, we need to ensure ongoing investment in the groundwater monitoring network, so we have the water quantity and quality information we need to manage the resource into the future.

Future climate change scenarios present challenges for industries

Mining and agricultural businesses in the Western region anticipate wet and dry cycles and plan for their businesses to withstand several years of low or no surface water flows.

Many farm businesses have adapted to the region's highly variable climate through:

- producing annual or seasonal crops
- investing in new technologies that have helped drive on-farm water use efficiency and on-farm storage in irrigated agricultural businesses
- improved rangelands management, which allowed many farmers to become more sustainable
- mines holding multiple water sources accessing licences that may maximise use of local runoff and waste water. Mines are able to use water of a lower quality than many other industries.

While the impacts of climate change are uncertain, our new modelling looked at a range of plausible climate scenarios for the Western region to understand how future climate risks may impact on water licences in the Barwon–Darling. The modelling shows that the future climate in the Western region could increase the water security risk for most surface water users, with:

- significantly less water available in dry periods, when compared to the last 130 years of data (Figure 30)
- a slight increase in water available during wet periods, when compared to the last 130 years of data (Figure 31)
- limited change in average years.

Figure 30. Average annual water extraction for A, B and C class licences in the driest 1-year, 5-year and 10-year climate sequences under observed historical data, long-term historic projections (paleo-stochastic data) and dry climate change scenarios

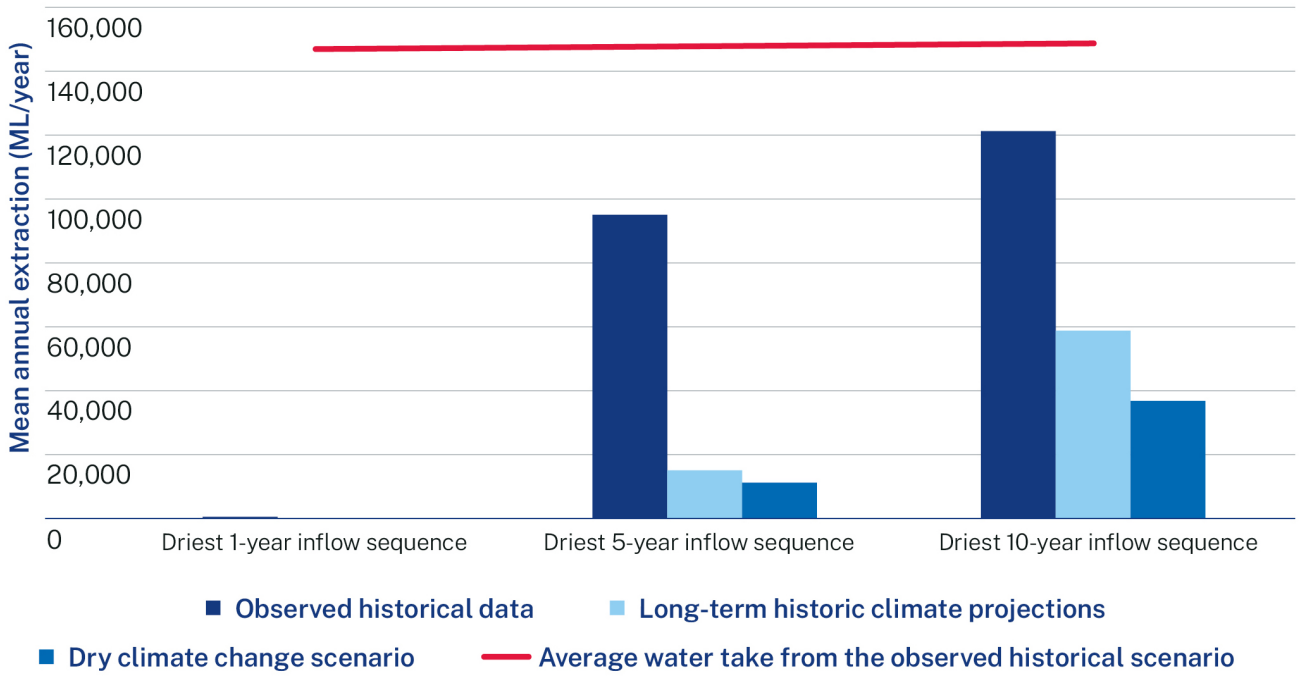
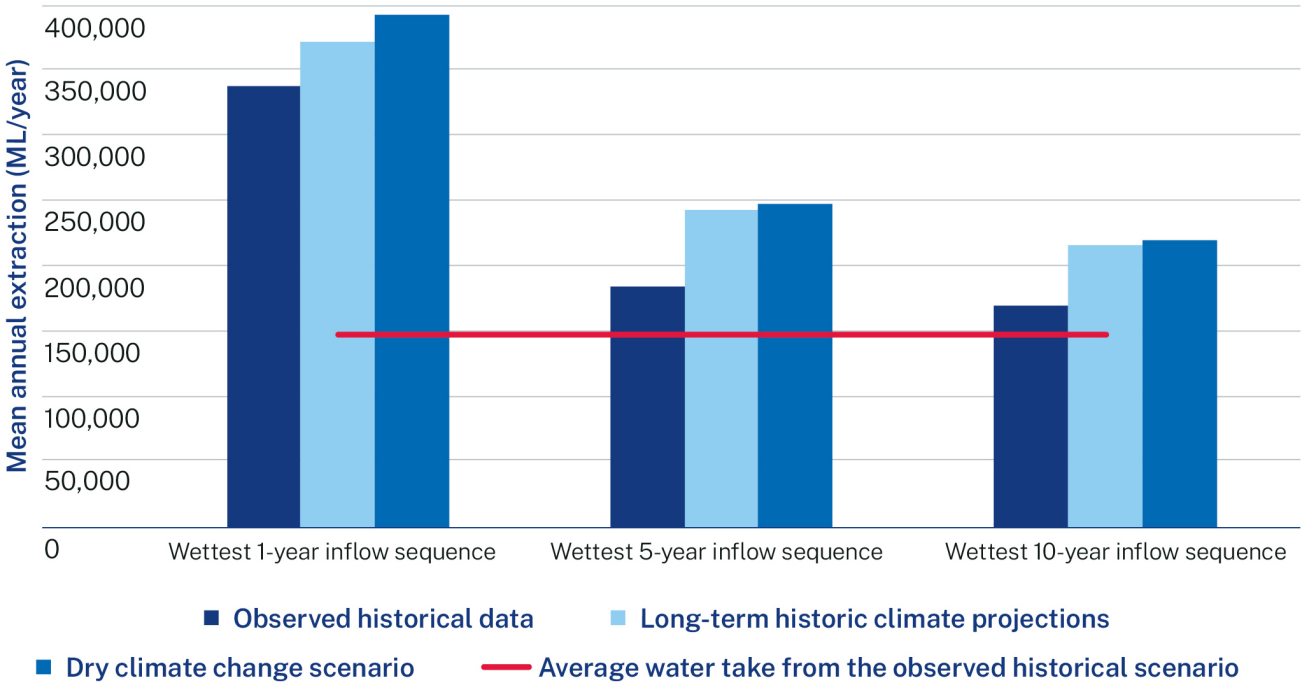


Figure 31. Average annual water extraction for A, B and C class licences in the wettest 1-year, 5-year and 10-year climate sequences under historical, long-term historic projections (paleo-stochastic data) and long term climate change scenarios



Challenge: Aboriginal people's water rights have not been delivered

Aboriginal people have practised their culture in the Western region for over 60,000 years and have lived through major environmental changes – including climatic changes and the changing path of major rivers, such as the Darling–Baaka and Lachlan Rivers – and were the first managers and carers of our land and waters. The Western region lies within the traditional lands of the following First Nations groups.

Table 4. First Nations of the Western region

Barkandji	Budjiti	Gomeroi/Kamilaroi
Guwamu (Kooma)	Kunja	Malyangapa
Maraura	Murrawarri	Muthi Muthi
Ngemba	Ngiyampaa	Ualarai/Euahlayi
Wangaaypuwan	Wayilwan	Wilyakali
Wongaibon	Wongkumara	

Aboriginal people strongly identify with water and some, such as the Barkandji (People of the River), derive their names from their relationship with water bodies. The lands and water resources of the Western region contain places of deep significance to Aboriginal people and are central to their spiritual and religious belief system. They are celebrated in rituals, ceremony, stories, dance and artworks. They also allow kinship, connection, stories, songlines and healing through medicine and food.

Protecting waterways and water-dependent sites is important to Aboriginal people and supports them in their custodial roles. Under their law and customs, Aboriginal people have rights and a moral obligation to care for Country, which includes caring for rivers, creeks and wetlands. This includes ensuring that people and ecosystems downstream have access to healthy water supplies.

Access to healthy surface water and groundwater systems is critical for maintaining the health, wellbeing and culture of Aboriginal people. The region's rivers are considered 'classrooms' for maintaining the continuity of Aboriginal culture, providing a purpose and pathway for young people to connect to culture, and providing a space for teaching. Aquatic, riparian and floodplain vegetation and healthy fauna species support Aboriginal cultural values and practices. Changes to flow regimes can directly or indirectly damage cultural sites and practices around rivers, wetlands or lakes.

Aboriginal people have lost access to water

Colonial laws, including the historical dispossession of land, including water licences allocated to land parcels, have continued to impact Aboriginal people's access to water. Private land, fences and locked gates prevent Aboriginal people from accessing water, carrying out cultural practices and using traditional knowledge to care for and manage waterways. In addition, changes to the flows in the river and a decline in water quality – due to upstream development, water extraction and the climate – have had impacts on Aboriginal people's ability to practice and teach culture and affected the natural environment of culturally important places.

The application process for cultural licences is not meeting Aboriginal people's needs

The Government's water management framework has evolved over time, and there are some legislative provisions to provide for cultural access licences. Aboriginal people's legal rights as they apply to water management have been recognised in international human rights treaties and conventions, in Australian and NSW Native Title and land rights laws, and in water plans. For the Western region, NSW water legislation provides for 3 types of licences for Aboriginal people:

1. **Aboriginal cultural access licences** – provide up to 10 ML/year per licence for cultural purposes such as cultural teaching or ceremonial purposes[23]
2. **Aboriginal environmental water licences** – provide 500 ML/year (with a combined limit of 2,000 ML/year for the water source) for enhancing Aboriginal cultural value of important lagoons and billabongs
3. **aquifer community development access licences** – provide up to 50 ML/year for various purposes that relate to Aboriginal communities and can be traded temporarily.

Under Commonwealth legislation, anyone who holds Native Title with respect to water can take and use water for personal, domestic and non-commercial communal purposes. Native Title holders often have water-related aspirations, such as the right to fish, the protection of water-related places of cultural importance or participation in decisions about water allocations and water management practices within a Native Title determination area. Under NSW legislation, Native Title holders have the right to take and use water in the exercise of Native Title rights without the need for an access licence, water supply work approval or water use approval.

In groundwater water sharing plans, where groundwater-dependent culturally significant areas are identified, rules are applied to ensure these are protected from any impacts associated with the construction or use of water supply works. Similarly, where flood-dependent cultural assets and values are identified in floodplain management plans, rules are applied to ensure they receive flood flows.

However, we heard from Aboriginal people in the Western region that the current provisions are not meeting their spiritual, cultural, social and economic needs. The application process for licences is not well understood and those who had gone through the process found it difficult to navigate. As a result, the use of the cultural licences is virtually non-existent.

We have heard that access to water for cultural purposes is a basic human right and we need to ensure the assessment frameworks for issuing Aboriginal water licences is culturally appropriate and clearly communicated to Aboriginal people.

We also heard that licences or water entitlements owned by Aboriginal people should be allowed for economic benefit. While some Aboriginal businesses, groups and Aboriginal Land Councils own water access licences, which are available on the market for trading, often the cost prohibits Aboriginal people from buying these entitlements and allocations.

Aboriginal people would also like to see more economic opportunities around the management of water and important cultural sites.

23. NSW Water Sharing Plans, accessed from, www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/status

Aboriginal nations feel like they are not being heard

During our consultations with Aboriginal people in the Western region, we heard that Aboriginal communities feel like they constantly speak to government agencies but are not being heard.

Aboriginal people want to be more involved in water management decision making, including how the water source is protected. Aboriginal people have watched the health of the river decline, which has taken a toll on their health and wellbeing and ability to practise their culture.

There is increasing recognition that Aboriginal knowledge is an essential element of how natural resources are managed in Australia. We have heard that we need to incorporate Aboriginal knowledge or cultural science to support and supplement the data that has been collected by NSW Government agencies since European colonisation. The complexities of water management legislation and licensing, along with a lack of opportunities to participate in decision making, are significant barriers to making better use of Aboriginal people's knowledge and skills.

Future climate change is concerning

For Aboriginal people, uncertainties around the future climate in the Western region add urgency to fully recognising Aboriginal water rights and providing dedicated water allocations. This includes prioritising water for Aboriginal people in water sharing arrangements.

Image courtesy of Carla Frankel. Mundi Mundi Lookout, Silverton.

Challenge: Declining health of natural systems

People from all over Australia travel to the outback of Western NSW to enjoy the landscape, native wildlife and internationally significant natural wonders. The Western region boasts desert areas – including arid and semi-arid desert areas – 'inland seas', freshwater and saline inland lake systems, and the floodplains and associated tributaries of the Darling River. The region is home to almost half (46%) of NSW's inland wetlands and internationally significant national parks.

The Barwon–Darling River plays a critical role in the Murray–Darling Basin by providing the ecological link between the northern and southern basins and is one of the most important ecological corridors across the Basin. This function is most apparent in the movement of the Basin's native fish populations, where successful fish spawning and dispersal in the Barwon–Darling results in benefits to fish communities across the Basin. For example, golden perch have been known to migrate from QLD into the southern Basin, a distance of about 1,600 km.[24] The Basin-wide Environmental Watering Strategy has also identified the entire river as a key asset for achieving fish-related outcomes under the Murray–Darling Basin Plan.[25]

The region's arid and semi-arid environments mean that groundwater sources also play a significant role in supporting a range of ecosystems – such as red gums, coolibah, lignum wetlands and freshwater wetlands – that are linked to groundwater sources.

The Great Artesian Basin springs are recognised nationally and internationally for their important geological and ecological features and significant Aboriginal cultural values. These springs represent one the few major systems in the world that have not been degraded irreparably by over-exploitation or land use.[26] Three artesian spring 'supergroups' are endangered and critically endangered ecological communities; they are naturally rare and each individual spring varies in shape, water flow, topographic and geographic location, which makes each ecological community unique.

The overall ecological value of the Barwon–Darling is medium to high, with higher value sections of river in the upstream reaches of the Barwon River;[27] a high diversity of species, habitats and geomorphology in the Darling River and medium ecological value in the Lower Darling. The unregulated rivers in the Intersecting Streams have high or very high ecological values.[28]

Many of the ecological values across the Western catchment are culturally significant to Aboriginal people and important to the broader community. The Baaka occupies a central place in Aboriginal culture: traditionally, the Barkindji lived on the banks of the Baaka, the floodplains and large areas around the river.[29]

Changes in river flows from upstream development have impacted the health of aquatic ecosystems

Regulation, water extraction and land use change in the Barwon–Darling, Lower Darling and upstream catchments has resulted in modifications to how water moves through the region's landscape and connected systems.

The health of river systems depends on there being a range of flows, including bankfull flows, overbank flows, freshes and dry spells, as well as periodic low flow and cease-to-flow periods. The extraction of water, operation of dams, pipelines and weirs in upstream tributaries and the Barwon–Darling has an impact on river ecology, as these change the timing, magnitude, duration and frequency of flows. By the mid-1990s, it was generally acknowledged that habitats along the entire river had been degraded by hydrological changes. Controlling river flow has resulted in a reduction of moderate to high flows downstream, with the greatest impact on large fresh, bankfull and overbank flows (Figure 32 and Figure 33) Alterations to frequency and the size of low flows and increased cease-to-flow durations have also been recorded.[30]

24. Stuart, I.G. and Sharpe, C.P 2020, *Riverine Spawning, long distance larval drift, and floodplain recruitment of a pelagophilic fish: A case study of golden perch (Macquaria ambigua) in the arid Darling River, Australia, Aquatic Conservation Marine and Freshwater Ecosystems* 30(4)
25. Murray–Darling Basin Authority 2018, *Basin-wide Environmental Watering Strategy*, www.mdba.gov.au/publications/mdba-reports/basin-wide-environmental-watering-strategy
26. Brake, L, Harris, C, Jensen, A, Keppel, M, Lewis, M & Lewis, S 2019, *Great Artesian Basin Springs: a Plan for the Future. Evidence-based methodologies for managing risks to spring values*
27. Department of Planning, Industry and Environment – Water 2019, *Risk Assessment for the Barwon–Darling water resource plan area (SW12)*, www.industry.nsw.gov.au/__data/assets/pdf_file/0008/273752/schedule-d-barwon-darling-risk-assessment.pdf
28. Department of Planning, Industry and Environment – Water 2019, *Intersecting Streams Surface Water Resource Plan, Surface Water Resource Description, Appendix A*, www.industry.nsw.gov.au/__data/assets/pdf_file/0005/236453/intersecting-streams-wrpa-description.pdf
29. www.lls.nsw.gov.au/__data/assets/pdf_file/0005/737627/Paakantyi_Booklet_WEB-updated.pdf
30. Murray–Darling Basin Authority 2018, *Ecological needs of low flows in the Barwon–Darling*, www.mdba.gov.au/publications/mdba-reports/barwon-darling-ecological-needs-hydrology

Figure 32. Modelled change in total number of different flow events in the Barwon–Darling River at Wilcannia over the last 130 years, with and without current development

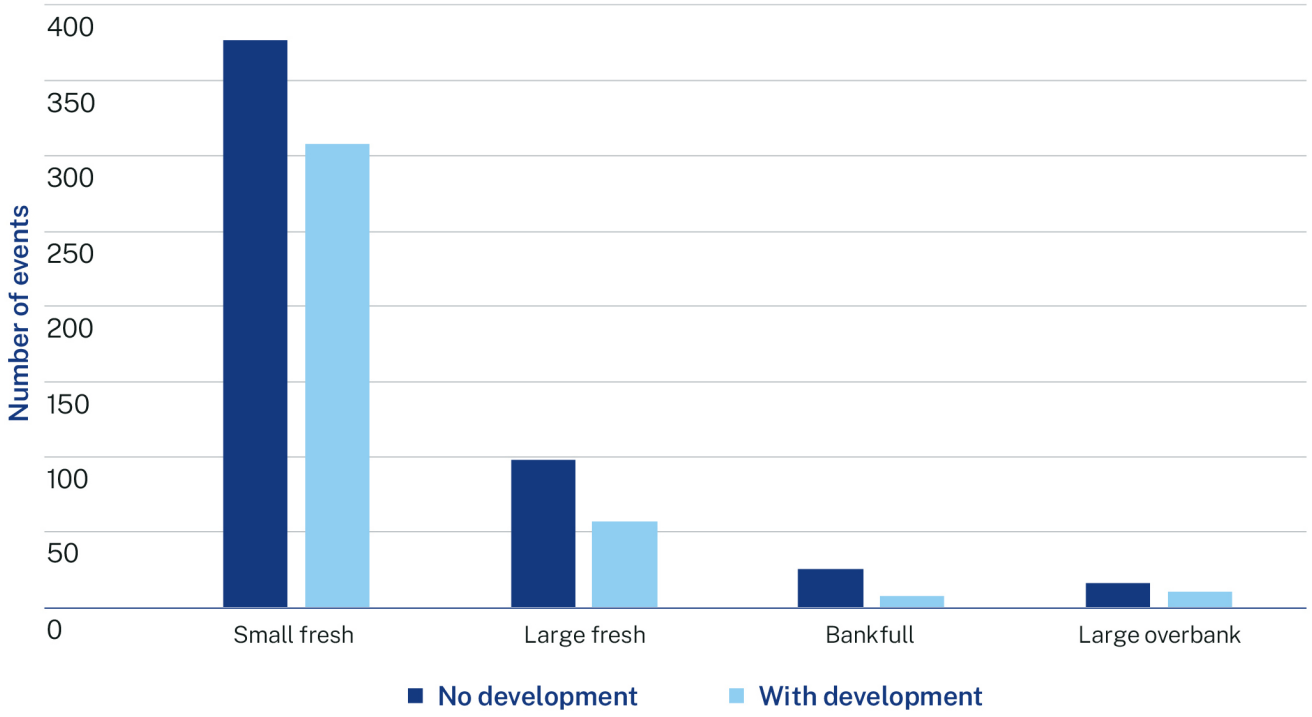
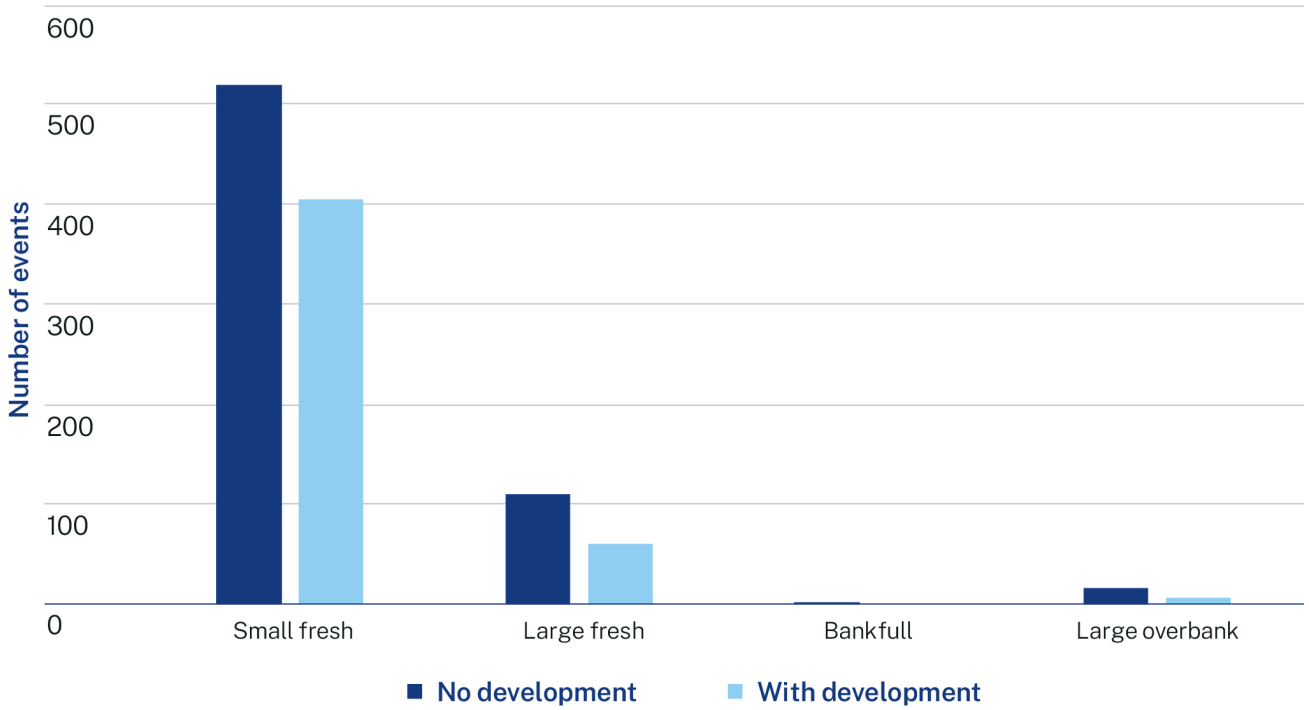
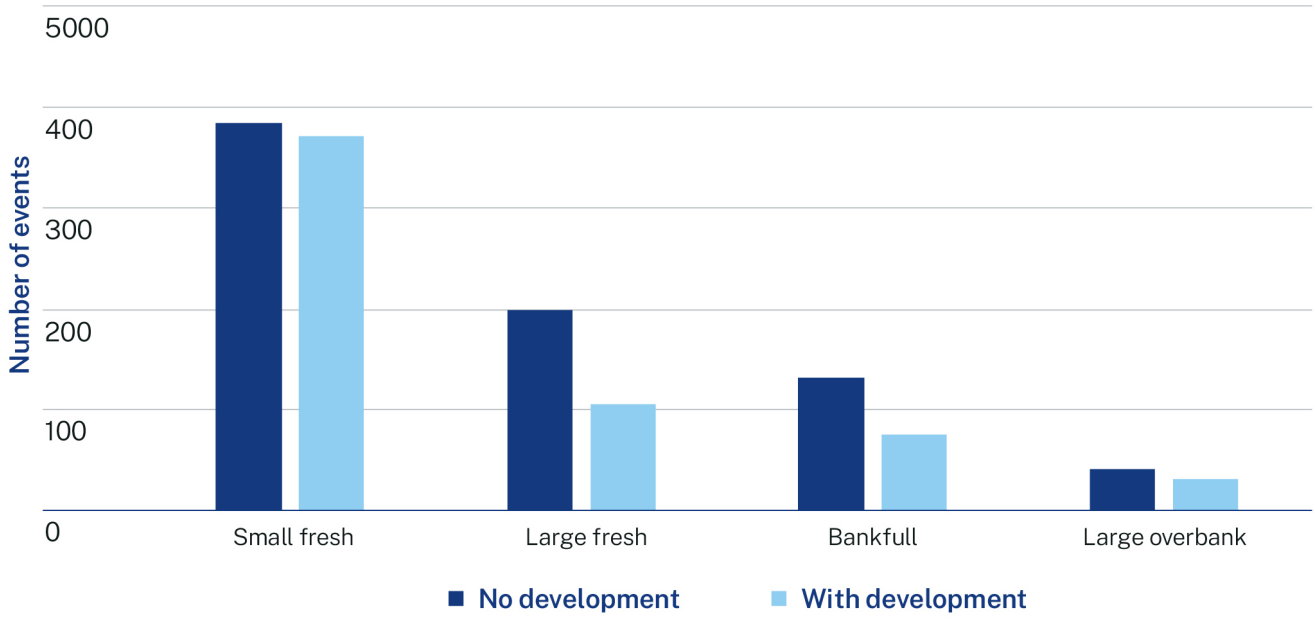


Figure 33. Modelled change in total number of different flow events in the Barwon–Darling River at Bourke over the last 130 years, with and without current development



In the lower part of the Border Rivers, which is an important tributary to the Barwon–Darling River, the number of large fresh and bankfull events at Mungindi has been reduced by approximately 50% since the development of irrigation (shown in Figure 34). Our modelling has shown that development has had the greatest impact on large fresh and bankfull flows.

Figure 34. Modelled change in total number of different flow events in the Barwon River at Mungindi over the last 130 years, with and without current development



Unconstrained floodplain harvesting, which is the capture of water that flows across floodplains by irrigators for later use, has also had an impact on the health of the floodplain and downstream waterways (particularly within valleys) by reducing the volume, frequency and duration of floods. Implementation of the NSW Floodplain Harvesting Policy will help to constrain growth in this form of water capture and bring it back within legal limits set by the Basin Plan and NSW Water Sharing Plans. Implementing the policy will return more than 50 GL/year on average to floodplains, rivers and creeks in the Northern Basin.[31]

Prior to the completion of the Menindee Lakes Scheme in 1960, the Lower Darling River was unregulated and subject to highly variable flow conditions. The Lakes scheme significantly altered the natural flow regime of the Lower Darling, through:

- substantial reductions in monthly and annual flow volumes
- changes to the seasonality of flows with greater flows during mid-summer
- a reduction in the peak flow and more persistent low flows.[32]

Altered flow regimes in the region's river systems have contributed to loss of native vegetation and wetlands and a decline in the condition of fish communities and waterbird habitat. These effects are likely to be exacerbated under future climate change. Research suggests that aquatic communities in the Barwon–Darling are under increased stress because of fewer opportunities to disperse to new habitats and increasing periods of still rather than flowing water.[33] Because the Barwon–Darling is a key movement corridor, flow alteration is also likely to have had a detrimental long term effect on fish populations in other parts of the Northern Basin.

The ecological community between Mungindi and the Menindee Lakes is an endangered ecological community (the Darling River EEC). The EEC includes all native fish and aquatic invertebrates and the classification was based on decline in several species and communities. Modification of natural flow is listed as the primary threat, although other threats such as barriers to movement, land clearing, water quality and pest species are also important factors.[34]

Poor water quality and extreme water quality events in parts of the region affect the ecology and survival of aquatic organisms, and the ability of the community to use the river. Water quality is impacted by both the flow characteristics of the waterway, as well as inputs from the land and river banks, including nutrients, sediment and organic matter. Temperature and light also play a role. While some water quality issues arise from the way that our waterways are managed, others such as temperature and light are not possible to influence.

31. NSW Department of Planning, Industry and Environment February 2021, *Modelled downstream effects of licensing floodplain harvesting Subtitle: NSW Border Rivers & Gwydir valleys*, www.industry.nsw.gov.au/__data/assets/pdf_file/0011/350201/modelled-downstream-effects-if-licensing-floodplain-harvesting-nsw-border-rivers-and-gwydir.pdf
32. NSW Department of Primary Industries April 2018, *NSW Murray and Lower Darling Water Resource Plan: Surface water resource description*, www.industry.nsw.gov.au/__data/assets/pdf_file/0008/145394/Murray-and-Lower-Darling.pdf
33. Mallen-Cooper M. Zampatti, B 2020, Restoring the ecological integrity of a dryland river: Why low flows in the Barwon–Darling River must flow, *Ecological Management & Restoration* 21(3)
34. NSW Department of Primary Industries, *Darling River EEC*, www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-ecological-communities/darling-river-eec

Infrastructure and pest species impact the resilience of aquatic species

Physical structures such as weirs and floodplain infrastructure can restrict the ability of native fish to move to breed, find food and ideal habitat.

The ability of native fish to migrate between river systems and between the river and its floodplain, has been constrained through the construction of weirs. In addition, approximately 1.3 million adults, larvae and juvenile fish across the Murray–Darling Basin are lost each year due to pumping and diversion infrastructure. The NSW Department of Primary Industries – Fisheries is leading a program to reduce this impact by installing fish protection screening throughout the basin.[35] In 2021 a screening program commenced in the Macquarie Valley. Plans to expand the program further, including the installation of approximately 130 new screens along the Barwon–Darling River, form part of the Australian Government's 2022 commitments under the Northern Basin Toolkit.[36]

There are 16 high-priority barriers to fish passage on the Barwon–Darling, which are planned to be remediated through the Western Weirs/Better Baaka, Northern Basin Toolkit, Lower Darling Fish Passage and Menindee Accelerated Fishways programs.

The Murray–Darling system has a high proportion of alien species: 12 out of 57 fish species are alien.[37] Carp are an abundant alien fish species that has been contributing to the degradation of the aquatic ecosystems of the Murray–Darling Basin since the 1960s. They now account for up to 90% of fish biomass in some parts of the Basin.[38] Carp populations have expanded rapidly, partly due to regulation creating conditions that preference their biological needs over those of native fish.

Environmental needs are under considerable strain during droughts

Droughts – like the most recent drought – are particularly damaging to the region's river systems and to species that require permanent water, such as native fish, aquatic animals and waterbirds.

Extended droughts lead to drying out of drought refuges and fish deaths. Events like the Menindee fish deaths in December 2018, January 2019 and throughout 2020 were caused by a combination of drought, water extraction, poor water quality and the drying out of refuges or habitat.[39] In 2016, before the most recent drought, the fish community of the Barwon–Darling's main channel was rated as being in fair condition. The long-term impacts of the most recent drought are not yet fully known.

As well as reducing inflows to streams, droughts lower groundwater levels. This can reduce groundwater discharge to connected streams which occurs during low flows at some locations on the Darling River[40] and reduces the ability for groundwater-dependent ecosystems to access water, resulting in poor ecosystem health and poor instream ecological values.

The NSW and Commonwealth environmental water holders own and manage a total of 324 GL of water entitlement in the Lower Darling – 93% of total regulated Lower Darling entitlement. Most of this water is held as supplementary licences (250 GL) and is only available during wet conditions when the lakes are spilling. The remaining environmental holdings are 4.7 GL of high security and 69.3 GL of general security licences (Table 5).

In the Barwon–Darling, environmental water managers hold approximately 30 GL of entitlement and in extraordinary circumstances such as the last drought, also rely on water holdings held in tributary valleys to support the Barwon–Darling environment.

35. NSW Department of Planning, Industry and Environment – Fisheries 2021, *Design specifications for fish-protection screens in Australia*, www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/1373577/Design-specifications-for-fish-protection-screens_FINAL_WPA.pdf
36. www.niaa.gov.au/indigenous-affairs/environment/indigenous-ranger-programs
37. Lintermans, M 2007, *Fishes of the Murray–Darling Basin: An introductory guide*
38. Commonwealth Environmental Water Office 2016, *Carp in the Murray–Darling Basin and Commonwealth environmental water*, accessed from, www.environment.gov.au/water/cewo/carp-murray-darling-basin
39. www.mdba.gov.au/sites/default/files/pubs/Final-Report-Independent-Panel-fish-deaths-lower%20Darling_4.pdf
40. www.industry.nsw.gov.au/__data/assets/pdf_file/0018/236061/draft-darling-alluvium-resource-description.pdf

Table 5. Western region environmental water holdings by type and entitlement

Barwon–Darling water holdings- type	Barwon–Darling water entitlements	Lower Darling water holdings – type	Lower Darling water entitlements
A, B and C class along with unregulated	30 GL	Supplementary	250 GL
		High Security	4.7 GL
		General Security	69.3 GL

The amount of licensed environmental water available varies year by year depending on supplementary flow events, water allocations and how much water has been carried over, in the same way that it does for other users. This variability is considered as part of the annual planning process by environmental water managers. However, it can mean that during dry periods, there may be less water available to release for the environment and, in some instances, limited opportunities to maintain critical environmental needs such as refuge river pools, core wetland areas and seed banks in the soil. Ongoing dry conditions also reduce the reliability of these licences.

Climate change scenarios could increase the long-term risks for natural systems

The worst-case climate change scenario identified in this strategy points to significant reductions in the volume of water flowing into the Barwon–Darling River each year. If these scenarios come to pass, there could be a reduction in the number and duration of floods, and high-flow events and freshes. This further reduction could have a detrimental impact on the health and resilience of water-dependent species and ecosystems, leading to a long-term decline in species and habitat.

In general, our modelling simulations estimate that under a dry climate change scenario:

- There could be less water flowing into the Barwon–Darling system from tributaries in NSW and QLD. The median annual inflows could be 42% lower when compared to our long term historical climate projections.
- There could be, on average, a 37% reduction in the number of high-flow events that fill the banks. These flows are identified in the Barwon–Darling Long-Term Water Plan as an important environmental water requirement.
- The number of freshes occurring every year is predicted to decrease by 33% and the duration of these flows when they do occur is expected to decline by 19%. This is expected to impact on the ability of the native fish population to breed, recruit and move, leading to a long-term decline in numbers.
- There could be a 15% reduction in the frequency of average (1,000 ML/day) flow events in the Great Darling Anabranch.
- There could be around a 22% increase in the time that the Menindee Lakes are under NSW control (i.e. when the volume in the lakes falls below 480 GL) when compared to our long term historical climate projections.

There could also be a large increase in the number of years in which a cease-to-flow event occurs. This is most pronounced in the unregulated river systems. Cessation of flow in rivers and streams could result in drying of flowing water habitats, increased sedimentation, water quality deterioration (elevated water temperatures and low dissolved oxygen levels) and the loss of connectivity throughout the river system – all of which will have damaging effects on aquatic ecosystems.

Importantly, these climatic changes will not occur in isolation: there will also be increasing demands on our water resources along with land use and agriculture changes. The impacts on natural systems from these concurrent changes will be made worse due to the impacts occurring in upstream catchments, as well as within the Barwon–Darling catchment. This means that, as we face a more variable climate, we will need to direct concerted and coordinated efforts across the Barwon–Darling and tributary valleys to support the region's vital environmental assets into the future.

Challenge: Reduced connectivity impacts critical needs

An adequate level of connectivity, or water flowing between river valleys, is critical to sharing water fairly and supporting environmental health across NSW.

There are 3 types of water connectivity across the Murray–Darling Basin:

1. **Longitudinal connectivity** relates to the flow of water along a river, between a river and its tributaries to downstream valleys.
2. **Lateral connectivity** refers to the connection between rivers and their anabranches, wetlands and floodplains.
3. **Vertical connectivity** refers to the connection between surface water and groundwater.

While many independent reports and community members agree on the need to improve connectivity, there is no clear agreement on what an acceptable level of connectivity is and how we can improve it. There is general agreement that there needs to be a focus on longitudinal connectivity. Communities in the Western region have expressed concern about the apparent reduction in connectivity between the river systems, the impact this has on the overall health of the river systems and the stress that it places on the environment.

Communities and ecosystems in the region rely on water flowing from upstream catchments

The Barwon–Darling River system relies heavily on water from NSW and QLD tributaries: over 90% of the flows in the Barwon–Darling system originate from the major upstream valleys. Most of these flow contributions occur during high flow periods. This means that industries, communities and ecological needs across the region rely on water flowing from upstream catchments that are influenced by climate conditions, water management and extractions in those catchments.

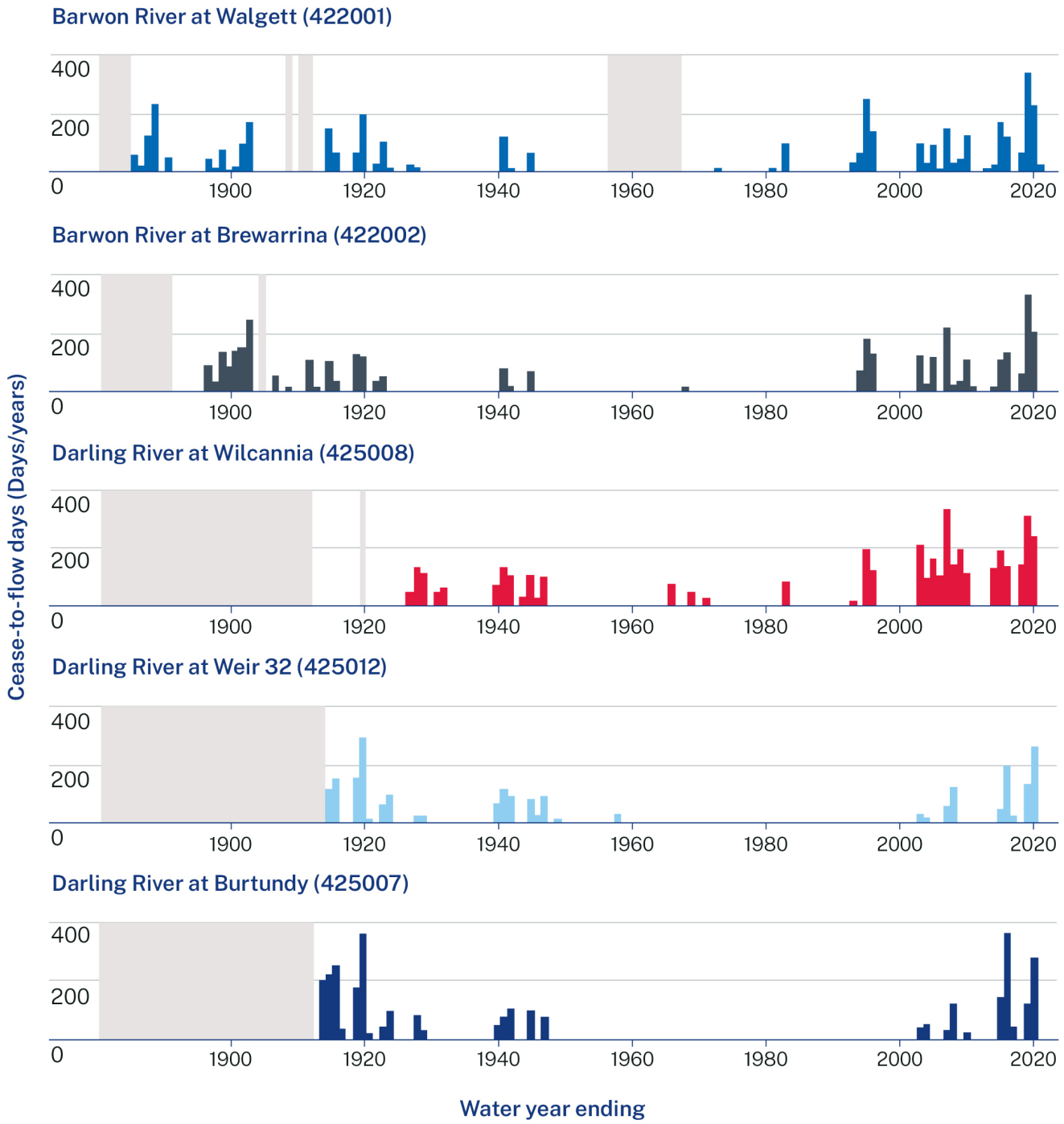
Connectivity supports communities and ecosystems at all times:

- connectivity during non-drought times builds the resilience of the system, providing opportunities for movement, spawning, and recruitment, and improving water quality and productivity in the system
- connectivity in wet periods supports large scale productivity, replenishing wetlands and flushing rivers to prepare systems for dry conditions
- connectivity in extreme droughts helps to avoid irretrievable damage to species, ecological communities and ecosystems.

Maintaining connectivity during extended dry periods is most challenging

The Barwon–Darling and Lower Darling naturally go through wetting and drying cycles. It is not unusual for the Barwon–Darling to stop flowing for extended periods (Figure 35). Even at the turn of last century, when there was little agricultural development upstream, there were long periods when the river did not flow. The last 20 years have been a dry period in our climate, with frequent and extended cease-to-flow periods. Extended and frequent dry periods reduces the recovery time in between droughts, affecting critical human needs and environmental health. Extended dry periods also have cultural impacts across the region.

Figure 35. Number of cease-to-flow days per year at different locations on the Barwon–Darling



Note: The grey areas indicate no usable records.

Water regulatory requirements require critical human and environmental needs to be protected across catchments, which can be challenging during extreme droughts. When most of the northern and western NSW catchments are experiencing a very dry period, it can be virtually impossible to maintain base flows and low flows along the length of a river system and into the Barwon–Darling. For example, during the last drought the Namoi River at Gunnedah stopped flowing between January 2019 and February 2020, with Keepit Dam levels too low to make any releases.

The challenge is determining how to prepare and build drought resilience to support critical human and environmental needs during acute climatic conditions. Improving connectivity during non-drought times may help to build resilience to future extended dry periods.

Water management tools have limited influence in extended dry periods

Over the last 50 years, development has occurred across western NSW, with accompanying changes to land use and water extraction. We have heard from some communities that development and water extraction upstream has resulted in less connectivity, or less water flowing downstream, that has extended droughts or brought droughts forward.

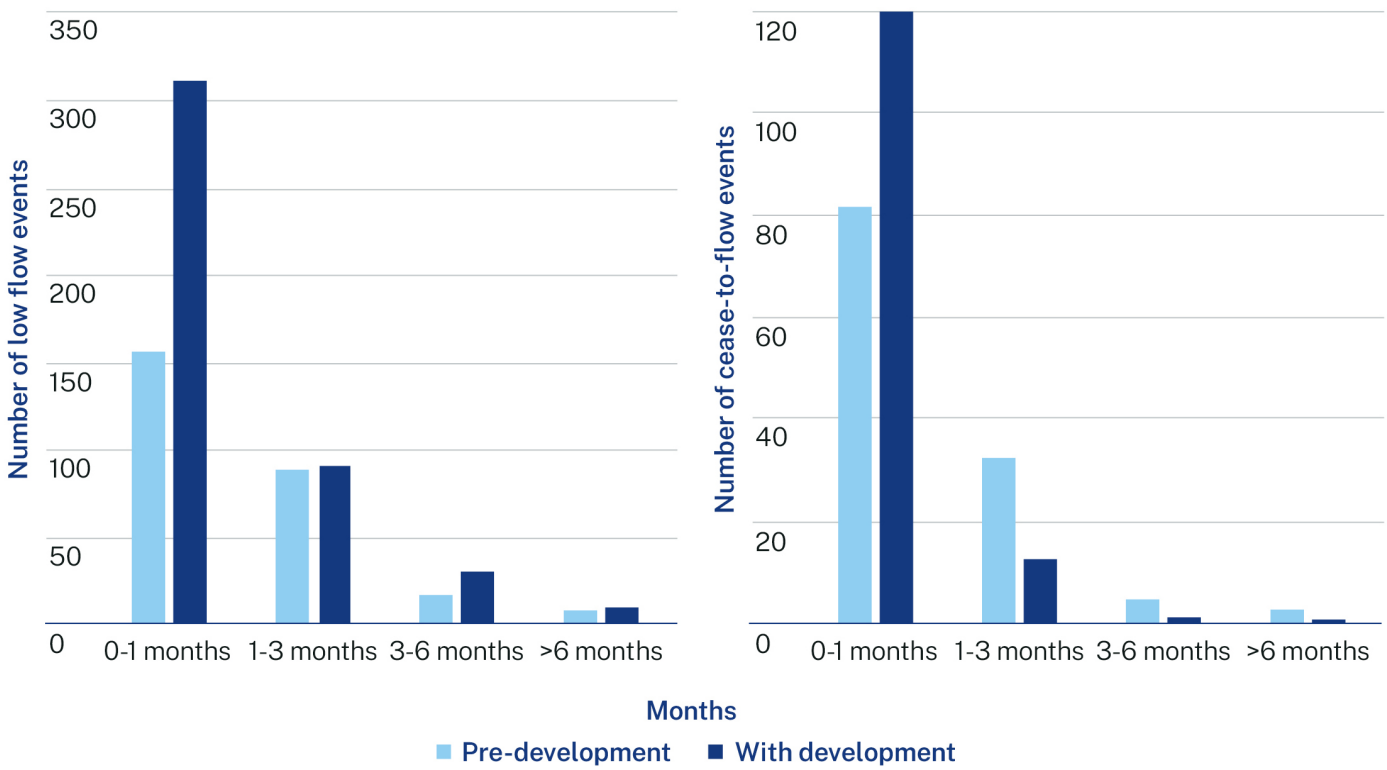
Our analysis shows that dams, water extractions and water management rules have likely increased the frequency of shorter cease-to-flow periods (0–1 month) and low flow periods in the Barwon–Darling. In some instances, low flows have increased by up to 50%, with a measurable increase in the frequency of low flows since the early 1990s.

However, longer cease-to-flow events are more likely to be driven by the climate, rather than irrigation development because very little inflow occurs during these events (Figure 36). This is because:

- In extended dry periods, there is little to no water that can be taken by upstream commercial water users and often water restrictions are placed on towns.
- Peaks of higher flows and freshes are extracted by water users in both NSW and QLD, potentially resulting in increased low flow events.
- Dams in the tributaries have been operated in recent years to avoid in-valley cease-to-flow periods for as long as possible, prolonging low flows and reducing no flows.
- Dams impact and capture low base flows and small and large freshes. Depending on the volume and timing of water released and the river conditions at the time, dam releases may or may not contribute to end-of-system flows and subsequent inflows to the Barwon–Darling.

This suggests that changing the rules and how we manage water can help to manage short cease-to-flow events and low-flow events but cannot address extended dry periods or maintain a constantly flowing river. Changes to address long cease-to-flow and low flow periods will require significant reform to how we share water or to the infrastructure within the system.

Figure 36. Modelled number and duration of low-flow (left graph) and no-flow (right graph) events with and without development, averaged across gauges at Bourke, Brewarrina and Wilcannia for the period 1895 to 2020



Climate change could result in less connectivity

New climate modelling for the regional water strategies suggests that extreme events could become more extreme – wet periods are likely to become wetter, and dry periods could become more acute. We don't know for certain what the future climate will be like. It may be similar to what we have experienced in the past, it could be wetter in some years and in other years it might be drier than we have seen in our lifetimes. Our analysis suggests that under a dry climate change scenario, there could be less water flowing into the Barwon–Darling from tributaries in NSW and QLD. The median annual inflows could be 42% lower when compared to our long-term historical climate projections.[41]

Over the last 130 years, the Namoi and Border Rivers have contributed more flows to the Barwon–Darling than other tributaries – particularly during average or wet years – and are the most efficient at contributing flows to downstream reaches.

Other valleys, such as the Paroo, Macquarie and Gwydir rivers, are less efficient at contributing flows at Menindee, as they contain large floodplain and wetland systems that absorb significant volumes of water before the flows can reach the Barwon–Darling.

Within these systems, there are channels for water to flow around some wetlands and provide flows into the Barwon–Darling. These include the Mehi River or Carole/Gil Gil Creek in the Gwydir Valley and the Bogan River or via the Bulgerega and Northern By-pass Channel in the Macquarie Marshes.

The impact of a dry climate change scenario varies across the Basin. Under a dry climate change scenario, there may be changes to the relative contributions that different systems make to inflows into the Barwon–Darling (Table 6). There could be:

- reductions in the relative inflow contributions of the Border Rivers, Namoi, Condamine–Balonne, Macquarie–Castlereagh valleys and Bogan River
- increases in the relative contributions of the Warrego and Moonie Rivers.

These future climate changes may make it more difficult to achieve connectivity objectives, particularly during dry periods as the contributions decrease from important tributaries such as the Namoi and the Border Rivers.

Image courtesy of Destination NSW. Menindee Lakes, Menindee.

41. We have looked at a 10,000-year dataset. Within that 10,000-year data set there are a range of 130-year subsets which have different average inflows sequences that range for 43% less on average compared to our long term historical climate projections, to double the average annual inflows when compared to the historical climate projections.

Table 6. Major tributary contributions to long-term average flow in the Barwon–Darling

River system	Major tributary flow contribution[42]	Projected change in the proportion of inflows (volume) from Barwon–Darling tributaries under a dry climate change scenario compared to long term climate data
Border Rivers	18.1%	-2.6%
Macquarie–Castlereagh and Bogan	17.3%	-0.5%
Condamine and Balonne Rivers	12.9 %	-0.8%
Gwydir River	8.3%	1.1%
Namoi River	18.8%	-1.5%
Warrego	1.6%	2.29%
Moonie River	18.1%	2.92%

Improving connectivity will have benefits and trade-offs

Improving connectivity has the potential to provide benefits to a range of people, ecosystems and industries. However, sharing water across connected systems means that any water management or infrastructure action will involve trade-offs. An action to improve connectivity may result in additional water being provided for one type of water use, or to communities in one part of the region, and water access being reduced for other users. Similarly, focusing actions on one part of the flow regime may not necessarily achieve all connectivity objectives. These challenges and trade-offs are likely to become more acute under a drier climate.

To achieve the right balance, we need to acknowledge these limits and trade-offs and understand the impacts a changing climate will have on water users, water resources and the natural environment. The key will be in continuing to strive for a balanced approach that protects the fundamental health of the environment while supporting the wellbeing of communities and sustaining the jobs and industries that drive regional economies.

42. Murray–Darling Basin Authority 2011, *Water resource assessments for without-development and baseline conditions Supporting information for the preparation of proposed Basin Plan Technical report 2010/20 Version 2 November 2011*, Table 10, page 25. The modelled flow contribution figures are based on the without development figures in Table 10, accessed from, www.mdba.gov.au/sites/default/files/pubs/1111-BPKld-water-resource-assessments-development-baseline.pdf

Challenge: Managing the impacts of poor water quality

Surface water and groundwater quality throughout the Western region varies, and monitoring and responding to water quality issues has been a long-term concern. There are gaps in our understanding of how water quality varies over time.

Water quality issues are often caused by a combination of factors, including alteration to natural flow regimes, loss and degradation of riparian vegetation, poor land management practices and the impacts of severe weather and drought. Low flows in the Barwon–Darling River in late 1991 led to an extremely large algal bloom. It stretched approximately 1,000 km from Mungindi to the Wilcannia weir pool. At the time, environmental factors such as stratification, increased nutrient levels, warm water temperature and low turbidity contributed to ideal bloom conditions.[43]

Recent extreme water quality events, including the large fish-death events around Menindee during 2018/2019 to 2019/2020, have highlighted the urgency to manage this issue, particularly in light of the potential impacts of climate change on the region.

Water quality is generally poor during periods of low or no flow in the Barwon–Darling and Lower Darling.[44] Poor water quality also occurs after droughts when flows return and begin to accumulate debris and dissolved material from previously dry river channels and floodplains.

The water is often murky (high turbidity), contains pathogens, nutrients and possibly pesticides, causing the water to smell and become less clear further down the catchment. These water quality issues are caused by a combination of factors including:

- land management practices such as the widespread conversion of land to cropping and irrigation uses, grazing practices, feral pigs, stock trampling and degraded bank and riparian condition
- high flow from rainfall and run-off, which can result in more soil and nutrients being washed into waterways, making the water less clear and prone to excessive algal growth when flows reduce
- the high clay content of alluvial soils in the Western region, which means these soils are more likely to remain in the water during both high and low flows.

In addition to high turbidity, prolonged periods of low flow and high temperatures result in weirs and refuge pools in the Western region often having algal bloom events and rivers having low levels of dissolved oxygen.

Poor surface water and groundwater quality affects the ecology and survival of aquatic organisms, is a risk to human health and stock, and impacts the social and recreational amenity of waterways. It consistently affects Aboriginal people's ability to practice culture on or near waterways. Poor water quality also presents significant water quality treatment issues for local water utilities and affects agricultural and other industrial processes that rely on water.

The Barwon–Darling Water Resource Plan identifies the middle and lower Barwon–Darling as a priority area to develop appropriate local water quality targets.[45]

43, 44, 45. Department of Planning, Industry and Environment 2019, *Barwon–Darling Water Course Water Resource Plan – Water quality management plan (SW12) Schedule H*, www.industry.nsw.gov.au/__data/assets/pdf_file/0010/273754/schedule-h-barwon-darling-wqmp.pdf

Options for the Western region

6

Image courtesy of Michael Scotland. Barwon–Darling River, Bourke.

The Western Regional Water Strategy provides an opportunity to investigate ways to build and invest in the resilience of communities, industries and the environment. A range of options are presented in this draft strategy aimed at improving information for business planning, diversifying water sources, changing infrastructure and investigating changes to the way we manage river systems and respond to drought conditions.

In preparing the options, we recognise the current and previous work underway to identify initiatives that could improve water management in the Western region. We have collated options from previous studies and supplemented them with additional options derived from recent experience and consultation with local councils and Aboriginal communities. Bringing all these options together will help us to align and better sequence the various water reform processes as we develop the strategy.

Attachment B contains the long list of options being considered for the region. Importantly, not all options in the long list will be short listed. Only feasible options will be progressed.

It is unlikely that a single option will be capable of addressing the identified risks across the objectives we have set for the strategy. The greatest benefits are likely to be realised by combining or packaging options together so that they complement each other to improve the efficiency of the system, and offset impacts or unlock greater benefits by using the different levers that are available – such as policy and infrastructure levers.

As development of the strategy progresses, preferred options and combinations of options – and their trade-offs – will be informed by multiple lines of evidence including modelling, expert judgement and community input. We have also outlined actions that are already being taken to address the challenges for the region identified in the previous section.

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

Image courtesy of Destination NSW. Murray and Darling Junction, Wentworth.

Improving water security for towns and industries

Improved water security and reliability for towns and industries will be critical to attracting and retaining people, businesses and jobs to the region and supporting the growing tourism industry.

We know from history, and the more recent drought experience, that water availability influences employment and business viability. As the river dries, the effects are felt by the local economy. We also heard from councils that access to reliable potable water supply was important to increasing and sustaining visitor numbers to the region.

Current population projections suggest a decline in population for the region over the next 20-40 years. Coupled with the potential risks of a more variable or changing climate, this may make it even more challenging to attract people to the region and support vital regional businesses and industries. The availability of water to support waterholes, town swimming pools and green spaces, providing refuge from extreme heat and some relief from the mental stress of drought, will also play into the way communities are sustained.

To address these risks and secure town water supply in the Western region, new approaches will be needed to keep pace with changing climate conditions, industry profiles, community health, and water needs, and to make sure that industries and communities across the region have access to reliable water supplies.

The Western Regional Water Strategy considers options that will help to mitigate these risks. This includes exploring questions around how we need to continue supporting existing industries in the region and whether future economic risks driven by the climate can be by mitigated by diversifying the region's industries and economy.

Image courtesy of iStock. Barwon River, Brewarrina.

Actions underway to support water security for towns and industries

Investments have been made in recent years to help secure water supplies for towns in the Western region and prepare the region's economy for a more variable or drier climate.

Every local water utility faces unique challenges and risks. In the Western region, the costs associated with implementing water security infrastructure solutions across a small and dispersed ratepayer base, attracting and retaining skilled staff, and working through regulatory requirements can make it challenging for local water utilities to operate.

The NSW Government's Town Water Risk Reduction Program is working in partnership with councils, local water utilities, government agencies and the broader sector to address these issues and improve management of town water risks. In addition, around $589 million has been invested in water security upgrades in the region through the Safe and Secure Water Program (see Box 5).

Box 5: Safe and Secure Water Program investment in the Western region

- Bourke Shire Council – $23.3 million, including new bores and a new water treatment plant
- Brewarrina Shire Council – $1.1 million for bore installation and pumping station modifications
- Central Darling Shire Council – $12.5 million for bores and treatment plants
- Cobar Shire Council – $32.5 million, including a new water treatment plant and pipeline replacements
- Wentworth Shire Council – $2.4 million, including Pooncarie emergency works and water treatment plant upgrades
- Walgett Shire Council – $17.9 million, including raising Walgett Weir and installing a fishway, new bores, tanks, and a water supply upgrade
- Replacing Wilcannia Weir – this project is fully funded and is planned to commence late in 2022. The raised weir will have a fishway and an operational gate
- Broken Hill City Council – $500 million to secure Broken Hill's water supplies, including construction of the $467 million pipeline from the River Murray to Broken Hill, temporary bores to provide back-up supply during the drought for Broken Hill and Menindee and a reverse osmosis plant.

Work is also underway to:

- **assess the vulnerability of agricultural industries to climate change** – the Department of Primary Industries – Agriculture is assessing how vulnerable cotton and livestock production systems are to climate change and how climate change scenarios could result in changes to yield and the occurrence of pests and diseases. The project is identifying adaptation options such as crop substitution, new management systems and including carbon farming as part of livestock enterprises or an increased focus on goat production
- **identify triggers to implement temporary water restrictions** to protect the first flush of water after an extended drought to support critical human needs (see section on Improving connectivity across the Northern Basin on page 99)
- **explore for groundwater in the region** – Geoscience Australia are undertaking a program of work to identify deep groundwater aquifers and sites with potential for future underground storage and to help to better understand groundwater systems in the Upper Darling River Floodplain
- **provide enabling infrastructure to support industry development and diversification**, including upgrades to the Silver City Highway and the Pooncarie–Menindee Road, the Broken Hill and Wentworth airport upgrades, Bourke's central business district revitalisation; and improvements to digital connectivity
- **activate and grow the critical minerals sector** – There are a number of important critical mineral deposits in the Western region. The NSW Government's Critical Minerals and High-Tech Metals Strategy aims to position NSW as a major global supplier and processor of these minerals and secure new long-term opportunities for the state's mining industry.

These actions will help to set the region's existing and emerging industries up for the future, and to further identify specific water needs, water management options, and availability issues that will need to be resolved to support them.

What other options could we consider?

A range of water-related options can be explored to support towns and industries into the future. Improving the integration of land and water management, exploring reuse options to diversify town water supplies, supporting demand management and leakage reduction, lifting performance standards, and investing in research and innovation will build the resilience of towns and industries to future climate risks.

Augment town water supply systems

The shortlisted options from the Western Weirs and Better Baaka Project (see Box 1) have been included in the Western Regional Water Strategy options long list. These include enlarging weirs at Bourke and Collarenebri. Increasing access to groundwater for a range of towns in the region, as well as in the Unincorporated Area, can augment water supplies for towns.

Making significant water security investments at strategic points in the system can also help to improve water security for smaller surrounding towns during times of scarcity through either in-river deliveries or carting.

Implement water efficiency measures

Water demand per household is significantly higher in the Western region compared to other parts of the state (Table 7). While water demand per household in the region is expected to be higher than the average in NSW given the arid and hot conditions, there may be opportunities in some of the higher demand towns and villages to implement water efficiency and demand management measures.

Table 7. Potable water demand and average household demand for towns along the Barwon–Darling

Town	Average potable demand (kL/year)	Average water demand per household (kL/year)
Mungindi	224,000	824
Collarenebri	200,000	913
Walgett	270,000	398
Brewarrina	200,000	543
Bourke	471,000	552
Louth	15,000	484
Tilpa	10,000	500
Wilcannia	132,500	594
Menindee	166,000	769
Pooncarie	62,000	886

The NSW Government has developed a Regional Leakage Reduction Program in collaboration with the NSW Water Directorate and local water utilities. The need to focus on reducing Local Water Utilities network leakage and water losses became more apparent during the recent drought and the immediacy of this has been reinforced during consultation with Councils and the wider water sector as part of the Town Water Risk Reduction Program. The 3-year program aims to reduce reported non-revenue water, and to increase the ability of councils to maintain a reduction in network leakage through improved leakage management assets, capacity and data quality.

A priority assessment of local water utilities has been completed to identify priority areas for the program. In the Western region, Bourke Shire Council, Central Darling Shire Council, Walgett Shire Council, Essential Energy servicing Broken Hill and Cobar Water Board have all been ranked as priority councils. Most of these councils have reported non-revenue water totalling over 20% and will benefit from improved network leakage reduction resourcing.

Similarly, there are opportunities to continue water efficiency measures for industry. Industry associations, research institutions and government have worked together for decades to improve traditional crop and livestock production systems, including lifting their water use efficiency and productivity. The cotton industry has significantly improved whole farm irrigation efficiency and producers now achieve twice as much cotton from the same amount of water as 25 years ago.

Continuing to improve the efficiency of water use by town based industries could reduce pressure on town water supplies and other water sources, set industries up for the future and may go a significant way towards mitigating future climate risks. Opportunities include an increased use of recycled water by industry and making sure that businesses have information about existing programs aimed at supporting greater water use efficiency. Opportunities for improving on-farm water use efficiency should also be explored.

Use groundwater more efficiently, innovatively and sustainably

Better understanding how groundwater can support industry and towns in the region might be one of the most significant opportunities available for improving water security over the longer term. Investing in technology and research to understand how treated groundwater can support towns, landholders and industries could help to secure water supplies for communities in the face of a drier climate with less water in rivers. This could include options such as investigating the feasibility of managed aquifer recharge,[46] promoting groundwater desalination and making sure groundwater of suitable quality is available for different purposes.

The draft strategy also proposes specific actions to further improve our management of the Great Artesian Basin and reduce wastage of groundwater from the Basin. This would include an extension of the Cap and Pipe the Bores Program, which has saved large amounts of water every year since 1999 and resulted in substantial recoveries in groundwater levels across the Basin.

Invest in research and development to identify the industries of tomorrow

There are opportunities to expand on the research currently underway to identify new enterprises that are likely to be suited to arid conditions under warmer and drier climate conditions. This research will support a more diverse and resilient industry base for the region in coming decades.

Options to improve water security for towns and industries

- Option 1. Promote groundwater desalination for industry and towns
- Option 2. Seek to increase secure and reliable access to groundwater for towns
- Option 3. Investigate managed aquifer recharge feasibility and policy
- Option 4. Review groundwater extraction limits
- Option 5. Better manage the Great Artesian Basin
- Option 6. Assess the possibility of water recycling projects
- Option 7. Investigate residential and non-residential water use efficiency in towns
- Option 8. Maintain water-related amenities during droughts
- Option 9. Repurposing Umberumberka Reservoir for recreation
- Option 10. Investigate potential pipelines for surface water and groundwater sources
- Option 11. Modify or renew town weirs
- Option 12. Determine potential for covered off-stream storage
- Option 13. Investigate options to secure water for small communities
- Option 14. Study the resilience of water-dependent industries.

These options are described in Attachment B.

46. Managed aquifer recharge (MAR) is the storage of surface, storm or recycled water in aquifers during wetter periods to use later.

Delivering on Aboriginal people's water rights and improving access to water

The NSW Government recognises there are systemic issues that need to be addressed to better enable the exercise of Aboriginal rights and access to water. These issues include access to cultural flows, self-determination and decision making regarding water policy, increasing Aboriginal peoples' understanding of the water management framework, and incorporating First Nations' knowledge and science about water systems into our water planning, management and policy.

Actions underway to deliver on Aboriginal water rights

A range of actions are underway to support Aboriginal water rights and access to water.

As a signatory to the National Agreement on *Closing the Gap*, NSW is committed to establishing a target to measure progress towards securing Aboriginal interests in inland water. NSW is contributing to national processes to confirm this target, which could be expressed as a percentage of water licences held by Aboriginal people or organisations. Further the NSW Water Strategy commits the NSW Government to enhancing Aboriginal People's access to water for cultural and economic purposes including:

- increasing water available for cultural and spiritual purposes
- increasing water entitlements in Aboriginal ownership (see Action 2.3).

The NSW Government is also developing an Aboriginal Water Strategy – the first of its kind in NSW – which will be driven by principles around:

- strengthening the role of First Nations/Aboriginal people in water planning and management
- providing Aboriginal ownership of and access to water for cultural and economic purposes
- working with First Nations/Aboriginal people to improve shared water knowledge
- working with First Nations/Aboriginal people to maintain and preserve water-related cultural sites and landscapes.

The Aboriginal Partnerships Program within the Department of Regional NSW is working in collaboration with local Aboriginal community representatives to co-design solutions to increase economic participation, grow employment, improve skills and employability and enhance services for Aboriginal people in regional NSW. The Australian Government's Indigenous Rangers Program supports the Barkandji Native Title Group Aboriginal Corporation in the Western region and a ranger program at Walgett with the Dharriwaa Elders Group.

Image courtesy of Annette Corlis. Paroo River, Wilcannia.

What other options could we consider?

We can do more. The Western Regional Water Strategy presents opportunities to support Aboriginal communities to develop local solutions and projects that cater to local needs. There is scope to improve Aboriginal participation and knowledge sharing in decisions about water use and management. Aboriginal communities would also like us to assist in preserving culturally important water-dependent sites in the Western region.

Continue to improve participation of local Aboriginal people in water management

Aboriginal people often feel like they are not being heard. Consultation with 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.

There are existing governance arrangements in the region that have been set up and driven locally to look at water issues. These include the Barkandji Native Title Group and Gomeroi Water Group.

The Western Regional Water Strategy includes options to fund existing or new Aboriginal groups that have developed a governance approach for involvement in water management processes. Local groups could be responsible for matters such as guiding the purchase and management of water entitlements for Aboriginal communities to receive cultural flows, informing decisions about water for the environment and progressing on-ground initiatives to access and care for Country.

Incorporate Aboriginal knowledge and science into decision making

Water management decisions are based on data and science collected and invested in by government over decades. However, the evidence base used to inform water decisions often does not include Aboriginal science or knowledge. We have heard from various forums, including the Connectivity Stakeholder Reference group and other groups, that Aboriginal science and knowledge needs to be integrated into government processes to help better manage and inform water management decisions.

As a first step, the Department of Planning and Environment is embarking on a project to collate social and Aboriginal data and knowledge, and supplement it with climate data collected by government over the last 130 years. This information can then be used in a culturally appropriate way to inform future water management processes. The Draft Western Regional Water Strategy includes an option to progress this project, as well as an option to integrate Aboriginal knowledge into groundwater and surface water decision making.

Support place-based initiatives to deliver cultural outcomes for Aboriginal people

The Australian Government's *Closing the Gap* report and the Local and Indigenous Voice Program highlighted Aboriginal people's desire for strong and inclusive partnerships in which local communities set their own priorities and tailor services and projects to their unique situations. Programs with demonstrated successful initiatives are often those that reflect local circumstances, are place-based, well resourced, locally driven and often cannot be scaled up.

The draft strategy includes options to fund and support Aboriginal organisations and communities to develop tailored projects for their communities, which could include projects around local riparian land rehabilitation, working in partnership with environmental water holders to deliver flows to culturally important sites, and developing culturally appropriate water knowledge programs.

These options aim to move away from central decision making towards a flexible program that can be adapted to local circumstances and is driven by the principle of self-determination: local communities 'speaking with their voice' to make decisions about the programs needed for their communities and Country.

These locally driven projects may need to be supported with water licences and allocations. The draft strategy includes options for reviewing cultural water licences and exploring ways in which water for the environment can be used to support the water needs of Aboriginal communities.

The strategy also includes an option to improve flows to Cawndilla Creek, an important cultural site near Menindee Lakes. This option, which is being investigated through the Better Baaka Program (see Box 1), explores ways to preserve and enhance the heritage of the area so that the Barkindji People can continue to practice their culture and support future economic development opportunities such as cultural tourism.

Our commitment to consultation

To date, our face-to-face engagement with Aboriginal communities in the Western region has been challenged by the COVID–19 pandemic and associated lockdowns. The Draft Western Regional Water Strategy reflects the results of this limited consultation and considers regional and statewide options for recognising and delivering Aboriginal water rights. These options have not been tailored to the specific needs of Aboriginal people in the Western region.

We are committed to having an ongoing dialogue with Aboriginal people as we continue to develop the strategy and shortlist options. Through this engagement, we hope to capture actions that are most important to Aboriginal people in the Western region and include these in the final strategy.

Attachment C contains further information about what we have heard from Aboriginal people in the Western region in our initial consultations.

Options to deliver on Aboriginal people's water rights and improving access to water

- Government commitment 1. River Ranger Program
- Option 15. Cawndilla Creek Watering
- Option 16. Support long-term participation of local Aboriginal people in water-related matters
- Option 17. Review Aboriginal cultural water access licences
- Option 18. Fund water entitlements for Aboriginal communities
- Option 19. Secure flows for water-dependent cultural sites
- Option 20. Shared benefit project (environment and cultural outcomes)
- Option 21. Integrate Aboriginal knowledge into groundwater decision making
- Option 22. Incorporate Aboriginal history of water and culture in the Northern Basin into water data.

These options are described in Attachment B.

Other options on the long list for the draft strategy, including environmental restoration works, improving water quality and options related to groundwater, may also contribute to advancing the rights, interests and aspirations of Aboriginal people in the Western region.

Protecting and enhancing natural systems

There is 121 GL of held environmental water in the Western region. Approximately 30 GL is in the Barwon–Darling River and 73 GL in the Lower Darling River – this means that about 75% of the regulated river entitlement in the Lower Darling is in the form of environmental water licences (not including the additional 250 GL of supplementary licences held by environmental water managers). This entitlement is used to help protect a portion of the flow to help maintain natural river flows, provide drought refuge and habitat, support native fish populations and vegetation, and to build ecosystem resilience. Despite this, water for the environment is not always available when it is needed, nor can it always be delivered to its best effect during dry and wet periods because of operational constraints. Additionally, in the Lower Darling there is a trade-off in releasing environmental water when Menindee Lakes drop below total storage of 480 GL. Without careful consideration, environmental flow releases may bring forward a cease-to-flow event in the Lower Darling.

Future droughts and long-term dry climate change scenarios will increase the pressure to provide environmental water to support ecosystems and native species. A range of NSW Government commitments and options are considered in this draft strategy with a strong focus on improving the health and resilience of natural systems and protecting aquatic species. These aim to:

- support native fish populations and habitat
- improve connectivity and protect flows in the river
- protect ecosystems that depend on surface and groundwater.

Actions underway to protect and enhance natural systems

Improving fish habitats and movement through the Northern Basin Toolkit

Programs funded by the Australian and NSW Governments are underway to improve the health and resilience of native fish in the Western region:

- **constructing fishways** – the Australian Government has provided funding through the Northern Basin Toolkit to construct fishways and undertake fish friendly rehabilitation works in the Barwon–Darling and Border Rivers, enabling fish to access to habitat along the length of the rivers and in key tributaries such as the Macquarie, Namoi, and Gwydir rivers in NSW, and the Warrego, Culgoa, and Moonie Rivers in QLD
- **installing fish screens** – the Australian Government is funding the installation of approximately 130 fish-friendly screens on irrigation pumps in the Barwon–Darling
- **establishing fish recovery reaches** – the Australian Government has committed to implementing the Native Fish Recovery Strategy to guide investment in native fish and river health actions that will help rebuild healthy and resilient native fish populations. The NSW and Australian governments are collaborating to deliver the strategy, including implementing management actions in the Lower Darling–Baaka Recovery Reach (see Box 1)
- **funding the Fencing Northern Basin Riverbanks Program** – this program supports landholders to protect valuable ecological sites and improve water quality and native fish habitat across the Northern Basin. This includes off-stream stock watering points, control of exotic woody weeds, minor erosion control works, revegetation and river re-snagging to protect native fish, and stock-proof fencing along riverbanks.

Toorale National Park

Toorale National Park is located about 65 km south-west of Bourke in north-western NSW. Toorale Station was purchased jointly by the Australian and NSW governments and added to the NSW reserve system to protect its outstanding environmental and cultural values. At the same time, the Toorale water access licences were purchased by the Australian Government to deliver environmental benefits in the Warrego and Darling rivers.

Toorale has extensive infrastructure dating back to the 19th century that was built to regulate water across the property for agricultural purposes. The Toorale Water Infrastructure Project is modifying, decommissioning and removing this water infrastructure to improve flow management. The project aims to maintain and enhance the important values of Toorale while passing more water to the Darling River.

Phase 1 of the project concluded in October 2019 with the removal of Peebles Dam. Phase 2 is underway, involving construction of new regulating structures at Boera and Homestead Dams. These new structures will enable more water to flow to the Darling River when downstream needs are a priority and provide for ongoing watering of important habitats at Toorale when needed. New fishways will increase connectivity and support healthier fish populations in the Warrego and Darling Rivers.

Maintaining environmental flows

Water sharing plans in the Western region include rules and tools to maintain and improve the flows of rivers and support environmental outcomes in the Western region. Box 6 summarises these rules.

Box 6. Rules in water sharing plans and other tools to support environmental water flows in the Western region

- Rules to protect low flows – There are limits on the portion of flows that may be extracted, with the remainder left in the river for environmental purposes. In 2020, amendments were made to the Water Sharing Plan for the Barwon–Darling Unregulated River Water Source 2012 to increase this protection by raising the thresholds at most locations for when A-class licence holders can access water.
- Individual daily extraction components set a daily extraction limit for water licence holders along the Barwon–Darling to manage the amount of water that can be taken out of the river each day during peak irrigation periods.
- Protections for licensed environmental water from extraction in unregulated river systems (active management) – Licensed environmental water is protected from extraction as it moves through the Macquarie, Gwydir and Barwon–Darling unregulated river systems. These provisions ensure that this water can remain in the river to provide its intended environmental outcomes and that water users are advised of these flows and know when they can't access water.
- Protections for the 'first flow' of water in the Barwon–Darling following extended low flows – These protections recognise that these first flows of water are critical to replenishing refuges and town weir pools.
- There is a 30 GL environmental water allowance in the Lower Darling for managing water quality issues (triggered by a high alert for blue-green algae).
- There are 121 GL[47] of held environmental water in the Western region. This includes:
  - 30,359 ML in the Barwon–Darling[48]
  - 72,879 ML in the Lower Darling[49] this is about 75% of the available 98,781 ML of regulated river entitlement (excluding supplementary entitlements
  - 17,826 ML in the Intersecting Streams.[50]
- Recommended minimum flow releases from Weir 32 at Menindee Lakes to the Lower Darling River to mitigate blue-green algae and maintain river health. This is prescribed by the Murray–Darling Basin Agreement.
- End-of-system flow rules in some northern tributaries require a flow to be retained at the end of the river system. This ensures that flow is maintained below the areas of major extraction. Current end-of-system flow targets in some tributary valleys such as Namoi and Border Rivers do not address no- to low-flow conditions, as they are not triggered during dry conditions.

47. Excludes 250,000 ML in supplementary entitlement, and unregulated entitlements in Queensland tributaries
48. Department of Planning, Industry and Environment – Water 2020, *Draft Barwon Darling Watercourse Water Resource Plan*, Currently in review.
49. Department of Planning, Industry and Environment – Water 2020, *Draft NSW Murray and Lower Darling Surface Water Resource Plan*. Currently in review.
50. Department of Planning, Industry and Environment – Water 2020, *Draft Intersecting Streams Surface Water Resource Plan*. Currently in review. This excludes held environmental water in Queensland tributaries.

What other options could we consider?

Continuing to reduce the impact of river regulation and infrastructure and improving the condition of key habitats can support the health and resilience of aquatic ecosystems. Additional options being considered for the Western Regional Water Strategy could help to maintain vital habitats, reduce the risk of fish deaths, protect and enhance threatened species and provide water to the wetlands and floodplains that characterise the region.

Fully implement the floodplain harvesting reforms

Floodplain harvesting happens when water is collected from floodplains during a flood or after a major or significant rain event (overland flows). It is a form of water take that has not been fully transitioned into the licensing framework provided by the *Water Management Act 2000*.

Floodplain harvesting is accounted for in the legal limits on water extractions as set out in the Murray–Darling Basin Agreement (the Cap), NSW water sharing plans (long-term average annual extraction limits) and the Basin Plan (sustainable diversion limits).

Floodplain harvesting in the Western region occurs within the Barwon–Darling Valley floodplain and accounts for an estimated 10-15% of the total amount of water taken from surface water resources on a long-term average in the region. The region's agricultural industries rely on water from floodplain harvesting take during wet periods to support existing and emerging industries. Similarly, the floodplains across the region rely on large flows to maintain floodplains and their dependent ecosystems.

There has been growth in floodplain harvesting across the Northern Basin over the last 20 years, with the amount of water being taken across all categories of water take now estimated to be greater than the limits set through some water sharing plans in a number of valleys. This growth in floodplain harvesting is largely historic, with 80% of growth in on-farm storages across the Northern Basin occurring prior to 2008.

The NSW Government is implementing the NSW Floodplain Harvesting Policy in the Northern Basin. Under the policy, floodplain harvesting will be licensed and managed within legal limits, providing business security and certainty while improving environmental and cultural outcomes. Floodplain harvesting is highly variable in nature and relies on wet conditions to create overland flows. In drier years, very little to no floodplain harvesting takes place. This means that connectivity benefits from floodplain harvesting reforms will occur during times where there are medium to high flows rather than during periods where there is low to no flow in the river. The reforms may provide both longitudinal and lateral connectivity benefits in the region.

Additional modelling is being undertaken to understand the combined impact of floodplain harvesting policy implementation on Barwon–Darling flows from upstream catchments and will be published in late 2022 in tandem with the roll out of floodplain harvesting licensing reforms.

Accelerate the program to remediate unapproved floodwork structures and enable water to flow across landscapes more easily

Structures in the floodplain can block and/or significantly alter the natural flow of water across the floodplain. Disconnection of these natural flow paths has negative impacts on ecological and cultural assets within and between river valleys.

The Department of Planning and Environment – Water has identified 110 priority areas (hotspots) in the Northern Basin where unapproved floodworks may be impeding flows. Identifying these unapproved works is a first step to removing or modifying them, which will improve lateral connectivity and water security, and help to protect flood-dependent environmental and cultural assets and values. The accelerated compliance program to address unauthorised works in these hot spot areas is known as the *Improving Floodplain Connections Program* and will be rolled out over the next 2.5 years.

In addition to unapproved floodplain structures, removing other constraints (including policy, physical and operational barriers) that inhibit the delivery of water for the environment can improve the ecological outcomes of water management and support environmental objectives. The strategy proposes options to investigate and remove these constraints, with a focus on the lakes, floodplain wetland and channels of the Darling Anabranch, Lower Darling River and Barwon–Darling River.

Actions could include upgrading old infrastructure and levees, improving bridges and creek crossings, desilting channels and negotiating flood easements and infrastructure solutions with landholders.

Improve habitats for native species

The health and resilience of rivers and the ecosystems they support is directly linked to the condition of waterways and their floodplains. Conserving remnant biodiversity and restoring degraded riverine and wetland ecosystems can strengthen their long-term resilience and improve the ecological response from environmental watering.

Land use changes and land clearing for urban and agricultural development have had detrimental impacts on the health of the rivers throughout the region. Water now moves more quickly and with more energy through the catchment, eroding land and waterways, reducing water quality and leading to less water being stored in the landscape.

Options are available to build on existing actions designed to improve habitats for native species. A suite of complementary options is included in this strategy for restoring riparian habitat and re-establishing threatened fish species. These options would also focus on engaging local landholders and building the skills and sharing the knowledge of landholders, community groups and Aboriginal people. This suite of options is being considered through the Better Baaka Program (see Box 1).

Change the management of Menindee Lakes

The Menindee Lakes storage is owned and operated by NSW in accordance with the Murray–Darling Basin Agreement. This agreement allows the Murray–Darling Basin Authority to use the water held within the lakes as part of the shared resource of the River Murray System when the volume is above 640 GL, until it next falls below 480 GL. Some of the water within the Menindee Lakes system is considered 'dead storage'[51] and cannot be accessed for release.

The lakes are an important ecological site and low storage volumes can have a negative impact on water quality and fish populations. We have heard from a range of stakeholders that the operation of Menindee Lakes needs to change to reflect the reduction in inflows to the lakes over the last 20 years. In particular, the dead storage in Menindee Lakes should be considered when managing water in the lakes. This will ensure a better reserve of water to meet critical needs in the Lower Darling.

Four councils in the region have also suggested the Menindee Lakes be listed under the Ramsar Convention on Wetlands of International Importance. The councils' view is that listing the Menindee Lakes as a Ramsar wetland site will help to protect the lakes' natural systems and ecological character. It would also provide additional ecotourism opportunities for the region.

These options have been included in the draft strategy. If these options are shortlisted, progressing them will require negotiation with other Basin states.

Better protect groundwater dependent ecosystems

Better protecting unique and highly vulnerable groundwater dependent ecosystems is a key challenge for the region. The Draft Western Regional Water Strategy provides an opportunity to explore options to advance our knowledge, management and protection of these ecosystems.

The Great Artesian Basin Springs Project is collecting hydrogeological and ecological data about springs fed by deep groundwater sources to develop a baseline dataset that will allow scientists to monitor changes over time and better manage the Great Artesian Basin. This will contribute to our knowledge on groundwater and dependent ecosystems in the Basin; however more data and information is needed on groundwater sources, processes, risks and impacts.

Actions taken through the strategy could include reviewing our monitoring and evaluation of groundwater dependent ecosystems, developing educational materials for water users and the wider community, establishing watering requirements for each type of groundwater dependent ecosystem and updating relevant policies and guidelines around managing, assessing and protecting these vital and sensitive ecosystems.

51. Dead storage is the volume of water in a storage that cannot be accessed under normal operating conditions (for example, the volume of water below a low-level outlet).

Options to protect and enhance natural systems

- Government commitment 2. Fully implement the NSW Floodplain Harvesting Reforms in the Barwon–Darling Valley
- Government commitment 3. Implement fish-friendly water extraction
- Government commitment 4. Improving floodplain connections: modifying or removing floodwork structures causing adverse impacts
- Option 23. Remediate fish passage
- Option 24. Restore riparian habitat and re-establish threatened fish species
- Option 25. Remove constraints to enable flows to reach important ecological sites
- Option 26. Improve protection of groundwater dependent ecosystems
- Option 27. Consider listing the Menindee Lakes under the Ramsar Convention on Wetlands of International Importance
- Option 28. Develop and implement technology to create fish refuges
- Option 29. Recognition of Queensland gifted water.

These options are described in Attachment B.

Other options on the long list for the draft strategy, including changing the operations of the Menindee Lakes. Implementing the North-West Flow Plan and improving water quality, may also contribute to supporting and protecting the environment and natural systems in the Western region.

Image courtesy of Destination NSW. Barwon River, Brewarrina.

Managing the impacts of poor water quality

The ability for communities, ecosystems and industries to use water is closely linked to the quality of that water. We have heard from a range of stakeholders that improving water quality is just as important as making sure there is water in the river.

Actions underway to manage water quality

Water quality is managed through several legislative and regulatory instruments and agencies.

The NSW Government has adopted the National Water Quality Management Strategy[52] as its policy to manage the quality of waterways in NSW. The strategy includes guidelines to support state and local governments, water authorities and industry to maintain and improve water quality according to local community environmental values and uses.

Water quality management plans have been prepared for the Barwon–Darling, Intersecting Streams and Murray and Lower Darling rivers as part of the relevant water resource plans. Water sharing plans also manage water quality in the Western region by using flow-based rules – such as extraction limits, protection of tributary flows and cease-to-pump rules – to help ensure enough flow is available to contribute to meeting water quality objectives and targets.

Additional rules are available through the approval and licensing framework, including ensuring set back distances from river banks and beds, and construction standards for bores that are enforced to limit groundwater drawdown and minimise the likelihood of increased salinity.

Five salt interception schemes are in place to help manage the ongoing issue of salinity from groundwater systems in NSW. This includes the Upper Darling Salt Interception Scheme south-west of Bourke, which was completed in 2012. In 2019/20, over 33,000 tonnes of salt was diverted from the river.[53]

What other options could we consider?

Additional options are being considered through the Western Regional Water Strategy to improve water quality. These options recognise that the quality of surface water and groundwater systems is directly affected by the land use and land management practices in surrounding catchments.

Consider broadscale, long-term catchment management and better integrate land use and water management

A region-wide approach is likely to be the most effective long-term solution to improving water quality in the catchment. The Western Regional Water Strategy offers the opportunity to consider a broadscale river and catchment recovery program that could include riparian restoration activities such as revegetation and fencing, works to remediate gully and watercourse erosion, stewardships and improved agronomic practices. The program could also build skills and share knowledge around catchment and landscape management.

The strategy also lists an option to investigate how to better integrate the NSW land use planning and water management frameworks. This could include assessing current land uses and land use trends in the Western region to identify spatial changes in industry water demand and potential pollution risks.

These options would need to build on existing programs, extending them to support and protect water resources on a region-wide and long-term basis.

52. www.waterquality.gov.au/guidelines
53. Murray–Darling Basin Authority 2019, *Murray Darling Basin – Basin Salinity Management 2030: 2019–20 Status report*, accessed from www.mdba.gov.au/publications/mdba-reports/basin-salinity-management-2030

Fill monitoring, modelling and research gaps

We have heard from different stakeholders about the need to undertake additional monitoring and address gaps in water quality monitoring. The Department of Planning and Environment has reviewed the current hydrometric monitoring network to understand the gaps in the network in terms of monitoring water quality. This review has informed the options presented in the draft strategy.

An existing network of dissolved oxygen and electrical conductivity sensors is installed at selected gauging stations on the Barwon–Darling River. These sensors give a good indication of dissolved oxygen and conductivity levels when the rivers are flowing and the water column is well mixed. However, the sensors do not provide information on how these levels vary at other times. Further monitoring at various depths would give a better measure of pool behaviour during low-and no-flow periods and guide appropriate management responses.

Conducting further gap analysis of surface water and groundwater quality information would identify where additional action is needed. Consideration could be given to undertaking further research around sources of pollution in the region, increasing the scope and responsibility of industries to collect groundwater quality data and establishing a more extensive remote water quality monitoring array to improve identification of emerging risks to water quality.

Review water sharing rules

There is a 30 GL environmental water allowance in the Lower Darling for managing water quality issues (triggered by high alert for blue-green algae). Currently, the Lower Darling Allowance can only be used when conditions are relatively wet and the operation of Menindee Lakes is under Murray–Darling Basin Authority control. However, water quality issues often arise in drier conditions when the lakes are at lower levels. This allowance has not been used since the start of the water sharing plan in 2004, mainly due to water not being available when water quality conditions trigger the need for its use. The draft regional water strategy includes an option to review this rule so the Lower Darling Allowance can be better used when at times when there is a high risk of water quality issues occurring.

Options to manage the impacts of poor water quality

- Option 30. Review the environmental water allowance rule for the Lower Darling Water Source
- Option 31. Investigate the costs and benefits of a river and catchment recovery program
- Option 32. Better integrate strategic planning for land use and water management
- Option 33. Analyse gaps in water quality research and modelling
- Option 34. Collect water quality data in the Lower Darling
- Option 35. Manage groundwater salinity.

These options are described in Attachment B.

Making water information more accessible and meaningful

To better understand current and future water issues, we need quality information and data that is useful and meaningful for all water users and managers.

Improving the information we have, and making this available so decisions are based on the best available evidence, is critical to making good investment and business decisions, undertaking good drought security planning and improving our ability to identify and mitigate ecosystem risks. Better information is essential to supporting sustainable water management and effective water sharing rules and is one of the tools we can use to be better prepared for the future.

Actions underway to improve our understanding of water

The NSW Government is taking action to improve our understanding of water and water take in the Western region.

River and groundwater monitoring networks

A network of 54 river flow gauges continuously records streamflow in the Barwon–Darling, Lower Darling and Intersecting Streams. This data is available to the public through Water NSW's Real Time Water Data website.

In 2021, NSW undertook a review of its river gauge and groundwater bore network as part of the Murray–Darling Basin Compliance Compact.[54, 55] The Hydrometric Network Review looked at the coverage and data quality obtained from the existing gauge network and identified ways to improve the information collected. Together with the Australian Government, NSW is installing up to 20 new gauge sites over 3 years in the NSW Northern Murray–Darling Basin, which will make our data collection and network more robust.

Accurately measuring water take

The Western region has some watercourses where streamflow gauges have not been installed and water extraction is not measured. This means there is less data available about water extraction and flow patterns, making it difficult to manage equitable sharing during dry conditions. This data gap is being addressed through the implementation of the non-urban metering framework.

The non-urban metering reforms require licensed water users to install tamper proof meters to monitor their take. The Western region leads the state in complying with the new metering rules: nearly 90% of water users are fully compliant with the rules and a majority of the remaining water users have compliant meters but are still to connect to telemetry.

The data from the metering and telemetry network will assist the Natural Resources Access Regulator, WaterNSW and the Department of Planning and Environment to undertake compliance and enforcement. It will also better enable billing, water planning and allocation decisions, and other water management activities. Water users will also be able to access their water use data via a private online dashboard.

54. In 2018, the Basin states and the Australian Government entered into an agreement called the Murray–Darling Basin Compliance Compact, which sought to 'restore public confidence in water resource management in the Basin by increasing transparency and accountability of surface and ground water management and regulation across the Basin.' For more information see, www.mdba.gov.au/sites/default/files/pubs/Basin-Compliance-Compact-12-December-2018.pdf
55. www.industry.nsw.gov.au/water/science/data/hydrometric-network-review

What other options could we consider?

This draft strategy includes options to make climate information more accessible and understandable, share knowledge and information about water use and needs, improve the participation of local Aboriginal people in water management and invest in technologies, monitoring and modelling to fill knowledge gaps and make us better water planners, managers and users.

Better understand how water is used

There are opportunities to gather more information about water use requirements and water user behaviour in the Western region. This includes the water requirements for Aboriginal cultural purposes, communities, industry (such as what the water is being used for, including crop types and yield values) and the environment (beyond the Long-Term Watering Plans that outline the region's environmental watering requirements).

Gathering and analysing this data would give us a more comprehensive and accurate dataset on water use in the Western region and changes in water user behaviour over time. It would improve our ability to identify existing or emerging water risks in the region for the environment and other water users. It would also support future decisions about water sharing and help us understand what a reduction in water availability may mean for different users and its implications for water quality.

Consider climate change in water management decision making

Water management planning relies heavily on access to good climate and hydrological information. Critical business and water management decisions are being made on information 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 clear indicator of the future. Our new climate data can improve our modelling and ability to forecast future water availability.

Not fully understanding the risks of future water availability can lead to poor investments, poor business decisions, poor drought security planning and loss of opportunities to invest in alternative, 'climate independent' water supplies. It also has implications for water quality and water-dependent habitats. Better understanding potential future climate scenarios will also improve our ability to identify, plan for and reduce ecosystem risks, as we face the potential for longer and more severe droughts that will increase the risk of debilitating ecosystem damage, fish deaths and severe blue-green algae outbreaks.

Build the capacity of communities to engage with water management

The draft strategy includes options to develop targeted education, learning and capacity building programs to build community confidence in water management in the Western region, help communities and industries to better manage their water needs and water-related risks, and help the department learn from communities about their water use, values and preferences. These programs could focus initially on the new climate data and modelling undertaken for the regional water strategies, the promotion of water efficient technologies and products, and how environmental water is managed in the intersecting streams.

The strategy includes an option to develop a culturally appropriate water knowledge program to increase the capacity of Aboriginal people across the region to participate more effectively in negotiations on water management and policy-related matters. The program could also provide ways to better incorporate Aboriginal knowledge and science in water management.

Improve public access to and understanding of climate information and water availability forecasts

To complement community education and capacity building programs, NSW needs to consider how best to publicly share data and what data analytics and information products are needed for different types of water users.

All parts of the community and government need access to reliable, clear and timely information to make informed decisions and participate effectively in water planning. Information on short-and longer-term climate conditions supports year-to-year tactical decisions on crop production levels, town water restrictions and environmental watering. Climate outlooks may also impact decision making and water allocations over the next 12 months.

The *NSW Future Ready Regions Strategy* recognises that providing clear and accessible information on surface water and groundwater availability allows industries to forward plan with certainty. Clear climate information will also support environmental water managers in planning and using their water portfolios. This data is often not accessible or available to water users in a format that is readily understood and useful to their needs or preferences. This can result in less optimal business decisions, particularly during drought periods. While the delivery 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 the regional water strategies is the first step in providing more information to water users on the future risks to water availability; however, tailoring the application of this data for communities and industry is likely to deliver the greatest benefits.

The strategy also considers the design and delivery of suitable training, and information products and platforms that will build on or complement existing state and national information platforms and products, including the Water Insights and Water Information Dashboards.

Improve our understanding of groundwater

Gaps in information on groundwater resources are a risk to drought security, as groundwater is often the backup water supply for towns and communities in drought.

Given the expected continuing demands on groundwater, enhancing our understanding of the interaction between surface water and groundwater resources in the Western region will help to improve our management of connected water sources. We need to understand where a change in groundwater use can influence flows to rivers and vice versa. We also need to understand how a changing climate is affecting the replenishment of groundwater resources. More broadly, we need to ensure ongoing investment in the groundwater monitoring network and sampling programs, so we have the water quantity and quality information we need to manage the resource into the future.

Options to make water information more accessible and meaningful

- Option 36. Better understand water use through data collection and analytics
- Option 37. Develop water education and capacity building programs
- Option 38. Develop a culturally appropriate water knowledge program
- Option 39. Improve understanding of groundwater sources
- Option 40. Improve information about the impacts of state significant developments and state significant infrastructure on water
- Option 41. Review the allocation and accounting framework for surface water
- Option 42. Review water markets and trade
- Option 43. Improve cross-border management of flows.

These options are described in Attachment B.

Image courtesy of John Spencer, Department of Planning and Environment. Darling River, Kinchega National Park.

Improving connectivity across the Northern Basin

Water flowing across connected catchments supports essential human and ecological needs in the Barwon Darling River and Lower Darling River. We are consulting on whether there are policy, infrastructure or rule changes we could progress that could improve overall water sharing outcomes in Northern Basin catchments.

The Northern Basin comprises of 6 NSW valleys (Border Rivers, Gwydir, Namoi, Macquarie–Waambul and the Intersecting Streams valleys) as well as a range of Queensland rivers that connect with the Barwon–Darling River at various locations along its length.

Options that seek to improve flows need to be targeted and realistic. Our data tells us that there have always been extreme dry conditions and periods of no flow in the Barwon–Darling. It is not possible through management to maintain a constantly flowing river and we have limited ability to break up drought induced extended cease-to-flow periods. As such, the options in this draft strategy focus on enabling water to flow across connected river valleys and downstream at important times for specific achievable outcomes.

Importantly, these options are not intended to:

- reduce the overall amount of water being taken out of rivers, consistent with the sustainable diversion limits set by the Basin Plan
- move productive use of water from one valley to another, nor from the northern to the southern basin
- secure connectivity between groundwater and surface water.

Ultimately any rules or infrastructure changes that aim to improve connectivity need to be based on agreed objectives and will require no net reduction in planned environmental water to meet obligations under the Basin Plan. Changes that significantly affect the amount of water available to licence holders may involve paying compensation.

Image courtesy of Wentworth Shire Council. Lower Darling River at Wentworth.

What has the NSW Government already done to improve connectivity flows in the Barwon–Darling?

Since the introduction of the Murray–Darling Basin Plan in 2012, over 2,000 GL/year of surface water has been recovered for the environment across the Murray–Darling Basin, with over 460 GL of this recovery coming from the Northern Basin in QLD and NSW.[56] This recovered water is managed in partnership between the NSW and Commonwealth Environmental Water Holders to achieve environmental outcomes. In doing so, it also helps to improve connectivity within and between systems.

The NSW Government has undertaken other reforms to improve flows along the Barwon–Darling River system. In 2020 the NSW Government made a range of changes to the Barwon–Darling water sharing plan to improve connectivity. These changes included:

- **raising the threshold at which A-class licence holders in the Barwon–Darling River can access water** – this protects low flows, supporting the water needs of basic landholder rights and resulting in more water being left in the river to flow downstream
- **establishing individual daily extraction components (IDECs)** – these establish a daily extraction limit for water licence holders, to manage the amount of water that can be taken out of the river during peak irrigation periods
- **a 'Resumption of Flows' rule** – this protects flows in the Barwon–Darling River after an extended dry period for cultural and local community outcomes
- **protecting licensed environmental water from extraction as it moves though the Barwon–Darling (active management)** – when held environmental water is in the river, commence-to-pump heights are raised to allow the held environmental water to remain instream to deliver its intended environmental outcome.

Through the modelling undertaken to date, we anticipate that these changes will help reduce the number of shorter low-flow and cease-to-flow periods on a long-term basis (see Figures 37 and Figure 38). The benefits are likely to culminate at Bourke and then reduce further downstream.

In addition to these 2020 rules, existing rules in water sharing plans support connectivity with varying levels of effectiveness.[57] These include:

- class B and C licence pumping thresholds along the Barwon–Darling
- end-of-system flow rules in the Namoi and Border Rivers catchments (which require a flow to be retained at the end of the river system below the areas of major extraction under various conditions)
- rules around sharing supplementary flows in the northern regulated river catchments.

56. www.mdba.gov.au/progress-water-recovery
57. See *stocktake of Northern Basin connectivity rules* – analysis of implementation and effectiveness available at, www.industry.nsw.gov.au/water/environmental-water-hub/outcomes

Figure 37. Modelled number of cease-to -flow events that would occur in the Barwon–Darling River with and without the 2020 water sharing plan rule changes in a repeat of the 1895-2020 climate (averaged across Bourke, Brewarrina and Wilcannia gauges)[58]

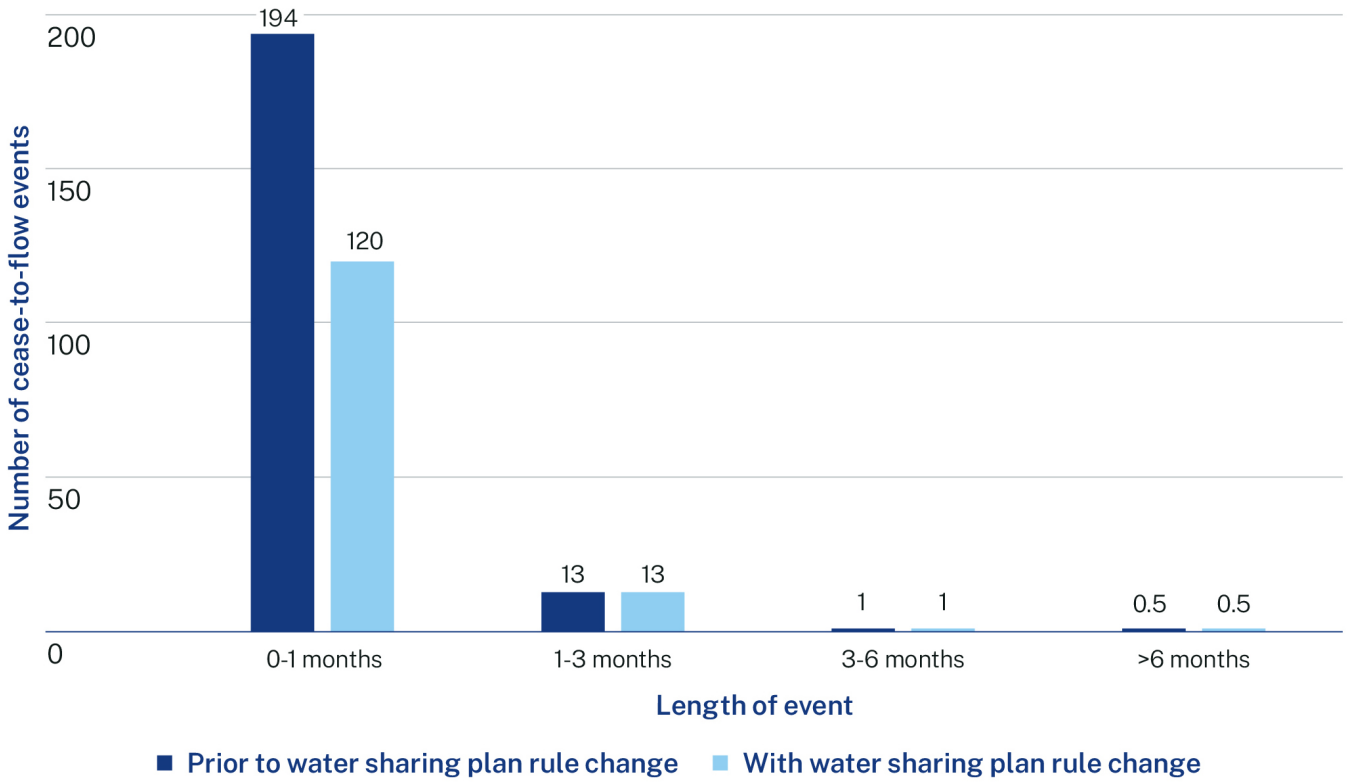
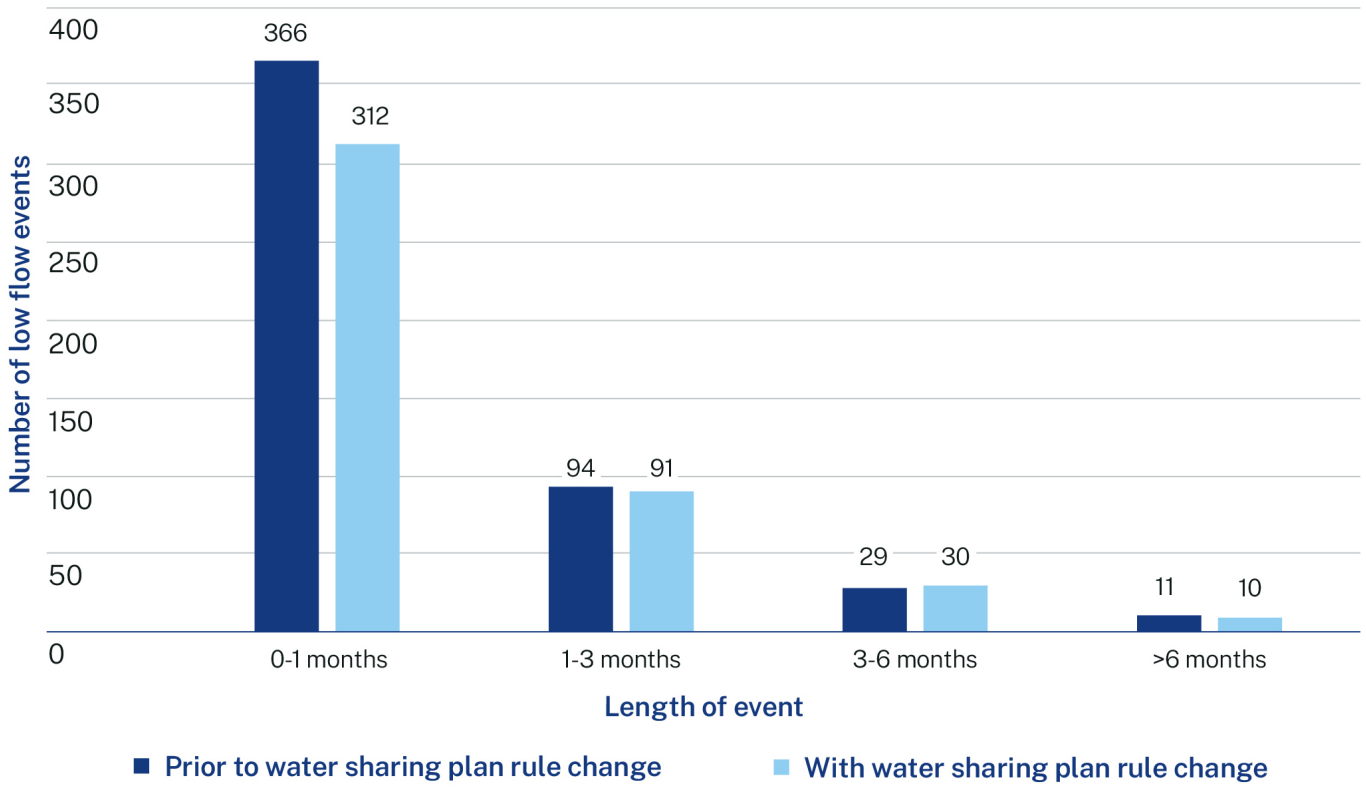


Figure 38. Modelled number of low-flow events in the Barwon–Darling River with and without the 2020 water sharing plan rule changes in a repeat of the 1895-2020 climate (averaged across Bourke, Brewarrina and Wilcannia gauges)

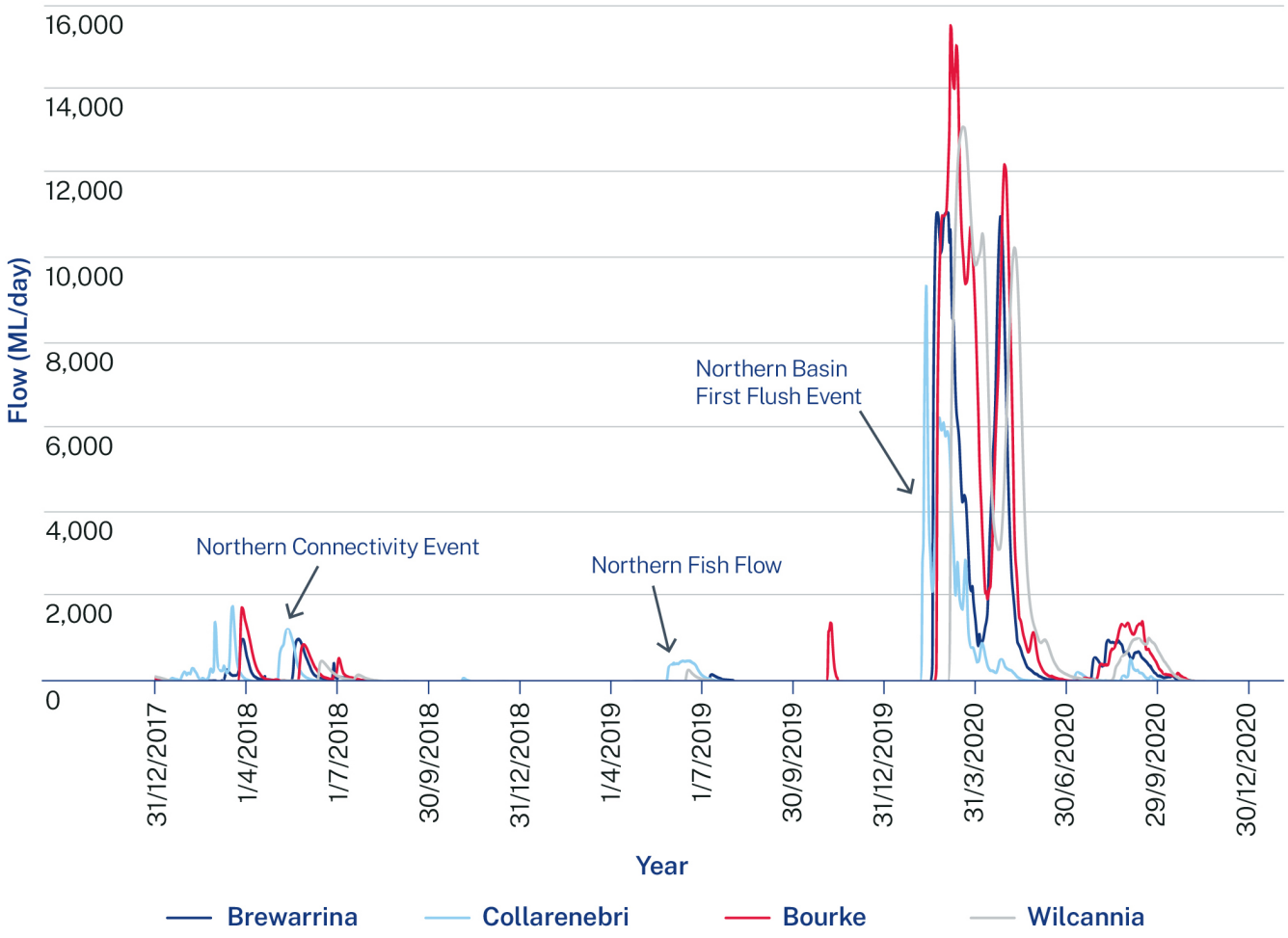


58. Model outputs and data used to create Figure 37 and 38 are available at datasets.seed.nsw.gov.au/dataset

Four managed connectivity events in the Barwon–Darling were delivered between 2018 and 2021 using water held for the environment combined with temporary restrictions on water users in the Northern Basin (under section 324 of the *Water Management Act 2000*). These measures were exceptional events, being the only time the rivers connected between 2017 and early 2020, demonstrating the significant outcomes that can be achieved through event-based management during an extreme drought. Figure 39 shows the flows from 3 of these connectivity events in the Barwon Darling.

Environmental water is not usually used for this purpose and the connectivity events relied on the flexibility of environmental water holders to redirect it for this purpose. Using water held for the environment for managed connectivity events remains an option going forward however the arrangements need to be determined in advance, so that benefits and risks can be more evenly shared.

Figure 39. Recent connectivity events in the Barwon–Darling River



Providing connectivity flows across the Northern Basin

Four managed connectivity flows between 2018 and 2021 using water saved for the environment in accounts, held environmental water, temporary water restrictions and natural flows helped to meet environmental demands during dry periods and provide connectivity across the Northern Basin. The ability to access unused water carried over from previous years is critical to meeting environmental demands in a variable climate, particularly in dry years where environmental damage can occur. Without these flows from environmental water accounts, many refuge pools would have dried up placing even greater impacts on already stressed systems.

The 4 events were:

- Northern Connectivity Event – From April 2018, Commonwealth and NSW environmental water holders released water from Copeton Dam (18.9 GL) and Glenlyon Dam (4.3 GL) in the Border Rivers. The releases aimed to support the environmental health of aquatic ecosystems, including the Gwydir Wetlands, and provide connecting flows into the Barwon–Darling River. The release flowed down the Gwydir and Mehi rivers and into the Barwon–Darling River and when combined with some small natural inflows, reached Wilcannia, with a small volume entering Menindee Lakes by June 2018.
- Northern Fish Flow Event – In April 2019 another release of environmental water was made (26 GL from Copeton Dam and 7.4 GL from Glenlyon Dam). However, the flows only reached just upstream of Bourke along the Barwon–Darling River because of the dry conditions.
- The 2020 Northern Basin First Flush Event – This event involved protecting significant inflows, from extensive rainfall, in early 2020 along the length of the Northern Basin and into Menindee Lakes by restricting commercial access. By the end of June 2020 more than 583 GL of inflows reached Menindee Lakes, with releases re-starting into the Lower Darling River by late March 2020.
- Northern Water Hole Top-Up Event – In late December 2020, 5.1 GL of Commonwealth environmental water in the Gwydir and 2.9 GL from the Border Rivers was released from Copeton and Pindari dams to top up in-channel refugia to help native fish survive by improving water quality in waterholes that were again drying. The flow started to reach the Barwon–Darling in early 2021. Early plans focused on the section from Mungindi to Walgett (around 230 km); however, with additional unregulated flows, water reached Menindee Lakes. Water monitoring was undertaken by the University of New England prior to and during the Northern Waterhole Top-Up. It showed overall improvements to water quality, including increased dissolved oxygen levels as water levels rose.

Objectives for connectivity

Our initial review based on experience of recent years and the views of stakeholders, suggests that focussing connectivity improvements on the following objectives will most likely provide the most benefit in addressing the challenges for Western region communities and ecosystems:

- **Reduce the impact of cease-to-flow periods and improve low flow connectivity.** While addressing this will be challenging, this is an area of great impact and importance to communities and the environment. Significant changes to infrastructure or water sharing arrangements may go some way to improving low flow connectivity. However, before this objective is progressed, we first need to focus on building the evidence base to understand what specific low flow connectivity objectives we need to aim for.
- **Continue protection of the first flush of water after an extended drought**. This is needed to protect critical human and environmental needs and support recovery post droughts.
- **Suppress algal blooms**. Algal blooms in the Barwon–Darling continue to be a persistent and priority challenge for towns, the environment and industry.
- **Support fish migration**. The Barwon–Darling, Lower Darling and Menindee Lakes System is the most ecologically important fish movement corridor in the Basin.

We would be interested in your views on whether these are appropriate connectivity objectives to progress in the Western region.

Options to improve connectivity

All options will be considered, but not all will be progressed. It is important to analyse how each of these options will address connectivity issues, how they will perform across different water management scenarios (including under a drier climate scenario) and the costs and benefits of each option.

Options for investigation are:

- **Guidelines on protection of the first flush of water after a dry period:**

  To provide clarity and certainty around when temporary water restrictions will be implemented to protect critical human and environmental needs. Further information is below.

- **Changing the timing of access for lower priority licences:**

  Investigating whether adjusting the timing of when water is taken by supplementary, B and C class licences can help improve connectivity at certain times. Further information is below.

- **Implementing the Western Weirs and Better Baaka Program to assist flows along the river:**

  Through the Better Baaka Program there are a number of town water supply weirs the government is considering upgrading to improve fish passage, as well as considering whether to remove 11 non-town weirs. If some or all of the non-town weirs are removed, this may help water flow throughout the Barwon–Darling River system and support fish movement up and down the river. Removing or modifying these weirs would need to be accompanied by additional measures to help provide water for the landholders that rely on these weirs. This could include access to groundwater.

- **Making 6 of the 7 Intersecting Streams free-flowing:**

  Through the Better Baaka Program, Water Infrastructure NSW is consulting with stakeholders and the community on the opportunity to secure 15 GL of water licences in the Intersecting Streams. This proposal could help to improve connectivity in the Intersecting Streams, and secure adequate flows to support environmental outcomes.

- **Considering the need to amend B and C class licences** in the Barwon–Darling. In 2019, the Natural Resources Commission reviewed the Water Sharing Plan for the *Barwon–Darling Unregulated and Alluvial Water Source (2012)* and recommended a review of flow class thresholds for the Barwon–Darling. The NSW Government has agreed to undertake this review, which will consider if the B and C class licence thresholds are fit for purpose.

- **Exploring options to increase dam reserves**, change end-of-system flows in the northern tributaries or work with environmental water holders to deliver water to the Barwon–Darling.

- **Better protect a range of flows** in achieving environmental outcomes under a changing climate.

- Investigating the feasibility of reconfiguring river operations and creating or upgrading infrastructure **to allow the Barwon–Darling to be a regulated system.**

- **Formalising arrangements** to deliver water from Lake Cawndilla to the Murray River via the Great Darling Anabranch.

- **Review the way the Lakes are operated** and investigate ways to increase the volume of water that is accessible for local and downstream communities when the Lakes return to NSW control. This will ensure a better reserve of water to meet critical needs in the Lower Darling.

Every option is likely to have positive and negative impacts for water users, communities and the environment. In developing options, we need to identify ways these impacts can be mitigated or offset.

We need to gather evidence through hydrological modelling, ecological and Aboriginal cultural heritage analyses, and consultation with the community to understand these trade-offs before committing to or shortlisting some of these broader long-term reform proposals.

Options to improve connectivity across the Northern Basin

- Government commitment 5. Review the North-West Unregulated Flow Plan rules
- Government commitment 6. Develop critical dry targets for the Barwon–Darling River
- Option 44. Modify and remove non-town weirs
- Option 45: Making 6 of the 7 Intersecting Streams free-flowing
- Option 46. Deliver replenishment flows from the Border Rivers, Gwydir, Namoi and Macquarie valleys
- Option 47. Review cease-to-pump flow-class thresholds
- Option 48. Regulate the Barwon–Darling River
- Option 49. Better protect a range of flows under a changing climate
- Option 50: Deliver water down the Great Darling Anabranch
- Option 51. Develop sustainable total daily extraction limits for the Barwon Darling Water Sharing Plan
- Option 52. Review how the Menindee Lakes are operated.

These options are described in Attachment B.

Guidelines on protection of the first flush of water after a dry period

Under Section 324 (s324) of the *Water Management Act 2000*, the Minister for Water has the power to prohibit water being taken from rivers and groundwater sources. These temporary water restrictions are put in place if it is in the public interest; for example, if it is necessary to manage a water shortage, threat to public health or safety, or to manage water for environmental purposes. The restrictions are designed to protect critical water supplies and water quality during extreme events. They are not intended to meet normal water sharing arrangements.

In early 2020 the NSW Government imposed temporary water restrictions across the NSW Northern Basin on commercial access, including floodplain harvesting, to protect the first major rainfall and inflows after the last drought. The temporary water restrictions protected significant flows and allowed town weirs and refuge pools to be topped up along the northern river systems, the Barwon–Darling River and into Menindee Lakes providing important social, cultural, and ecological outcomes.

An independent review[59] recommended that the department publish triggers to provide guidance about when temporary water restrictions will be implemented after a prolonged dry period to improve transparency and certainty. The review also recommended that the triggers applied for lifting the restrictions should be reviewed.

As a result, the Department of Planning and Environment is using the best available science to clarify when critical dry conditions could trigger temporary water restrictions for critical human and environmental needs. These triggers could be implemented whenever the conditions are met and are a short-term measure to support connectivity following a dry period.

The proposed triggers for protecting critical human and environmental needs are in Table 8 below with further detail on how these triggers were developed in Attachment E. For critical human needs we have considered the water needs for towns, domestic and stock and basic landholder rights. For critical dry environment needs we have looked at the thresholds at which a deterioration in refuge pool conditions could lead to an increased risk of unacceptable damage to environmental assets. These thresholds are the points when timely intervention may prevent damage altogether.

The critical dry environmental triggers are based on the MDBA guidelines for the maximum cease-to-flow durations that would naturally occur at Bourke and Wilcannia.[60] We are currently looking at developing other ways to identify critical thresholds including active monitoring of refuge pools once flows have ceased. If this is a viable approach, locations other than Bourke and Wilcannia could be identified where critical conditions will be monitored to increase our understanding of outcomes to inform future management options.

Temporary water restrictions are designed to protect inflows to critical water supplies and water quality during unexpected extreme events. They are not intended to be used routinely on an ongoing basis. We heard from a range of different stakeholders that temporary water restrictions should not be relied upon as they do not provide certainty for water users, and they are at the discretion of government decision makers. Instead, most stakeholders prefer these types of restrictions to be implemented through legislative instruments such as water sharing plan rules. This could be done in the future once the guidelines have been finalised.

Further information is available in the Critical dry condition triggers to reduce risk to environmental and human water needs Discussion Paper (Attachment E).

59. www.industry.nsw.gov.au/water/allocations-availability/northern-basin-first-flush-assessment
60. MDBA 2018, *Ecological needs of lows flows in the Barwon–Darling: Technical Report* (PDF 3.32 MB), www.mdba.gov.au/sites/default/files/pubs/ecological-needs-low-flows-barwon-darling.pdf

Table 8. Proposed critical dry conditions triggers

Proposed trigger for implementing temporary water restriction	Proposed trigger for lifting temporary water restriction
When there is a high confidence forecast cease-to-flow period of 120 days at Wilcannia (20 ML/day at Darling River at Wilcannia 425008).	Forecast 400 ML/day for 10 days (or 4,000 ML).
When there is a high confidence forecast cease-to-flow for 60 days at Bourke (0 ML/day at Darling River at Bourke 425003).	Forecast 972 ML/day for 10 days (or 9,720 ML).
Menindee Lakes storage[61] forecast to fall below 195 GL capacity.[62] Once this trigger is reached there would be no releases beyond the minimum flow requirements from lakes Wetherell, Pamamaroo Menindee, Cawndilla and Tandure.	If releases have ceased below the Menindee Lakes, restrictions would not be lifted until the Lakes were forecast to have enough water to provide up to 12 months supply for human needs and allow the river to be restarted in a way that reduces the risk to water quality issues downstream and fish deaths. This will depend on conditions at the time and any operating constraints. For example: • if the Lower Darling river hasn't ceased to flow, triggers could be lifted once the Lakes are above 195 GL • if the Lower Darling River has ceased to flow, additional water above the 195 GL, such as 60 GL, may be required to restart the river[63] • if evaporation rates are extreme and operational constraints require water to be held in inefficient lakes, more water will be required in the Lakes before the restrictions can be lifted. The trigger for lifting restrictions may need further refinement following consultation.
All or most of the northern valleys and/or Barwon–Darling River system are classified as Drought Stage 4 criticality under the Department's drought stages, and/or Cease-to-flow for 30 days or more extended periods for any of the following locations:[64] • Border Rivers – Macintyre at Goondiwindi (416201A) • Gwydir River – Mehi at Moree (418002) • Macquarie – below Warren Weir (421004) • Namoi – below Mollee Weir (419039).	Resumption of flow targets for the Northern tributaries such as: • Border Rivers – Macintyre at Goondiwindi – 3,600 ML over 7 days • Gwydir River – Mehi at Moree – 3,600 ML over 7 days • Macquarie – below Warren Weir – 21,000 over 7 days • Namoi – below Mollee Weir – 8,000 ML over 7 days.[65]

61. Menindee Lakes Storage has the same meaning as it does under the Murray–Darling Basin Agreement
62. A 195 GL floodplain harvesting restriction is also being proposed which would be eased when local valley targets are forecast to be met
63. A 60 GL Lower Darling River flow restart allowance has been proposed to be included in the water sharing plan for the Lower Darling
64. Locations and cease-to-flow period to be determined following feedback from consultation
65. The northern valley triggers are interim proposals and linked to when the regulated valleys are in Drought Stage 4. We will continue to research the most appropriate trigger locations and durations.

Changing the timing of access for lower priority licences

Access to water under supplementary licences is already limited to times defined by water sharing plan rules. Some of these rules aim to restrict supplementary licence take in upstream valleys when specific downstream targets have not been met. These targets aim to support critical human needs, improve water quality and support fish passage. These rules were based on the North-West Flow Plan and have been in water sharing plan rules since 2004. However, they have not been implemented due to challenges in forecasting flows and operationally implementing the triggers.

The Department has been reviewing the flow targets in the North-West Flow Plan in the context of contemporary understanding of the ecohydrology of the Barwon–Darling system and the contemporary science documented in the Barwon–Darling Long Term Watering Plan. Further detail about the North-West Flow Plan and the review is available in Attachment D – North-West Flow Plan Discussion Paper.

The fish passage targets in the North-West Flow Plan were designed to deliver water down the Barwon–Darling to overtop the fixed-crested weirs to allow fish to move around these structures. The need for these flow rates may be different in a river with fishways on weirs and fewer weirs, which is being explored through the Better Baaka Program.

Moving forward, we propose to investigate updated rules and operational decisions that could better achieve the proposed connectivity objectives and are more feasible to implement than the existing North-West Flow Plan rules. In our investigations, we will also consider ways to preserve economic outcomes. This includes looking at ways to adjust the timing of access to take water so that less access at one time is offset by more access at another time, noting this may require arrangements for farmers to store greater volumes of water on-farm. Any proposal to amend the timing of access would also have to ensure it is not unnecessarily restricted when the flow event is unlikely to travel far enough down river to achieve the intended targets.

In addition to supplementary licences on regulated rivers, these rules would extend to floodplain harvesting licences and B and C class licences on the Barwon–Darling.

Draft triggers for restrictions are presented in Table 9. These were developed based on the review of the North-West Flow Plan, the latest scientific assessments and consultation with targeted stakeholders.[66]

We would like your feedback on the best arrangement of implementing these targets, as the initial modelling suggests that while restrictions are best placed to deliver fish migration targets, and the higher algal suppression targets, low flow targets may be more effective when achieved through general security Held Environmental Water (HEW) releases. The *Stocktake of Northern Basin Connectivity Rules – Analysis of Implementation and Effectiveness*[67] concluded exploring held environmental water releases would be a more productive use of time than exploring additional restrictions to access because it is subject to less uncertainty around forecasting.

66. The Alluvium Consulting review report can be found at, www.industry.nsw.gov.au/water/environmental-water-hub/working-on/north-west-flow-plan, Information on the Stocktake of Northern Basin Connectivity Rules – Analysis of Implementation and Effectiveness can be found at: www.industry.nsw.gov.au/water/environmental-water-hub/outcomes Information on the Connectivity Stakeholder Reference Panel can be found at: www.industry.nsw.gov.au/water/what-we-do/stakeholder-engagement/connectivity#:~:text=The%20Connectivity%20Stakeholder%20Reference%20Group,proposed%20approach%20to%20river%20connectivity
67. Available at, www.industry.nsw.gov.au/__data/assets/pdf_file/0010/397909/analysis-of-implementation-and-effectiveness.pdf

Table 9. Proposed targets and triggers for restricting access to lower priority licences (Floodplain harvesting, supplementary and B and C class licences) to support flows at certain times downstream

Target	Trigger for restrictions
Menindee Lakes and Lower Darling Protect the first flush and support drought recovery.	Restrictions could be implemented if Menindee Lakes Storage[68] is forecast to fall below 195 GL. If releases have ceased below the Menindee Lakes, restrictions would not be lifted until the Lakes were forecast to have enough water to provide up to 12 months of water for human needs and allow the river to be restarted.
Northern Valleys Protect the first flush and support drought recovery.	Cease-to-flow for 30 days: • Border Rivers: below Goondiwindi Weir • Gwydir River: below Yarraman • Macquarie: below Warren Weir • Namoi: below Mollee Weir. Resumption of flow triggers are being developed for each of the Northern tributaries for lifting restrictions.
Algal suppression Preserve a flushing flow event to break up and disperse algal blooms.	To achieve a flow of 3,000 ML/day for 7 days at Wilcannia if flows are below the following triggers throughout the spring/summer period: a. Walgett – 250 ML/day b. Brewarrina – 510 ML/day c. Bourke – 450 ML/day d. Wilcannia – 350 ML/day.
Fish migration Preserve events needed for fish dispersal, spawning, and migration at appropriate times of the year.	Achieve the following: • Dispersal and condition: 15,000 ML/day for 15 days at Bourke between July and September • Spawning: 15,000 ML/day for 15 days at Bourke between October and April • Migration: 14,000 ML/day for 15 days at Brewarrina between October and April. These targets will be revised once fishways are installed.

68. Menindee Lakes Storage has the same meaning as it does under the Murray–Darling Basin Agreement

To scope the possible flow benefits in the Barwon–Darling that could be achieved by restrictions, we have undertaken an initial analysis to understand potential benefits and impacts (see Table 10). These results are based on applying restrictions using the triggers in Table 8, and assuming perfect flow forecasting capacity – this means only restricting upstream access in years when we know the resulting flows will meet the downstream targets. The potential impacts make no allowance for possible compensatory increases in access at other times, which have not yet been explored.

In summary, our analysis shows that restrictions on water access for supplementary and Barwon–Darling class licences which are modelled assuming perfect hindsight are:

- unlikely to reduce extended cease-to-flow periods because supplementary access is not announced during cease-to-flow periods
- likely to increase the number of times when there are flows downstream to help suppress algal blooms at Wilcannia
- likely to reduce the time Menindee Lakes falls below 195 GL, helping to preserve water for critical needs
- unlikely to have much effect on flows to support fish migration, because the restrictions have only a small effect on the larger flows needed for this target.

This analysis will need to be supplemented with further work to understand how these results translate to social, economic and cultural outcomes.

Table 10. Benefits and impacts of restricting access to supplementary and Barwon–Darling class licences under a perfect forecasting scenario

Need	Benefits	Potential Impacts[69]
Breaking up extended cease-to-flow periods	Unlikely to have an effect – water taken under supplementary and B and C class licences (and floodplain harvesting) does not occur during cease-to-flow periods.	
First flush	Reduction in the time Menindee Lakes is below 195 GL needed to meet downstream critical human and environmental needs from 6% (under current conditions) to 3%.	Initial estimate of potential change in overall water taken by licences: • Border Rivers: 1% reduction • Gwydir: 1% reduction • Namoi: 1% reduction • Macquarie: no change • Barwon–Darling: small reduction likely.
Algal suppression	Approximately 16 additional years over a 119-year period with at least one algal suppression event at Wilcannia which could help break up and disperse algal blooms.	Change in total long-term diversions: • Border Rivers: -4% • Gwydir: -3% • Namoi: -3% • Macquarie: no change • Barwon–Darling: small reduction likely • Average: -2.5%.
Fish migration	Approximately 5 additional years with at least one fish spawning and migration flow events over a 119-year period, and one additional year with a dispersal event.	

69. If these targets are progressed without ways to offset the impacts, the impacts on licence holders would likely be larger, as these impacts assume there is perfect forecasting knowledge which is beyond our current forecasting capability. With imperfect knowledge (or imperfect forecasting ability), a conservative approach to restrictions would be taken, which means restrictions are likely to be imposed more often in these circumstances when downstream flow targets are unlikely to be met. These forecasting challenges are planned to be further investigated.

The above initial analysis assumes restrictions apply only at certain times based on the triggers in Table 9 and presents overall changes in water taken. This analysis recognises that some of the reductions in supplementary access are offset by increases in general security use. The impacts will be highly variable, in most years there is likely to be minimal change however during wet years after dry periods we would expect to see a large effect as the rule restricts water take to deliver downstream outcomes. Impacts on supplementary access are more pronounced when:

- we assess impacts on supplementary licences without considering increases in general security use
- when considered on a year by year basis as opposed to a long-term average (see Table 11 and 12 below).

Table 11. Annual impacts – Net impacts in 2001/02 if supplementary licences were restricted to meet fish and algal targets based on a perfect forecast run

	Reduction in total diversions for 2001/02	Reduction in supplementary diversions in 2001/02
Namoi	0%	0%
Border Rivers	0%	-3%
Gwydir	-1%	1%

Table 12. Annual impacts – Net impacts in 2005/06 if supplementary licences were restricted to meet fish and algal targets when there were significant flows available following a dry period. General security carryover balances were progressively increased throughout 2005/06[70]

	Reduction in total diversions for 2005/06	Reduction in supplementary diversions in 2005/06
Namoi	-16%	-90%
Border Rivers	-10%	-93%
Gwydir	-11%	-71%

During drought years when there is no water available, or in very wet years the targeted restrictions are not required because there is either plenty of water or no water. The impacts of restrictions are felt the most in the occasional years in between the extreme wet and dry periods. When flows are available in the year after droughts there is often competition for these flows as they are important for communities, farmers and the environment. This underlines the need to ensure that there are rules in place to share these flows equitably.

The above tables demonstrate that including dry years in the impact assessment minimises the visibility of the impact on access during wet years. In addition, the large flows of water following dry years play an important role in both supporting environmental needs as well as sustaining industries through extended dry periods.

Some stakeholders have suggested completely removing all supplementary and Barwon–Darling take until flows are restored in the Lower Darling River. Our analysis demonstrates that blanket bans on supplementary licences are inefficient.

Completely removing supplementary and Barwon–Darling access would produce only marginal additional benefit in the Barwon–Darling from the above scenario where restrictions are limited to specific triggers. For example, completely restricting supplementary licences and B and C class licences would provide 2 additional fish spawning and migration flows and 10 additional years with algal suppression flow events over a 119-year period. These benefits would cause significant social and economic impacts across the Northern Basin. Given this, completely restricting all supplementary and Barwon–Darling take is not an option that will be considered as part of the strategy.

70. Further information on historical available water determinations is available at: www.industry.nsw.gov.au/water/allocations-availability/allocations/dashboard

There are specific years where restricting supplementary licences can help meet downstream needs, but restricting licences during these years, without alternative access rules outside of these windows, comes close to removing supplementary access completely in those years. In other years there is no impact on supplementary access opportunities. These rules are attempting to identify periods when high priority access needs downstream may mean that the timing of supplementary access needs to be amended.

If this proposal is to progress, we need to investigate ways to maintain healthy farms alongside healthy communities and healthy rivers. This could include offsetting options such as providing the opportunity for increases in water access at other times or other compensatory actions that allow jobs and production to be maintained.

Limiting upstream restrictions requires close to perfect forecasting of when flows are sufficient to achieve the targeted downstream outcomes. However, good quality forecasting at the level assumed in the design of the original North-West Flow Plan has proved to be an intractable issue and means we cannot implement these targets by using flow forecasting methods alone.

If the amended targets are to be introduced, then improvements will first need to be made to the operational flow forecasting capability which will require a significant amount of investment over a long time period. Without upgrading forecasting capability, implementing the connectivity targets will either result in unnecessary impacts or missed opportunities to improve connectivity at important times.

If these connectivity targets are progressed in the short term they will need to rely on:

- a rules based approach with simple, blunt triggers which provide direction on when to restrict water users upstream and allow flows downstream. This would not rely on any forecasting and would provide clarity to water users, but may be less effective in meeting downstream targets at important times; or
- using the current level of forecasting capability combined with a decision support system to guide operational decision-making on when to restrict water users to meet the proposed targets. This option would require each flow event to be managed on an individual basis which is more complex operationally and dependent on expert judgement. This approach could be more effective in meeting downstream targets at important times.

The benefits of restricting floodplain harvesting on the algal suppression and fish migration targets is more difficult to assess. We are not yet able to simulate the additional proportion of floodplain harvesting that would actually return to rivers if restrictions were made. As such we have considered what would be expected if it is assumed that restrictions to floodplain harvesting would result in all floodplain water otherwise taken returning to the river from the floodplain. The initial modelling indicates that there would be some improvements to meeting the algal suppression flow targets, but mostly in the years where these flow targets had already been met at least once. For the fish migration targets, restricting floodplain harvesting access alongside restrictions to supplementary and B and C class access did provide benefits to meeting the fish migration targets.

Further work will be done to improve our ability to model floodplain harvesting as it is likely that, should the algal suppression and fish migration targets be implemented, restrictions on floodplain harvesting would also be imposed alongside supplementary and B and C class restrictions.

Remediating fish barriers, as proposed through the Better Baaka Program could also improve outcomes for fish along the Barwon–Darling River and could lead to reduced triggers for restrictions.[71] Fishways reduce the magnitude of flows that are needed for successful fish passage.

This initial analysis does not include data from the last drought which will be incorporated into the model later this year.

We seek your views on whether the benefits of this option outweigh the potential impacts, and what additional steps we can take to offset the potential impacts.

71. Noting that the fish movement triggers also provide opportunities for related ecosystem outcomes such as increased productivity, increased dispersal and improved lateral connectivity with floodplain habitat.

Using general security held environmental water to meet connectivity objectives

The 2019 *Stocktake of Northern Basin Connectivity Rules – Analysis of Implementation and Effectiveness* report concluded that given the challenges associated with implementing the North-West Flow Plan connectivity rules, initiatives to improve connectivity in the Barwon–Darling River should focus on the use of regulated held environmental water releases. The use of unregulated tributary flows downstream of headwater storages to provide connectivity flows in the Barwon–Darling is subject to much greater forecasting uncertainty than releases of water from dams. In the interests of exploring all possible ways to meet the connectivity objectives, we have modelled the maximum possible benefits associated with using 232 GL (or 14%) of general security licences to meet downstream outcomes. This amount of general security licences is equivalent to the entire general security held environmental water portfolio in the Border Rivers, Gwydir, Namoi and Macquarie–Waambul valleys.

Our analysis has shown that there are mixed results when using held environmental water versus restrictions on productive licences. Held environmental water licences could be better at meeting lower flow targets, but with limited effect given its smaller volume. Restrictions on supplementary licences could be better at meeting higher flow targets but the timing of supplementary access events often doesn't align with the times when the algal suppression or fish migration targets are required. For example, while fish migration targets and the higher flow algal suppression target at Wilcannia could be better supported with the use of restrictions, the lower flow algal suppression targets can be better supported by the use of held environmental water licences (Figures 40 and 41).

We have also modelled the extent to which held environmental water or restricting supplementary licences can help meet the base flow targets in the Long Term Water Plan at the end of each northern tributary valley. Figure 42 shows the changes that completely restricting supplementary licences or using all of the general security held environmental portfolio make to increasing the proportion of days that flows are above low flow targets at the end of each tributary valley. The results are largely proportional to the volume of supplementary or held environmental water in the individual valleys.

If the entire general security portion of the environmental water portfolio was used for connectivity purposes, support for bird or fish breeding events in areas such as the Gwydir or Macquarie Marshes would have to rely on existing planned environmental water provisions, high security held environmental water, and other inflows.

The supplementary and Barwon–Darling access restrictions are included in the figures for comparison purposes.

Figure 40. Number of years that there is at least one flow that meets the proposed updated fish migration targets through restrictions to B and C class and supplementary access or using general security held environmental water

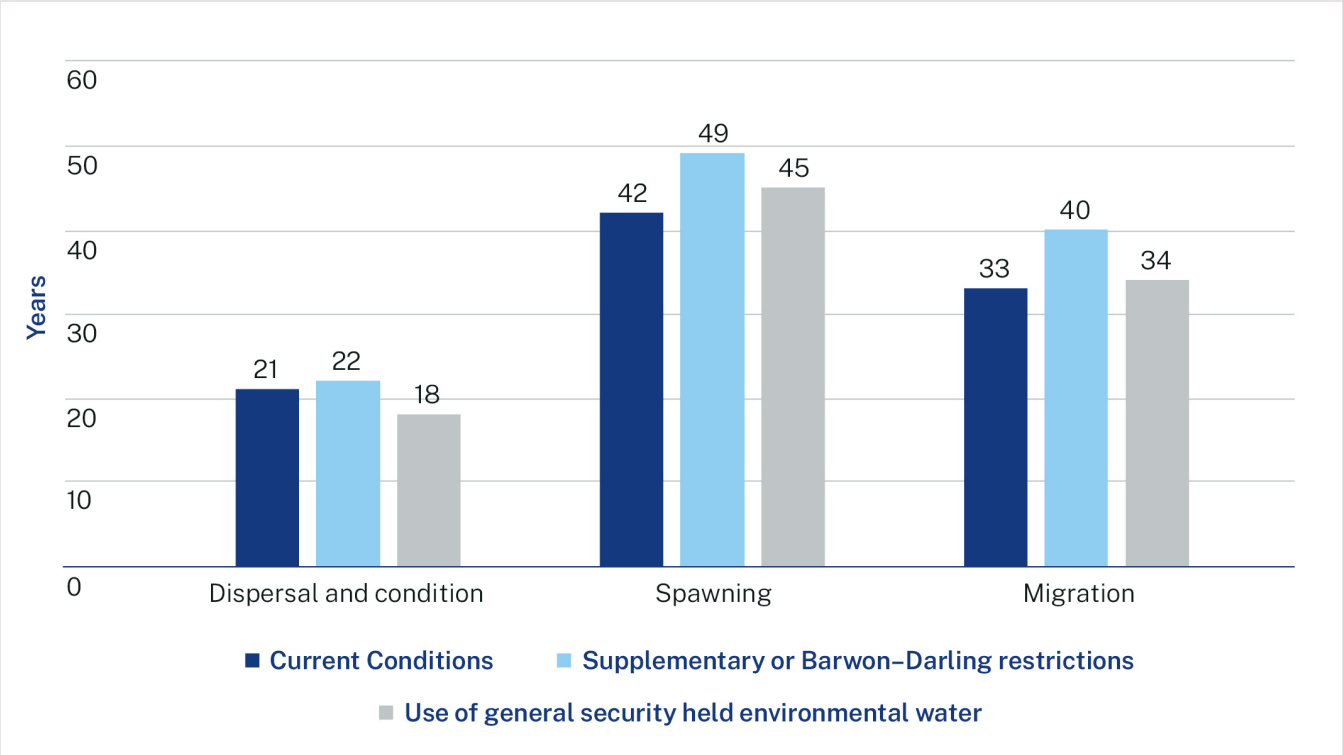


Figure 41. Number of years when any or all of the algal suppression targets are met in comparison with the 3,000 ML/day target at Wilcannia through restrictions or using general security held environmental water

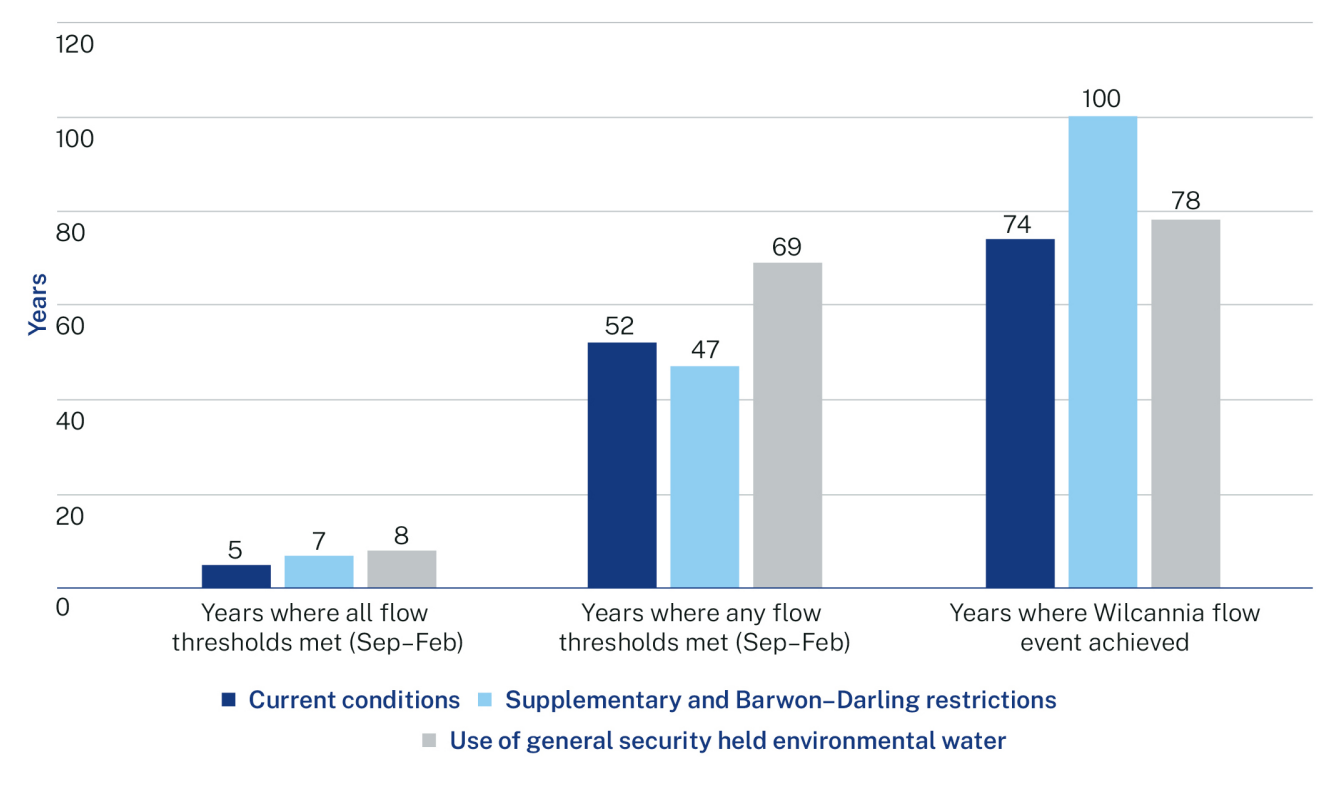
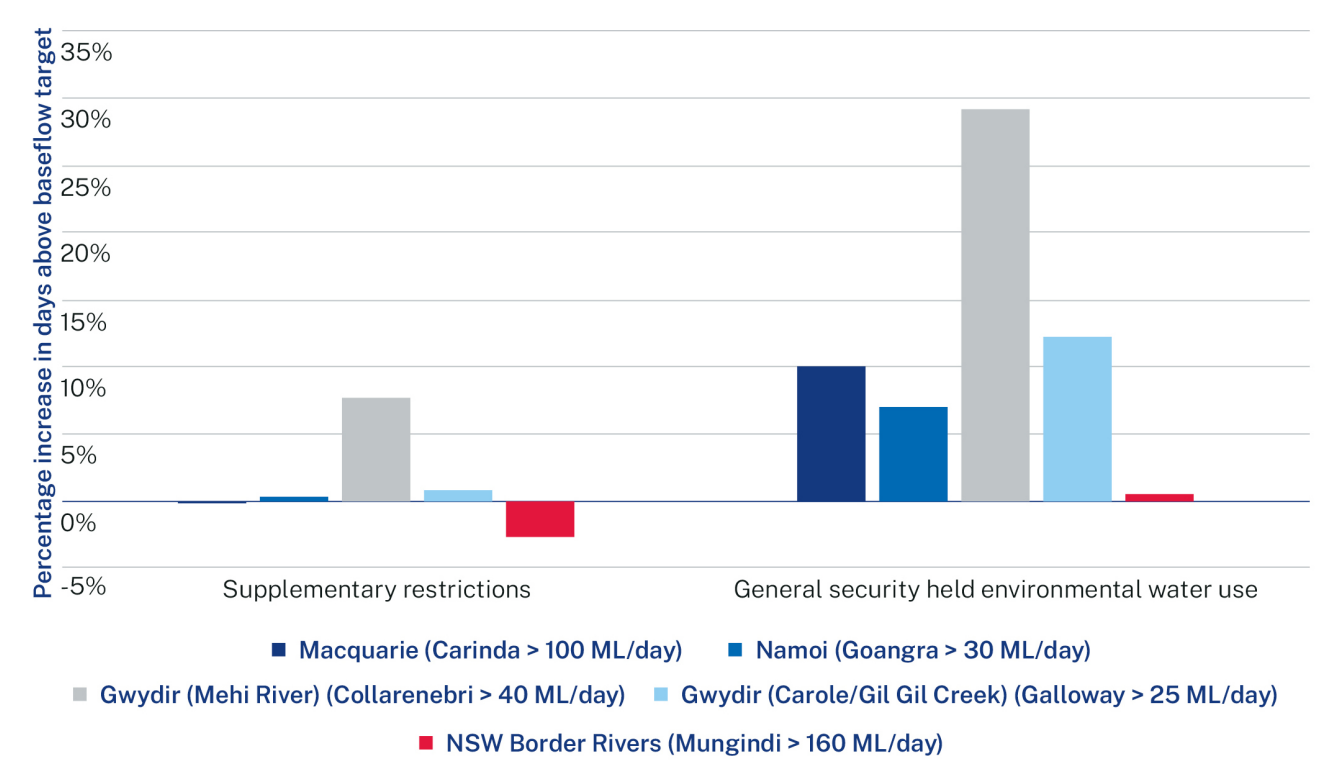


Figure 42. Increase in the proportion of days that flows are above baseflow targets at the end of each northern tributary valley based on completely restricting supplementary licences, or using all of the general security held environmental water portfolio



Next Steps

We need to be confident that the benefits of implementing the proposed new triggers outweigh the impacts and that the triggers can be effectively implemented and operated. If we can achieve perfect forecasting, this initial analysis suggests there could be benefits in implementing these targets at certain times, but overall, implementing these actions will not solve all connectivity issues. The benefits are likely to be marginal and they come with impacts on water users but may change when assessed against different climate scenarios. The operational challenges associated with improving connectivity in a fair and effective way will need continued, concerted efforts to overcome. Further consultation with stakeholders and the community is also required in order to progress these actions.

We also need to focus on building the evidence base to understand what flow connectivity objectives we need to aim for. Some of our modelled climate scenarios suggest we may not be able to sustain the flow regime that we have now, nor achieve the regime we have had in the past. We also need to understand whether breaking up extended cease-to-flow periods in the future should be a priority. We need to undertake work now to understand what trade-offs the community are willing to accept in the future. This will need to be done in conjunction with other Basin states and the Murray–Darling Basin Authority.

The next steps to progress the review of the North-West Flow Plan are:

1. **develop decision support guidelines** based on the approach developed for the 2020 Northern Basin First Flush Event as a starting point and test this approach through desktop modelling, live examples and community consultation
2. **undertake more detailed impact and economic analysis** on the proposed options. No changes will be made to any of the rules without public consultation and further analysis on the potential impacts, operational feasibility, as well as investigating how to mitigate the impacts
3. **identify and assess compensatory actions (if required)** to remove or offset economic impacts
4. **expert panel review of the proposed targets and triggers**: The 2021 Border Rivers Regulated Water Sharing Plan requires an independent expert panel to review any changes to downstream connectivity targets and, if changes are recommended, views sought from the public. The expert panel assessment will need to consider:
   - critical needs of the environment, basic landholder rights, domestic and stock, towns in the Barwon–Darling River
   - the adequacy of the proposed targets to meet these needs
   - the impact of any changes on supplementary access in the northern tributaries.
5. **public consultation** on any specific water sharing plan changes. This would occur before any amendments to water sharing plans were made.

Image courtesy of Sally Anderson-Day. Barwon River, Brewarrina.

Image courtesy of Destination NSW. Townscape, Wilcannia.

Next steps

7

Image courtesy of Wentworth Shire Council. Darling and Murray River junction.

How and when will options be implemented?

A core task for the Western Regional Water Strategy is making sure it identifies clearly the options and investments that are needed now and those that will or may be needed further into the future.

The strategy considers a 20-year timeframe from now until 2040, aiming to chart a progressive journey that enables us to meet existing challenges, identify and prepare for foreseeable future challenges, and lay the groundwork for adapting to uncertainties and changed circumstances.

Following public consultation, we will determine which options should be shortlisted and prioritised. Some of our draft long-list options are still in a conceptual state. We need to continue to work with communities, environmental managers, Traditional Owners and industries to develop and refine these ideas further. Other options may be required at a future date, when specific triggers or thresholds are observed – these would be proposed for implementation and funding as the relevant circumstances evolve.

In addition to feedback from public consultation, we will also take into consideration initiatives proposed and the associated consultation, analysis and evidence bases that have been developed as part of other water-related programs that are currently progressing or have occurred in the Western region in recent years. These programs of work include:

- Better Baaka Program (including the former Menindee Lakes SDLAM Program and the outcomes from the Western Weirs Business Case)
- Barwon–Darling Water Sharing Plan Remake 2023
- Connectivity options and feedback from the Connectivity Stakeholder Reference Group
- Wilcannia Weir replacement.

Community engagement does not end with consultation; it is a vital part of implementing the regional water strategies. The final strategy for each region will include:

- a final package of actions approved by the NSW Government
- a plan for implementing the strategy within clear timeframes, which includes existing commitments
- clearly defined roles, responsibilities and governance arrangements for delivering each action or combination of actions
- well-defined opportunities for local and regional partnerships to deliver actions
- a schedule and plan for monitoring and reviewing each strategy.

Critically, the ongoing monitoring, evaluation and review of the strategies will identify if any key underlying assumptions are no longer valid, and when a revision is required. This process will require regular re-evaluation of the strategy's outcomes against any updates in the available climate data.

Not all options will be commenced at once. Funding and other water programs in the region 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 coordinating and prioritising initiatives in the Western region and seeking funding as future opportunities arise.

Some options – in particular, those that have been assessed through the Western Weirs Business Case – have already undergone extensive analysis from modelling and targeted stakeholder feedback. This analysis is expected to be strong enough to enable those options to be shortlisted without delay. These options may be recommended to go through to final business case assessments.

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

Your voice is important

We have prepared this draft strategy to continue our discussions with you about the future management of water in your community. It has been prepared in consultation with local councils and Aboriginal communities.

We would like to hear your views on the draft strategy and whether you have any further information that could help us to assess the benefits or disadvantages of any of the options. This may include:

- how your household, business, industry or community currently manages the impacts of a highly variable climate
- the current and future challenges you see in the Western region and how you think these should be addressed
- how the management of water resources can be improved or leveraged to create and take up new opportunities in the region
- the options presented in this draft strategy
- how we can achieve our aims for accountability and transparency
- the best ways of partnering with communities and regions to implement the strategy.

Your views on the strategy's vision and objectives are also important.

This Draft Western Regional Water Strategy is on public exhibition from 1 June 2022 to 13 July 2022 for a 6-week period. A range of supporting information is available at www.dpie.nsw.gov.au/western-regional-water-strategy

We are consulting jointly on the Draft Western Regional Water Strategy, amendments to the Barwon–Darling Water Sharing Plan (WSP) and the licensing and regulation of floodplain harvesting (FPH) in the region. The proposed amended WSP and a package of information about the proposed FPH rule are also on public exhibition alongside the draft strategy.

We will be meeting with people in the Western region over the coming months to help shape the final strategy. You can also have your say on the draft strategy by providing written feedback to the Department of Planning, and Environment by midnight 13 July via:

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

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

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

We will be holding online and face-to-face sessions on the draft strategy during the public exhibition period to help shape the final strategy. These sessions will give participants an understanding of the context for the strategy, what the latest modelling is telling us and what the options for better managing water in the Western region could mean. Times and locations for these sessions can be found at www.dpie.nsw. gov.au/western-regional-water-strategy

We will also continue to meet with local councils, local water utilities, Aboriginal communities and other stakeholders. Talking with these groups is critical for designing a strategy that builds on their knowledge and capacity, is feasible in terms of implementation and links to their relevant initiatives, plans and strategies.

Image courtesy of Michael Scotland. Collarenebri Weir, Walgett.

Glossary

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Image courtesy of Wentworth Shire Council. Lower Darling River at Wentworth.

Term	Definition
Access licence	An access licence entitles its holder to take water from a water source in accordance with the licence conditions. Key elements of an access licence are defined in section 56(1) of the NSW *Water Management Act 2000* as: a. *specified shares in the available water within a specified water management area or from a specified water source (the share component), and* b. *authorisation to take water:* i. *at specified times, at specified rates or in specified circumstances, or in any combination of these, and* ii. *in specified areas or from specified locations (the extraction component).* An access licence may also be referred to as a water access licence or a WAL.
Allocation	The specific volume of water licence holders can access. The amount of water allocated to licence holders varies from year to year based on the type of licence, size of their individual entitlement, dam storage levels, river flows and catchment conditions.
Aquifer	Geological structure or formation, or landfill, that can hold water.
Basic landholder rights	Where landholders can take water without a water licence or approval under section 52, 53 and 55 of the NSW *Water Management Act 2000*. There are 3 types of basic landholder rights under the NSW *Water Management Act 2000*: • domestic and stock rights – where water can be taken for domestic consumption or stock watering if the landholder's land has river frontage or is overlying an aquifer • harvestable rights – where landholders can store some water from rainfall runoff in dams • Native Title Rights – anyone with a Native Title right to water, determined under the Commonwealth's *Native Title Act 1993*.
Catchment	A natural drainage area, bounded by sloping ground, hills or mountains from which water flows to a low point. Flows within the catchment contribute to surface water sources as well as to groundwater sources.
Cease-to-flow event	In the modelling, cease-to-flow is identified as 25 ML/day at Walgett, 20 ML/day at Brewarrina and Wilcannia and 5 ML/day at Weir 32.
Cease-to-pump rule	A requirement in water sharing plans that licence holders stop pumping when the river flow falls below a certain level.
Climate-independent water source	A source of water that does not depend on rainfall or streamflows for replenishment. Includes seawater desalination and recycled water.
Climate variability	Describes the way key climatic elements, such as temperature, rainfall, evaporation and humidity, depart from the average over time. Variability can be caused by natural or man-made processes.
Cold water pollution	An artificial decrease in the temperature of water in a river. It is usually caused by cold water being released into rivers from large dams during warmer months.

Term	Definition
Cultural flows	While the NSW *Water Management Act 2000* does not define cultural flows, the Murray Lower Darling River Indigenous Nations Echuca Declaration, 2007, defines cultural flows as: 'water entitlements that are legally and beneficially owned by the Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, natural, environmental, social and economic conditions of those Nations'.
Dead storage	Water within a water storage that is stored below the level of an outlet or spillway and cannot be released.
Direct employment	Refers to employment directly arising from the demand for a specific product or service.
Distributary	A stream or channel that branches off and flows away from a main river or stream. This is the opposite to a tributary, which flows towards and joins another river.
Drawdown	A lowering of the water level.
Ecological community	A unique and naturally occurring assemblage of plants and animals. Determining factors for the presence of ecological communities include, for example, soil type, position in the landscape, climate and water availability.
Effluent	Flow leaving a place or process. Sewage effluent refers to the flow leaving a sewage treatment plant. An effluent stream is one that leaves the main river and does not return.
Endangered ecological community (EEC)	Ecological communities as listed in 'Schedule 2' of the *Biodiversity Conservation Act 2016* or Schedule 4 of *the Fisheries Management Act 1994*.
End of system	The last defined point in a catchment where water information can be measured and/or reported.
Entitlement	The exclusive share of the available water that a licence holder can take, subject to allocations.
Environmental asset	Natural features that contribute to the ecosystem of a region. The Murray–Darling Basin Plan defines water-dependent ecosystems with particular characteristics as 'priority environmental assets' for the purposes of environmental watering.
Environmental water	Water allocated to support environmental outcomes and other public benefits. Environmental water provisions recognise the environmental water requirements and are based on environmental, social and economic considerations, including existing user rights.
Evapotranspiration	The combined effect of evaporation and transpiration.
Evaporation	The process by which water or another liquid becomes a gas. Water from land areas, bodies of water and all other moist surfaces is absorbed into the atmosphere as a vapour.
Extraction limit	A limit on the long-term average volume of water that can be extracted from a source.
Fish passage	The free movement of fish up and down rivers and streams.
Floodplain	Flat land bordering a river or stream that is naturally subject to flooding and is made up of alluvium (sand, silt and clay) deposited during floods. Floodplain harvesting is the collection or capture of water flowing across floodplains.
Floodplain harvesting	The capture and use of water flowing across a floodplain.

Term	Definition
General security licence	A category of water access licence under the NSW *Water Management Act 2000*. This category of licence forms the bulk of the water access licence entitlement volume in NSW regulated rivers and is a low-priority entitlement (i.e. receives water once essential and high security entitlements are met).
Gross regional product	A measure of the market value of all goods and services produced in a region within a period of time. Gross regional product is a similar measure to gross state product and gross domestic product.
Gross value added	A measure of the value of goods and services produced in an area, industry or sector of an economy. Gross value added is a similar measure to gross regional product.
Groundwater	Water located beneath the ground in the spaces between sediments and in the fractures of rock formations.
Groundwater dependent ecosystem	Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.
Headworks	Apparatus for controlling the flow of water in a river or canal.
High flows	Also called bankfull events, these reshape the channel, creating habitats such as pools, bars and benches.
High security licence	A category of water access licenses in regulated rivers implemented under the NSW *Water Management Act 2000*. Receives a higher priority than general security licences but less priority than essential requirements in the available water determination process. Many high security licences are held by water users that have inflexible water demands, such as those growing permanent plantings and mining companies.
Indirect employment	Jobs that are created by other businesses to support the primary employment sector.
Inflows	The amount of water coming into a surface water source or groundwater source.
Joint organisation	An entity formed under the NSW *Local Government Act 1993* to perform 3 principal functions in a region: strategic planning and priority setting, intergovernmental collaboration and shared leadership and advocacy. Each joint organisation comprises at least 3 member councils and aligns with one of the state's strategic growth planning regions.
Local water utilities	Generally, these are council owned and operated utilities that provide water supply and sewerage services to local communities.
Low flow/extended low flow event	In the modelling, low flow is 326 ML/day at Walgett, 468 ML/day at Brewarrina, 450 ML/day at Bourke and 200 ML/day at Wilcannia. Depending on the location, extended cease-to-flow events are based on experiencing these volumes for a time period of between 90 and 150 days.
Managed aquifer recharge	Intentional recharge of water to aquifers for subsequent use or environmental benefit.
Operational rules	The procedures for managing releases and extractions of water (surface and groundwater) to meet the rules of relevant legislation and policy (e.g. water sharing plans, long-term water plans).
Paleoclimate data	Refers to climate records prior to instrumental records. Various environmental indicators can be used to reconstruct paleoclimate variability extending back hundreds of thousands of years in time. These indicators include marine and terrestrial deposits, tree rings and ice cores.

Term	Definition
Permanent plantings	Crops that are not replanted after a growing season. These crops generally require more than one growing season to be productive. Examples include grapes, citrus fruits and almond trees. These are different from annual (or broadacre) crops, which are harvested within 12 months of planting and require replanting to produce a new crop.
Pre-requisite policy measures	Murray–Darling Basin state governments agreed to implement pre-requisite policy measures in the southern connected basin under the Intergovernmental Agreement on Implementing Water Reform in the Murray–Darling Basin 2013. The aim is to maximise the beneficial outcomes of water recovered under the Basin Plan. In NSW they apply in the NSW Murray and Lower Darling and Murrumbidgee regulated rivers.
Ramsar Convention	The Convention on Wetlands of International Importance (Ramsar Convention) is an international treaty to halt the worldwide loss of wetlands and conserve those that remain. Australia has 66 Wetlands of International Significance listed under the convention.
Recharge	Groundwater recharge is a hydrologic process where water drains downward from surface water to groundwater. Groundwater is recharged naturally by rain, floods and snow melt and to a smaller extent by drainage directly from surface water (such as rivers and lakes).
Recycled water	Water that has been treated to a 'fit for purpose' standard for a specific application as per the *Australian Guidelines for Water Recycling*, www.waterquality.gov.au/guidelines/recycled-water
Regulated river	A river system where flow is controlled via one or more major man-made structures (e.g. dams and weirs). For the purposes of the NSW *Water Management Act 2000*, a regulated river is one that is declared by the Minister to be a regulated river. Within a regulated river system, licence holders can order water which is released from the dam and then taken from the river under their water access licence.
Resilience	Resilient water resources are those that are able to withstand extreme events, such as drought and flood, and/or adapt and respond to changes caused by extreme events.
Resumption of flow rule	This rule protects the critical first flows after an extended low-flow or dry period in the Barwon–Darling. The rule is triggered when a flow event occurs after a continuous period of dry or low flow conditions and prevents water users from accessing the first flow for a period of time.
Riparian	The part of the landscape adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within them.
Renewable Energy Zones	A region identified by the NSW Government's Electricity Strategy to play a vital role in delivering affordable energy generation to help prepare the State for the expected retirement of thermal power stations.
Salinity	The concentration of sodium chloride or other dissolved minerals in water.
Stochastic climate datasets	Stochastic climate datasets are extended climate sequences that are synthesised using statistical methods applied to observed data of rainfall and evapotranspiration and can include paleoclimatic data. These extended sequences include a more complete sample of climate variability, part of which describes more severe drought sequences.
Storage	A state-owned dam, weir or other structure which is used to regulated and manage river flows in the catchment. There are also a range of storages owned by local water utilities. Also refers to the water bodies impounded by these structures.

Term	Definition
Stormwater	Flow generated from rainfall falling on hard (impervious) surfaces.
Supplementary licence	Where a surplus flow from rain events cannot be captured in storages or weirs, and this water is not needed to meet current demands or commitments, then it is considered surplus to requirements and a period of Supplementary Access is announced. Supplementary Water Access Licence holders can only pump water against these licences during these announced periods. Other categories of licence holders may also pump water during these periods.
Surface water	All water that occurs naturally above ground including rivers, lakes, reservoirs, creeks, wetlands and estuaries.
Sustainable diversion limit	Sustainable diversion limits are how much water, on average, can be used in the Murray–Darling by towns, communities, industry and farmers in a particular surface water or groundwater source. The limit is written into law in NSW through water sharing plans.
Synthetic datasets	Data that is artificially created using algorithms and not obtained by direct measurement or generated by actual events.
Transmission losses	Water that is, from an accounting perspective, considered lost. This water has been lost through surface water seeping into the ground or evaporation.
Transpiration	The process where plants absorb water through their roots and then evaporate the water vapor through pores in their leaves.
Tributary	A smaller river or stream that flows into a larger river or stream. Usually, a number of smaller tributaries merge to form a river. This is the opposite to a distributary, which is a stream that flows away from a larger river or stream.
Unregulated river	These are rivers or streams that are not fully controlled by releases from a dam or through the use of weirs and gated structures. However, in some catchments there are town water supply dams that control flows downstream. Water users on unregulated rivers are reliant on climatic conditions and rainfall. For the purpose of the NSW *Water Management Act 2000*, an unregulated river is one that has not been declared by the Minister to be a regulated river.
Wastewater	Water that is an output of or discharged from a particular activity, for example from domestic, commercial, industrial or agricultural activities. The chemical composition of the wastewater (compared to the source) will be contaminated.
Water accounting	The systematic process of identifying, recognising, quantifying, reporting, assuring and publishing information about water, the rights or other claims to that water, and the obligations against that water.
Water reliability	Refers to how often an outcome is achieved. It is often considered to be the likelihood, in percentage of years, of receiving full water allocations by the end of a water year for a licence category. For example, a 60% reliability means that in 60% of years a licence holder can expect to receive 100% of their licensed entitlement by the end of the water year. Other measures of volumetric reliability could also be used; for example, the percentage allocation a licence holder could expect to receive at a particular time of the year as a long-term average. Reliability may also refer to how often an acceptable water quality is available. A reliable water supply gives some clarity to water users and helps them plan to meet their water needs.

Term	Definition
Water resource plan	A plan made under the *Commonwealth Water Act 2007* that outlines how a particular area of the Murray–Darling Basin's water resources will be managed to be consistent with the Murray–Darling Basin Plan. These plans set out the water sharing rules and arrangements relating to issues such as annual limits on water take, environmental water, managing water during extreme events and strategies to achieve water quality standards and manage risks.
Water rights	The legal right of a person to take water from a water source such as a river, stream or groundwater source.
Water security	Water security refers to the acceptable chance of having sufficient town water supplies to meet critical needs. This requires community and government to have a shared understanding of a 'fail event' (for example, no drinking water or restrictions below a defined level for longer than a defined period, or unacceptable water quality) and the level of acceptability they will pay for. The NSW Government's guidance around an appropriate security of supply for sizing town water supply head-works is the 5/10/10 rule. Under this approach, the total time spent in drought restrictions should be no more that 5% of the time, restrictions should not need to be applied in more than 10% of years and when they are applied there should be an average reduction of 10% in water usage. This allows full demand to be met in most years and also allows for water restrictions to be implemented infrequently to conserve supplies.
Water sharing plan	A plan made under the NSW *Water Management Act 2000* which sets out the rules for sharing water between the environment and water users, and between different water users, within whole or part of a water management area or water source.
Water source	Defined under the NSW *Water Management Act 2000* as 'The whole or any part of one or more rivers, lakes or estuaries, or one or more places where water occurs naturally on or below the surface of the ground and includes the coastal waters of the State'. Individual water sources are more specifically defined in water sharing plans.
Water trade	The process of buying and selling water entitlements and water allocations.
Water year	The annual cycle associated with the natural progression of hydrological seasons: starting with soil moisture recharge and ending with maximum evaporation/transpiration. In NSW (as for all of the southern hemisphere), the water year runs from 1 July to 30 June.
Wetland	Wetlands are areas of land where water covers the soil – all year or just at certain times of the year. They include swamps, marshes, billabongs, lakes, and lagoons. Wetlands may be natural or artificial and the water within a wetland may be static or flowing, fresh, brackish or saline.

Image courtesy of Michael Scotland. Barwon–Darling River, Walgett.

Attachments

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Image courtesy of Destination NSW. Menindee Lakes, Menindee.

Attachment A: Background on the Western region, its water and climate

Attachment B: Long list of options

Attachment C: What we heard through targeted stakeholder engagement

Attachment D: North-West Flow Plan Discussion Paper

Attachment E: Critical dry condition triggers to reduce risk to environmental and human water needs Discussion Paper

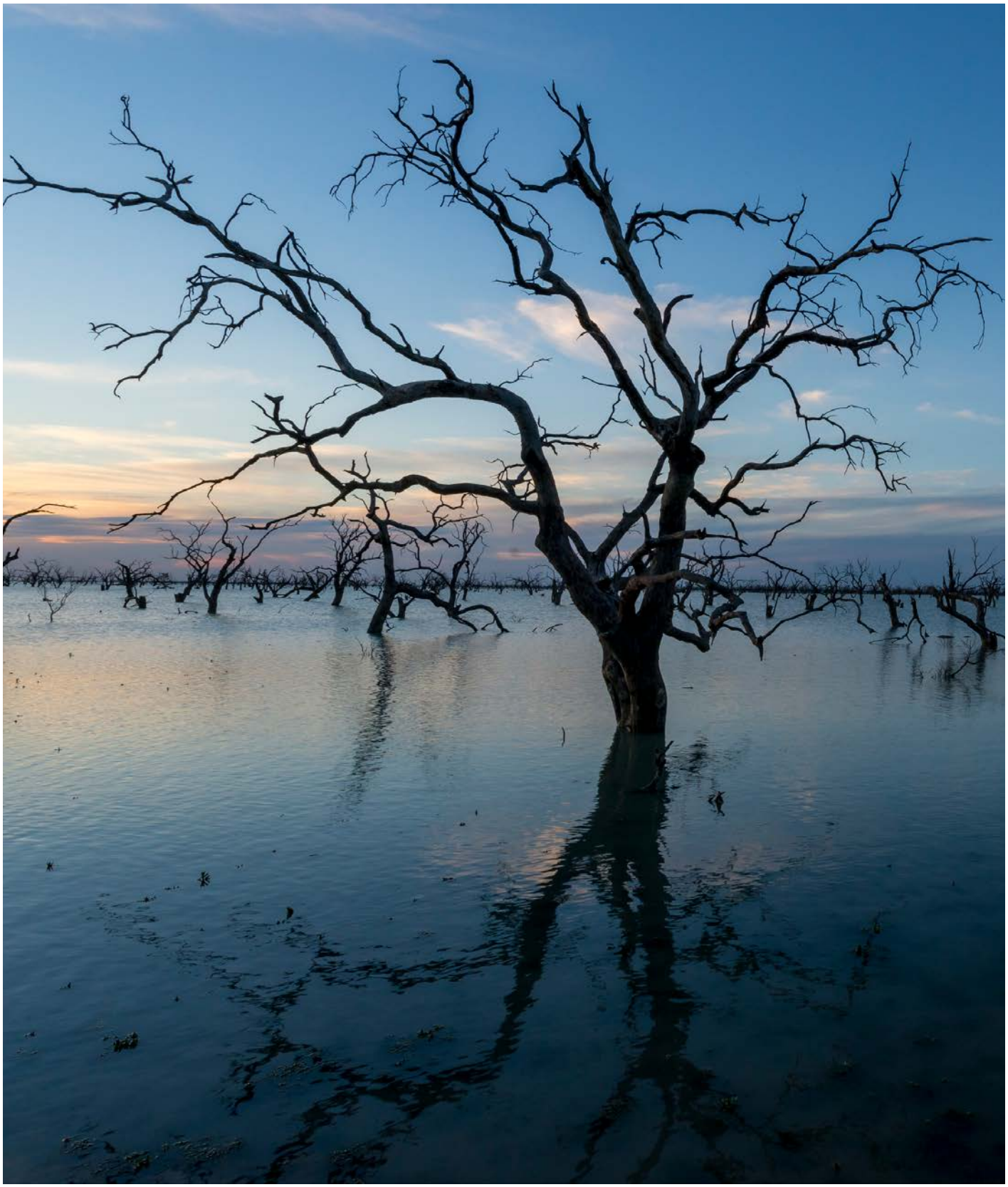

Image courtesy of John Spencer, Department of Planning and Environment. Lake Pamamaroo, Menindee Lakes.

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