

Draft Regional Water Strategy

Namoi:
Shortlisted Actions – Consultation Paper

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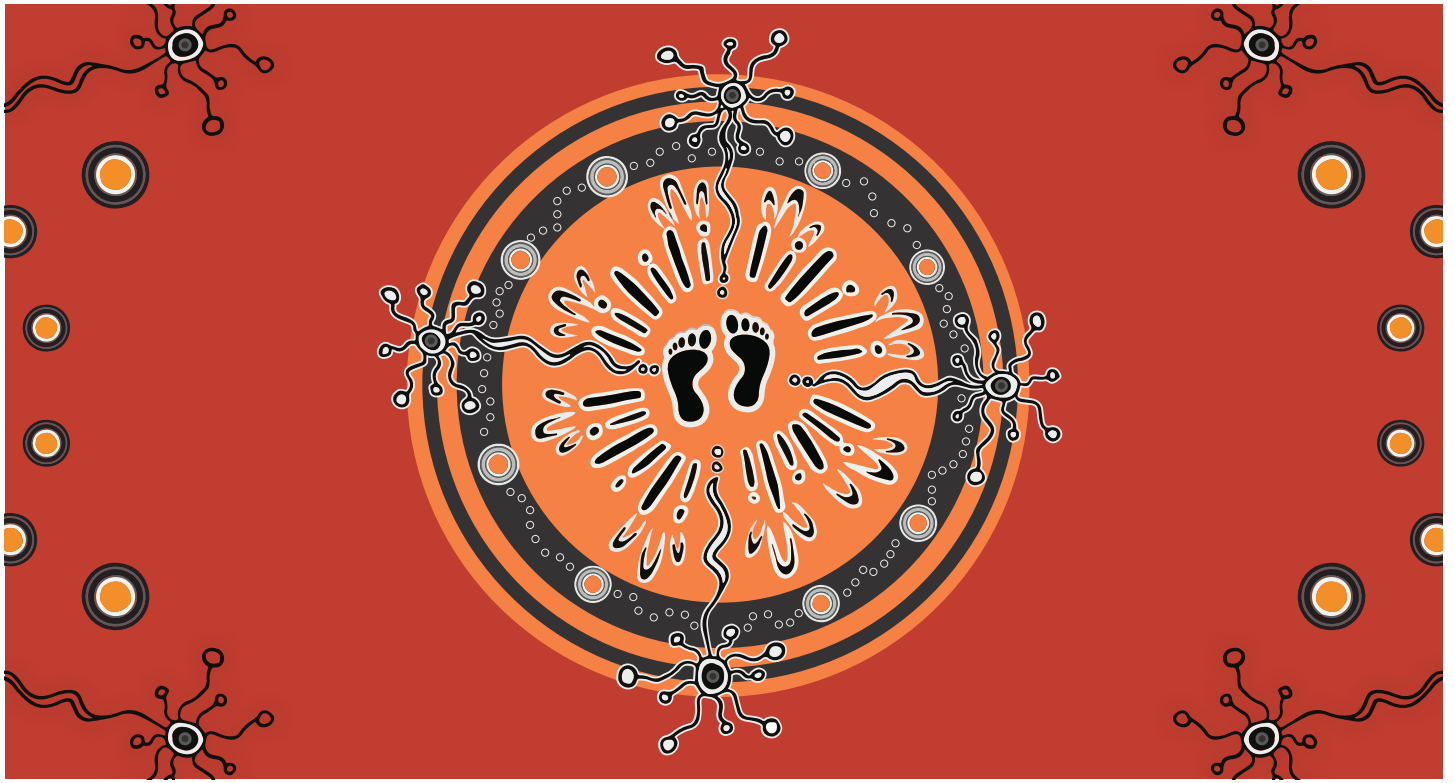
Cover image Image courtesy of Tim Haeusler, Department of Planning and Environment. Gulligal Lagoon, Namoi.

More information water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies

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Acknowledgement of Country

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

Today, they practice the oldest living culture on earth.

The NSW Government acknowledges the Gomeroi/Kamilaroi/Gamilaroi/Gamilaraay Nations as having an intrinsic connection with the lands and waters of the Namoi Regional Water Strategy area. The landscape and its waters provide the First Nations people with essential links to their history and help them to maintain and practice their **Traditional** culture and lifestyle.

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

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

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

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

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

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.

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

The Namoi is home to around 95,000 people and the important regional centers of Tamworth, Gunnedah and Narrabri. The region is located within the traditional lands of Gomeroi Nation and is home to a range of rare, endangered and threatened animal and plant species.

Agriculture and mining industries are the engines of the regional economy. Together these industries employ around one third of the regions work force and account for over 20% of the region's \$6.36 billion yearly economic output. But we know that future droughts will place the regional economy at risk.

Our state is no stranger to extremes; we have always had to manage our water resources through floods and prolonged droughts. In the face of an increasingly variable climate future, we must prepare for even longer and more severe wet and dry periods, particularly in the Namoi region. During 2017-2020, the region experienced the worst drought on record. This experience taught us a great deal about managing our water resources and we need to put these lessons to good use in preparing for future extreme weather events.

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

Working closely with the community, we are now making decisions around future investments that will set the region up for the future, support the new industries coming in through the renewable energy zone, Namoi Regional Job Precinct and Narrabri Special Activation Precinct, and support the health of the environment.

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 Namoi.

This strategy, alongside 11 other regional and two 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.

The Namoi Regional Water Strategy will put forward the best mix of solutions to address these challenges and support environmental, social and economic outcomes. After widespread community consultation, we have shortlisted proposed actions to ensure water for critical human and environmental needs, underpin sustainable water resources for new and existing businesses, and best use existing water to support a healthy environment.

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 Namoi to get involved and contribute to the strategy. Water is for everyone, and we are ensuring our water management policies support the future of the Namoi and all of NSW.

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

Contents

Snapshot	8
1. What is the purpose of this consultation paper?	10
Why we are developing regional water strategies	13
How do regional water strategies fit with other water strategies?	14
We want to hear from you	18
2. What we have heard so far	20
3. Where should we focus first?	24
Addressing Tamworth's long term water security risks	26
Addressing water security risks of regional towns across the Namoi Valley	31
Supporting a growing regional economy in a future of potentially reduced water availability	35
Improving the health and resilience of aquatic ecosystems	41
Dismantling barriers to Aboriginal water rights	49
4. Addressing the challenges	52
Priority 1. Supporting the long-term water needs of Tamworth and other towns in the region	54
Priority 2. Supporting a growing regional community under a more variable and uncertain future climate	70
Priority 3. Improving the health and resilience of water dependent ecosystems	90
5. How to have your say	100
When will the actions be implemented?	101
6. Attachments	102
Attachment 1: Summary of the options assessment	103
Attachment 2: Assessment of options that impact supply, demand or allocation of water	114



Image courtesy of Destination NSW. Farmer herding sheep on a farm in Barraba.

Snapshot

The Namoi region



94,700
population



43,000
km² area



Aboriginal Nations:
Gomerioi/Kamilaroi



Regional centres include:

Tamworth, Gunnedah
and Narrabri



**Smaller towns and
localities include:**

Barraba, Manilla, Nundle,
Quirindi, Caroonna, Breeza,
Tambar Springs, Walgett, Wee
Waa and Werris Creek



Main rivers:

Two main river systems.
The Peel River and
the Namoi River



Major water storages:

Keepit Dam, Chaffey Dam, Split Rock Dam,
Dungowan Dam and Quipolly Dam



Groundwater sources:

Upper Namoi Tributary Alluvium (Curabubula Alluvial, Quipolly Alluvial, Quirindi Alluvial), Peel Alluvium, Manilla Alluvial, Upper Namoi (Zones 1-12), Lower Namoi, Great Artesian Basin Surat Shallow, Surat, Southern Recharge, Gunnedah-Oxley Basin Murray Darling Basin, Peel Fractured Rock and New England Fold Belt Murray Darling Basin



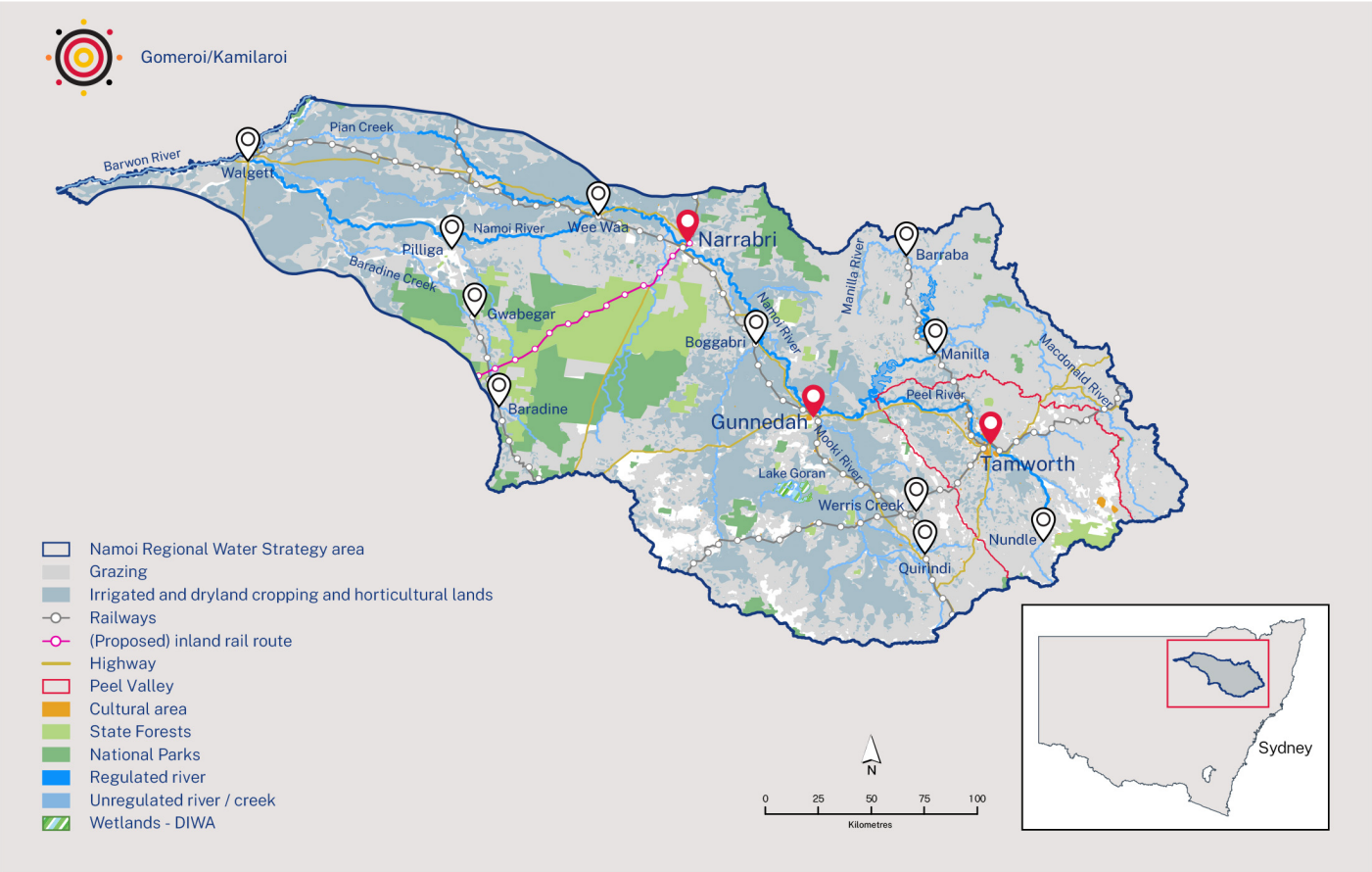
Key environmental assets:

A range of significant ecosystems include Lake Goran and various billabongs, lagoons and floodplains. Some threatened or key species that are flow dependent or heavily reliant on water include the Murray Cod, Bell's Turtle, Sloane's Froglet, many water birds, rakali and platypus

Gross Regional Product: **\$6.36 billion**



Figure 1. Map of the Namoi region



Mount Kapure National Park.

What is the purpose of this consultation paper?

1

Landscape around Gunnedah at dusk. Gunnedah, NSW.

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

The draft Namoi Regional Water Strategy, including a long list of options, was released for public consultation in March 2021.¹

Since then we have taken on board what we heard, undertaken additional analyses to prioritise key challenges and shortlisted a number of action to help meet these challenges. This consultation paper seeks your feedback on these challenges, priorities and proposed actions to help us finalise the Namoi Regional Water Strategy and implementation plan. A summary of these can be seen in Figure 2.

You can find additional background information in the *What we heard report*² and *Options assessment process: Overview* prepared for the Namoi Regional Water Strategy.³

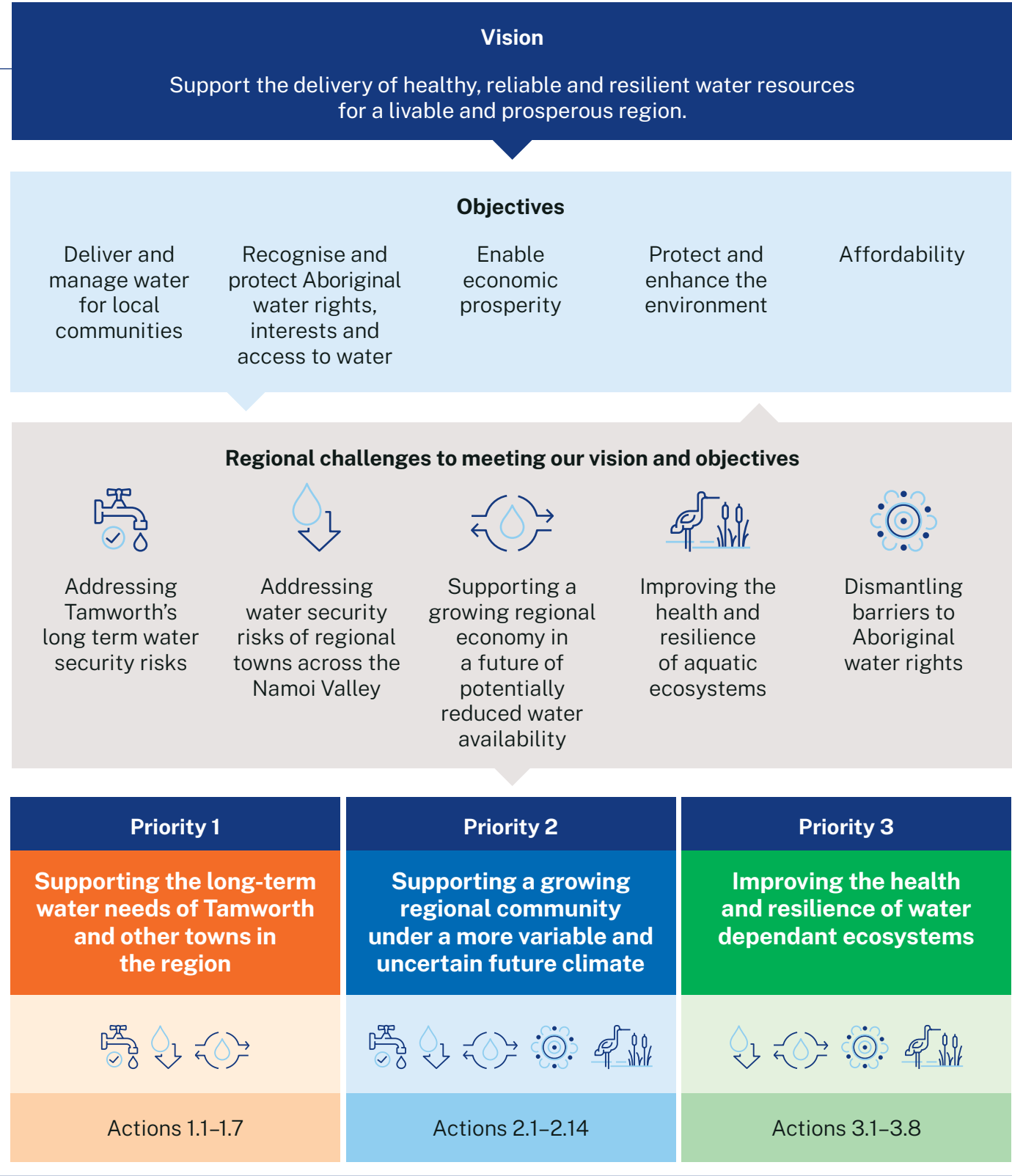
Other regional water challenges described in the draft Namoi Regional Water Strategy are important and will be revisited during future ongoing reviews of the final strategy, planned to be every 3 to 4 years.



Image courtesy of Destination NSW. Oxley Scenic Lookout, Tamworth.

1. Full descriptions of the region, its water resources and water needs are provided in the draft strategy, which can be viewed and downloaded at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/namoi-regional-water-strategy
2. Available for download at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard
3. Available for download at www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/identifying-and-assessing

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



Why we are developing regional water strategies

Across New South Wales, 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 regional water strategy process is identifying these risks and understanding how we can manage and be best prepared for these future uncertainties and challenges.

In addition to understanding and managing future pressures, there are opportunities to consider the role water resources will play in growing our regions, improving liveability and making sure each region remains a great place to work, play and raise a family.

The NSW Government's strategic investments in special activation precincts, regional job precincts, renewable energy zones and actions identified through regional economic development strategies are critical to realising this vision. However, all of these activities rely on access to water.

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

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



Machine harvesting cotton, Namoi Valley.

How do regional water strategies fit with other water strategies?

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

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 Nations' water rights and interests in water management

- the NSW Groundwater Strategy – to ensure sustainable groundwater management across NSW
- the Town Water Risk Reduction Program – in collaboration with local water utilities, this program identifies long-term solutions to challenges and risks to providing town water supply and sewerage
- 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 Namoi 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 *New England North West Regional Plan 2041*.



Image courtesy of Destination NSW. Streetscapes, Tamworth.

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

NSW Water Strategy core objectives	NSW Water Strategy strategic priorities	Regional water strategy objectives	
Protecting public health and safety	Priority 1 Build community confidence and capacity through engagement, transparency and accountability	Aligned with all regional water strategy objectives.	Affordability – identify least cost policy and infrastructure options
Liveable and vibrant towns and cities	Priority 2 Recognise 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.	

Climate data in the regional water strategies

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

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

- **Historical data:** data from rainfall and evaporation records collected by Australian government meteorological records over the past 130 years.
- **Long-term historical past climate:** 10,000 years of stochastic-generated climate data developed using paleo climatic information from The University of Adelaide, Australia.
- **Dry future climate:** Applying the NSW and Australian Regional Climate Modelling (NARCLiM) climate projections for 2060–2079 compared to the baseline period of 1990–2009 to define a dry climate change scenario.

The dry future climate change scenario⁴ is the *SRES A2* which represents a high carbon emissions scenario, and thus results in higher projected climate change impacts on the region.⁵ This is not a forecast of how climate change is expected to eventuate, but it is one possible future outcome.

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

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

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



Image courtesy of Destination NSW. Oxley Scenic Lookout, Tamworth.

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

What the future climate could look like in the Namoi region

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 or it might be drier than we have seen in our lifetimes. Our analysis of different

climate projections tells us that droughts could become hotter and longer, and there could be higher evaporation rates and more unpredictable rainfall and river flows.

Changing rainfall patterns

Potential for **less than average annual rainfall**, coupled with less frequent, but **higher intensity, rainfall events**.



More droughts

Prolonged drought meaning **less total rainfall than the observed record** coupled with more frequent, short and sharp droughts.

Higher evaporation

Evapotranspiration could increase by up to

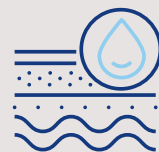
**6%
by 2070**



compared to levels between 1990 and 2009, with the largest increases in winter and spring.

Reduced recharge of groundwater sources

Under a drying climate, the amount of **rainfall seeping into the ground** and replenishing alluvial and artesian groundwater **may reduce**.



Lower inflows into Keepit and Split Rock dams

Minimum 24-month inflows into Keepit and Split Rock dams could **reduce by 50% by 2070** under the driest climate scenario.

We want to hear from you

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

We are seeking your feedback on the prioritised regional water challenges and proposed shortlisted actions in this document, including the focus questions under each priority.

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

The final strategy will identify a range of solutions – from policies, plans and regulation through to new technology and infrastructure changes – aimed at mitigating water-related impacts across the region and supporting 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 Namoi region's water needs
- directed towards creating new opportunities for the region
- focused on delivering the objectives of the regional water strategies and the NSW Water Strategy.

Benefits and impacts of actions on Aboriginal people and communities

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

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

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

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



Image courtesy of Gerhard Koertner, Department of Planning and Environment.
Rock cliff next to creek, Warrabah National Park.

What we have heard so far



2

Kangaroos grazing near new housing estate, Tamworth.

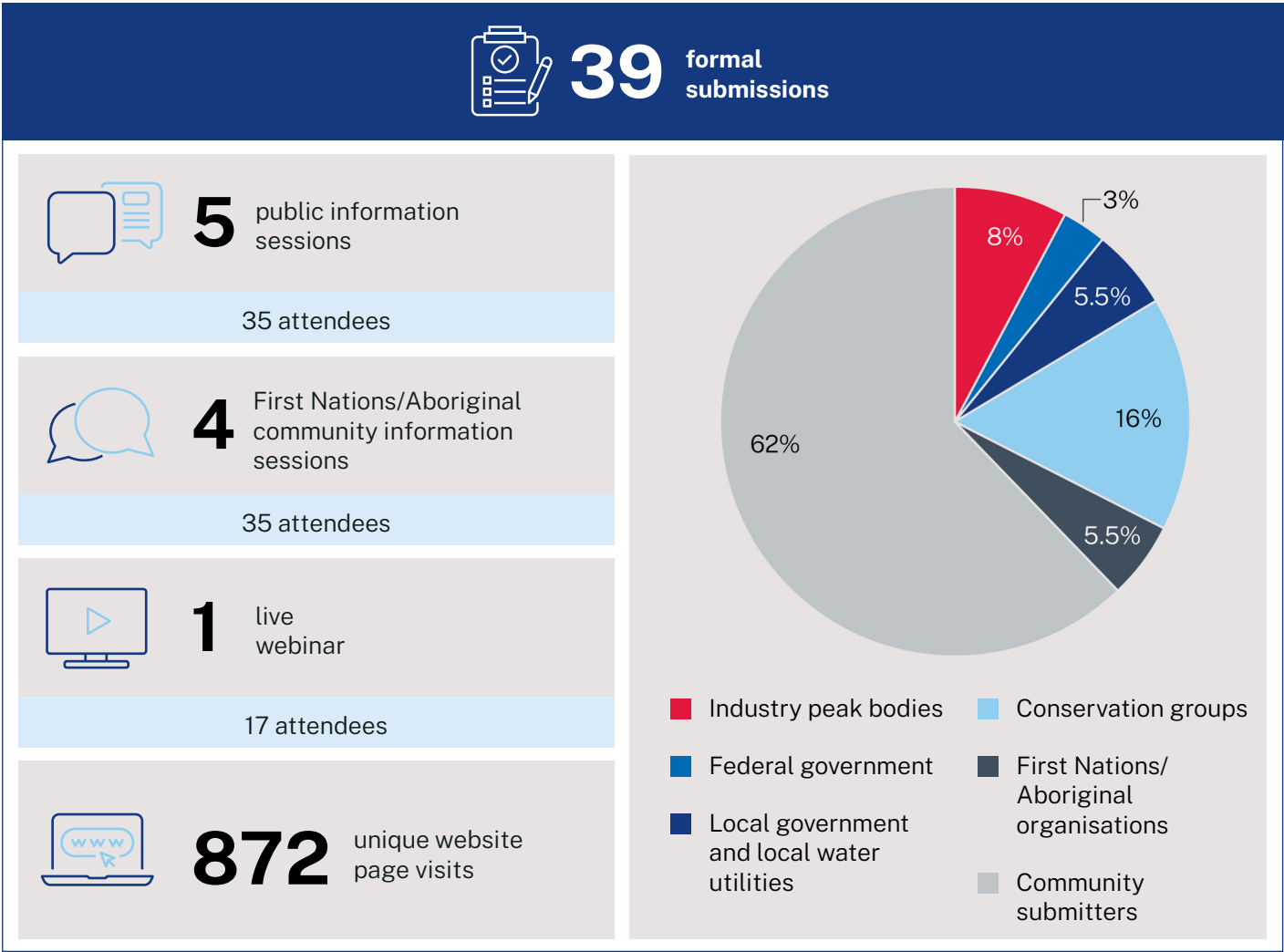
We sought public input on the Draft Namoi Regional Water Strategy and long list of options from March to May 2021 (Figure 4). The *What we heard report*⁶ for the draft strategy summarises the key issues we heard during the first round of public exhibition. It highlights how the feedback we received during this period has informed the next steps in the development of the Namoi Regional Water Strategy.

There was general support for the development of regional water strategies, but some stakeholders suggested that insufficient consultation had been undertaken in developing the draft strategy.

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

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

Figure 4. Stakeholder engagement during public exhibition period on the Draft Namoi Regional Water Strategy



6. Available for download at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard

Figure 5. Additional engagement undertaken for the proposed Dungowan Dam and pipeline project



Unless stated otherwise, all stats are cumulative totals from January 2020 and are updated at the end of each month.

* Cumulative from August 2020 – present

During consultation, we heard people's views on a range of water-related issues

Maintaining and diversifying water supplies



- Stakeholders showed strong support for options around water reuse and recycling, dual water systems and improving water security for small communities.
- There was mixed feedback on new infrastructure including the proposed new Dungowan Dam and pipeline, interregional pipelines and other system operational changes. While there was support for infrastructure options that brought additional water into the region, there was concern about the impacts of these options on the environment.
- Stakeholders voiced concerns about how costs may be passed on to users.

Protecting and enhancing natural ecosystems



- There was general support for options aimed at protecting and enhancing natural ecosystems, restoring connectivity across catchments and building understanding of how water systems in the Namoi region work and interact with the environment. However, there was concern about the extent to which connectivity across catchments could be improved given the natural drying cycles of the climate.
- There were some concerns raised about the potential impact of coal seam gas activities on groundwater sources.

Improving water-use efficiency and community preparedness for climate extremes



- Stakeholders showed strong support for water-use efficiency projects in the region. This includes looking at incentives to improve the efficiency of water use and ensuring that domestic and industrial water use does not impede environmental flow provisions.
- There was general support for options relating to a review of urban water restrictions policy and implementing the Great Artesian Basin Strategic Management Plan.
- Stakeholders were overwhelmingly in support for taking action to prepare for climate change.

Improving recognition of Aboriginal people's water rights, interests and access to water



- Aboriginal stakeholders showed support for the regional water strategies and highlighted the importance of improving the recognition of Aboriginal water rights, interests and access to water.
- There was a strong message that Aboriginal people have a lot to offer in water decisions and want more involvement in long-term water management.
- There were concerns about water overuse in the system, which is impacting culturally important locations and sites.

Where
should we
focus first?

3

Chaffey Dam in the Peel Valley.

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

The Namoi region is in northern inland NSW, where the landscape changes from hills and mountains in the east to flat alluvial plains in the west. It is a part of the Murray–Darling Basin and lies within the traditional lands of the Gomeroi/Kamilaroi Nation.

The Namoi region is a productive agricultural and mining region, containing large and strategic regional towns. It is home to a wide variety of aquatic ecosystems, including ecologically and culturally significant lakes and wetland complexes.

Like all regions across Australia, the Namoi 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 needs.

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



Addressing Tamworth’s long-term water security risks.



Addressing water security risks of regional towns across the Namoi Valley.



Supporting a growing regional economy in a future of potentially reduced water availability.



Improving the health and resilience of aquatic ecosystems.



Dismantling barriers to Aboriginal water rights.

Addressing these challenges will help us meet the vision and objectives we have set for the Namoi Regional Water Strategy.



Image courtesy of Destination NSW. Paradise Fresh, Tamworth.



Challenge: Addressing Tamworth's long term water security risks

Tamworth is an important regional centre

Tamworth is the largest regional centre in north-west NSW and an important hub for services and employment for the region. Currently, around 63,000 people – 65% of the Namoi region's population – live in the Tamworth area. The city of Tamworth provides key services in manufacturing, transport, health care, entertainment, retail and education. Tamworth's gross regional product is currently \$4.2 billion per year,⁷ and is growing at an average of 3.8% each year.

In addition to supporting social services for much of the inland north, Tamworth is of state-wide significance to the agricultural and manufacturing industries. The area hosts some of the largest livestock processing facilities in Australia as well as distribution facilities that drive employment and help to link farmers in the region with national and international consumers. Because of this, Tamworth has:

- the largest number of agricultural employees for a local government area in NSW
- the highest number of food manufacturing employees outside metropolitan Sydney.

Tamworth is growing

Tamworth is expected to grow significantly in population, housing and employment over the next 20 years. Much of this growth will be stimulated by local, state and national investment in schemes such as the New England Renewable Energy Zone and the Namoi Regional Job Precinct. These programs will drive business and population growth across the north-east of NSW.⁸ Population growth projections range from a modest 10% increase to a 50% increase over the next 20 years.⁹ The economic growth of Tamworth is fundamental to the success of the Namoi region and surrounding regions.

A key challenge for all levels of government is to ensure that Tamworth's growth is sustainable. This includes ensuring access to reliable and secure water supplies, while retaining and enhancing the character of the environment, the town and surrounding regions.

There is a real risk that Tamworth could run out of water

For Tamworth to continue to grow, communities and businesses require confidence that water sources are reliable and able to support future demand. Currently, even without growth, there is a real risk that Tamworth could run out of water in a severe and prolonged drought. There could be extended periods when Tamworth residents are on high or persistent water restrictions.

Tamworth's water supply relies heavily on rainfall-dependent storages, making it vulnerable to droughts and climate change. The majority of Tamworth's water supply comes from both the Chaffey and Dungowan dams, and only a very small proportion comes from groundwater. The local groundwater source – the Peel Alluvium – is relatively small and unreliable during extended dry periods. The Peel Alluvium relies on rain or water from the Peel River and its tributaries to recharge the groundwater source. When there is no rain and low river flows, groundwater levels drop quickly. This means that during severe drought, groundwater cannot sustain the needs of Tamworth for extended periods of time.

7. REMPLAN gross regional product of Tamworth Regional Council, based on 2011 and 2020 data from the Australian Bureau of Statistics.

8. Tamworth Regional Council 2020, Local Strategic Planning Statement 2020

9. NSW Department of Planning, Industry and Environment 2019, Common Planning Assumptions

Tamworth's town water usage

On average Tamworth currently requires around 25 megalitres (ML) per day or 9,200 ML per year (unrestricted demand) to supply communities and industry reliant on town water supplies.

Tamworth Regional Council holds:

- 16,400 ML/year of high-priority local water utility entitlement in the Peel Regulated River system (Chaffey Dam)
- 5,600 ML/year of entitlement in the unregulated river water sources (Dungowan Dam).

If these amounts could be realised every year with absolute certainty, Tamworth would not have a water supply problem. But this is not the case, since the entitlement is not a guarantee of water but a high-priority share of the available water. The entitlement is only realised if there are sufficient inflows to the dams.

This was demonstrated during the recent 2017–20 drought. After almost 2 years without rain, Chaffey and Dungowan dams had fallen from full in June 2017 to 13% capacity in January 2020. At this time, Tamworth had just under 18 months of water remaining even with severe water restrictions in place. Plans were being made for making even harder decisions about cutting water use further, making additional expensive investments in emergency water supplies, such as additional bores and pipelines, and trucking in water to meet the town's most essential needs.

Without action to reduce demand or improve supply, Tamworth could go from full dams to running out of water within 6 years. The risk of Tamworth being in water restrictions for extended periods of time or running out of water will become more acute as the population grows (Table 1) or if climate change impacts involve drier conditions. Although these scenarios may not occur, analysis undertaken for the regional water strategies tells us that we need to have plans ready for this as a future possibility.

These risks demonstrate that doing nothing is not an option. All levels of government need to invest in multiple actions to address Tamworth's long-term water security risks and ensure that the city remains resilient to climate change impacts as its population grows.

Table 1. Probability of Tamworth water supply being restricted under different climate and water demand scenarios if there are no changes to policy, infrastructure, or demand management

TWS* Unrestricted Water Demand (ML/year)	TWS* Water mean diversions (ML/year)	Nominal population	% of time under any restrictions	% of time under level 5 restrictions	Frequency of any shortfalls**
Tamworth water security under historical climate projections (paleo-stochastic climate dataset)					
9,200	8,900	50,000	17.7%	3.5%	1 in 1,400 years
11,000	10,500	60,000	21.3%	5.4%	1 in 520 years
Worst case dry climate change scenario (NARCLiM)					
11,000	9,700	60,000	58.6%	30.3%	1 in 20 years
12,900	10,900	70,000	62.9%	36.1%	1 in 12 years

* 'TWS' as town water supply.

** A 'shortfall' event is where Tamworth's water demands under level 5 restrictions cannot be met from the existing supply system because the dams are empty for 2 weeks or more. A 'major shortfall' is where the dams are empty for 3 months or more.

The townships of Manilla and Barraba are also within the Tamworth local government area but source water from the Upper Namoi catchment. Manilla relies on surface water from the unregulated Upper Namoi River, supplemented by supply from Split Rock Dam in dry years. Barraba relies on supply directly from Split Rock Dam but has some bores that can be used when needed.

Our analysis suggests that surface water is likely to be less reliable than previously thought for these towns. There could be a higher risk of Split Rock Dam being at critically low levels or empty for longer, increasing the water security risks for Manilla and Barraba for longer (see Table 2).

Table 2. Probability of Split Rock Dam being at critically low levels

Split Rock Dam capacity	Historical climate projections (paleo-stochastic climate dataset)	Worst case dry climate change scenario (NARClIM)	Implications
3% capacity	0.5% (1 in 200 years)	5% (1 in 20 years)	Water is preserved for Manilla and Barraba only
Dead storage	0.2% (1 in 500 years)	2% (1 in 50 years)	Manilla will run out of surface water. Barraba can access dead storage

The NSW Government has invested in new modelling methods and datasets to develop a better understanding of both historical climate variability and likely future climate conditions. We are using new scientific methods that augment the observed historical record which is about 130 years of rainfall, temperature and evaporation data with paleoclimate data (data reconstructed from before instrumental records began, using sources such as tree rings, cave deposits and coral growth).

We have also applied a worst case dry regional climate change projection from NARClIM (the NSW and ACT Regional Climate Modelling project) to stress test the water system. This scenario may not occur, and if it does, the full impacts are not expected to occur for another 40 years.

This greatly improves our ability to identify plausible climate impacts and risks, and it represents a significant and important advance in water planning for NSW.

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.

The proposed new Dungowan Dam will significantly reduce water security risks, but not eliminate long-term risks

To help address these water security challenges, the NSW and Australian governments have made provision for a new Dungowan Dam and transfer pipeline. This dam could increase the volume of the current Dungowan Dam from 6.3 gigalitres (GL) to 22.5 GL, with this increase in storage being equivalent to around 2 years of restricted supply for Tamworth.¹⁰

At current levels of demand, the proposed new Dungowan Dam could:

- nearly halve the risk of Tamworth running out of water, reducing the risk of Tamworth running out of water from a 1 in 1,400 year probability to a 1 in 2,450 year probability. This will also help to reduce the risk of triggering extreme emergency supply measures

- significantly reduce the frequency and duration of water restrictions in Tamworth. If our future climate is similar to our long term historical climate projections, the frequency of Tamworth residents and businesses experiencing water restrictions could go from a 1 in 4 year probability to a 1 in 9 year probability with the proposed new Dungowan Dam
- improve the resilience of Tamworth's water supply in droughts worse than what we have experienced in our past without impacting the average allocation for general security licence holders

In the long term, the risks to Tamworth's water supplies increase with the growth in water demand from industry and population, and with the possible onset of a drier climate. The extra storage capacity of the proposed new Dungowan Dam will help to support Tamworth and any growth up to 20%. Additional water actions will be needed to support growth beyond this. In the short term, actions should focus on managing demand and improving the security of water supply.

10. The water security benefits for Tamworth from the new Dungowan Dam are dependent upon the drought data being applied. As droughts drive the performance of the dam, estimates of how much water the new dam could provide Tamworth are different depending on the dataset used. The NSW Government has invested in new climate datasets that allow us to assess the performance of the dam against extreme droughts that are worse than those we have experienced in the last 130 years. This provides a more robust analysis of infrastructure as it factors in climate risk and demonstrates how well the dam will perform under conservative future assumptions about droughts.

Effect of proposed new Dungowan Dam on Tamworth's water supply under different climate scenarios as Tamworth water demand grows by 20%

As part of the investigations of the proposed new Dungowan Dam business case, the NSW Government has analysed how the proposed new dam could improve Tamworth's water security under different climate scenarios and with an increase in water demand. The analysis shows that climate risks will increase the time Tamworth residents spend in water restrictions, but the proposed new Dam will help mitigate some of those risks.



What a wet future could look like in 2070?

Rainfall increased by about 14% and runoff reduced by about 6% (due to higher temperatures and increased evapotranspiration).



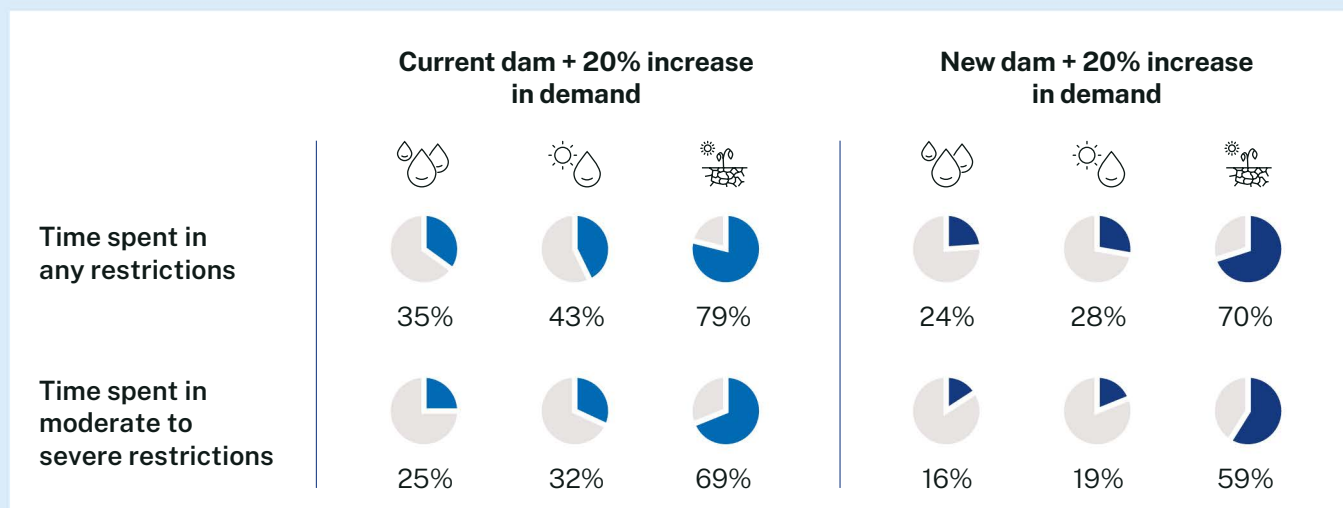
What a medium future could look like in 2070?

Rainfall reduced by about 4% and runoff reduced by about 21%.



What a dry future could look like in 2070?

Rainfall reduced by about 17% and runoff reduced by about 60%.



Legend:



Wet climate



Median climate



Dry climate



Challenge: Addressing water security risks of regional towns across the Namoi Valley

Many towns are dependent on groundwater for their water supply

Gunnedah and Narrabri are important regional centres in the Namoi Valley. These large regional towns have a combined population of around 16,000 and provide a hub for important services to the surrounding rural areas. The population and economies of both centres are projected to grow in coming years, stimulated by major schemes and projects that are planned for the region. These include:

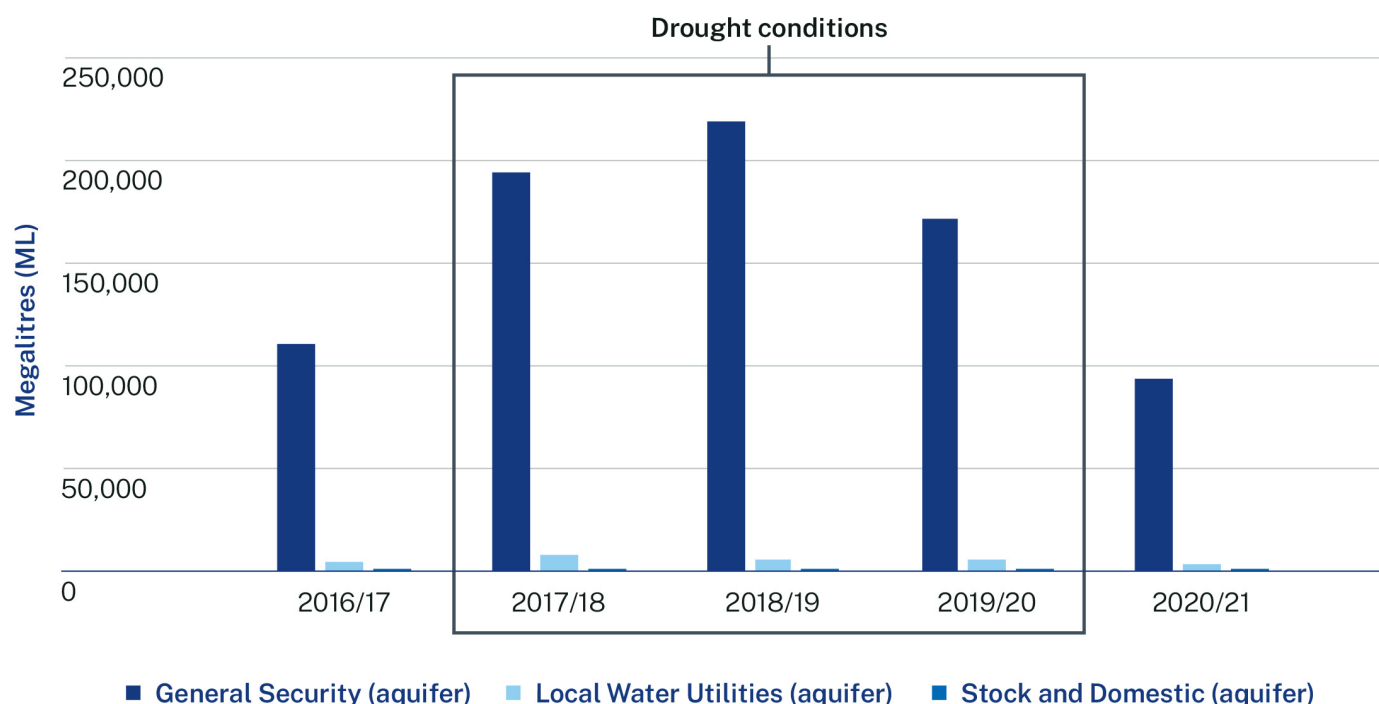
- Narrabri Special Activation Precinct
- Namoi Regional Job Precinct
- Narrabri Gas Project
- expansion of Gunnedah coal mining industry
- inland rail, which will connect Narrabri directly with ports and processing facilities in Queensland and Victoria.

Narrabri and Gunnedah rely on groundwater for their water supply. Many small towns in the region with populations below 3,000 also rely on groundwater, including Boggabri, Quirindi and Wee Waa. For most towns in the Namoi region, groundwater is their main, or only, source of water.

There is uncertainty about water security for groundwater-dependent towns in severe droughts

Most of the groundwater in the region is used for irrigation purposes. During extended dry periods many water users increase their use of groundwater compared to average years (Figure 6), and the amount of water recharging aquifers from rivers and rainfall is diminished. Combined, these conditions can result in severe localised water level drawdowns and create difficulties in accessing water for town water use until the drought breaks and the groundwater levels recover.

Figure 6. Licensed groundwater use in the Namoi and Peel valleys between 2016 and 2021



During the recent drought (2017–20), there were declines in groundwater levels – for example, in Zone 4 of the Upper Namoi groundwater source, which supplies Gunnedah and Curlewis. Groundwater-dependent towns in the region were able to maintain town water supplies during this period. However, had the drought continued for longer, local water level declines may have impacted the ability of some towns to maintain the same pumping rate from groundwater.

There is uncertainty in several locations about the implications for local short-term drawdowns in groundwater levels if future droughts are worse than what we have experienced in the past. The NSW Government collects data on groundwater levels at a regional scale; however, this information is often not sufficient to show local impacts on groundwater

or support council decision making. Because of the complexity of the aquifer systems, our knowledge of how these aquifers will react in future extended dry conditions is still developing. To better understand the short-term localised behaviour of aquifers, we need further data, modelling and investigations.

Some locations are also experiencing long-term declining trends in groundwater levels which are exacerbated during droughts. From 2006 until 2021, groundwater levels declined by between 2 and 5 m in the area south of Breeza (Upper Namoi Zone 8), where Caroon draws water. Over this period, groundwater levels declined by between 5 and 10 m in the area north of Wee Waa. In the longer term, a drying climate may increase long-term drawdowns.

It can be challenging for councils to secure water for small towns as a result of limited resourcing

Town water in the Namoi region is supplied by local water utilities that are owned and operated by local councils. Six main water utilities supply town water: Gunnedah Shire Council, Liverpool Plains Shire Council, Narrabri Shire Council, Tamworth Regional Council, Walcha Shire Council and Walgett Shire Council. These local water utilities provide water and sewerage services for their communities.

For many small towns across the Namoi region, ensuring that water supplies are secure can be difficult. Councils often do not have the technical skills and financial resources to undertake investigations to assess water security risks and to identify supply options. The NSW Government is currently working on ways to improve support for councils in delivering water for small communities through the Town Water Risk Reduction Program and the Safe and Secure Water Program.

During dry periods surface water is not reliable for towns like Walgett

Walgett, with a population of approximately 2,100, is largely dependent on water from Keepit Dam, which flows down the full length of the Namoi River. While bores are used in dry times, the groundwater can be saline and requires treatment. However, attracting and retaining skilled staff to operate treatment plants and manage water quality is a significant challenge.

Due to Walgett’s distance from Keepit Dam (approximately 350km) the township often cannot rely on accessing water from the dam during drought periods. During the most recent drought the river was cut off for extended periods of times. At points only 1 ML out of every 20 ML released from the dam would make it to Walgett due to increased water seeping into groundwater systems and evaporation. A more variable future climate will mean that surface water is likely to become less reliable, increasing the probability of surface water supplies for Walgett failing (Table 3). Walgett may therefore need to rely more heavily on groundwater sources in future.

Table 3. Percentage of time when surface water supplies from the Namoi catchment to Walgett fail

	Repeat of historic climate 1889-2021	Long-term 10,000-year climate projection	Long-term 10,000-year worst-case dry climate change projection
Walgett	0.50% 1 in 200 years	2.0% 1 in 50 years	10.0% 1 in 10 years



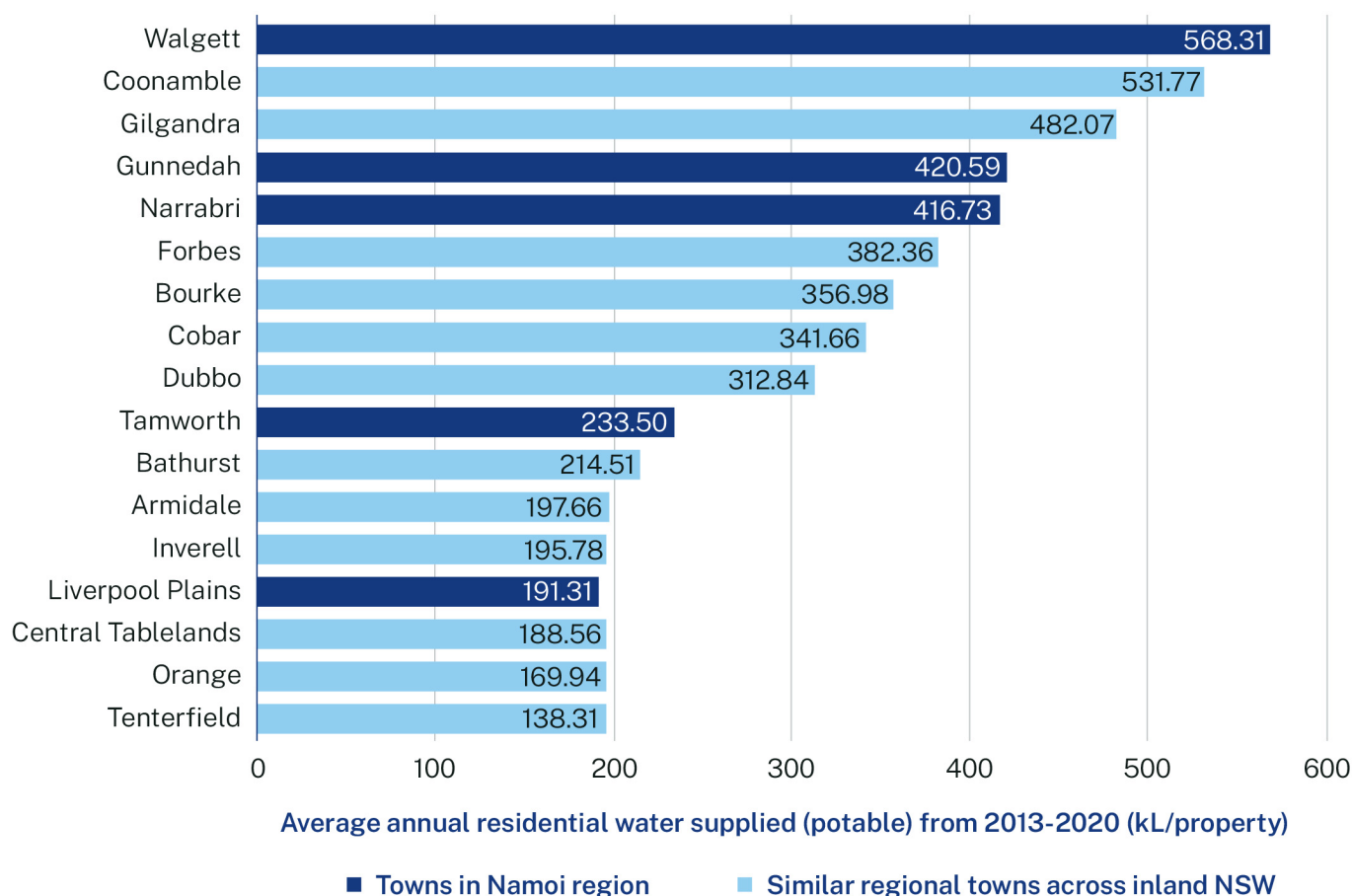
Glossy Black Cockatoos in wattle tree.

Water demand and water-use efficiency can improve town water security

Programs to improve water-use efficiency, reduce leakage and reduce demand can help improve water security for these towns. Some towns have implemented rebates for more efficient appliances and community education programs to manage demand over multiple years.

Water demand per capita in the Namoi region is expected to be higher than the average for NSW, given the semi-arid and hot conditions. Between 2013 and 2020, some groundwater-dependent towns in the region were among the largest per capita residential water users in the state (Figure 7). During drought, water use in these towns remained similar to demand before the drought, whereas other similar regional centres that rely heavily on surface water reduced residential water use significantly. Tamworth reduced domestic water use by up to 52%: 286 kilolitres (kL) per property in 2013 versus 140 kL per property in 2020.

Figure 7. Annual residential water (potable) supplied to regional towns in inland NSW (2013-20)



Source: www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data



Challenge: Supporting a growing regional economy in a future of potentially reduced water availability

Agriculture and mining are important to the regional economy

The Namoi region is one of the most productive agricultural and mining areas in NSW. Agriculture and mining provide employment for more than 33% of all workers in the region, and account for around 25% of the region's economic output (Figure 8).

Agriculture is the dominant land use in the region, including extensive livestock, dryland and irrigated cropping operations, and an agribusiness cluster for chicken, meat and eggs around Tamworth.

Each year, the Namoi region produces approximately \$1.8 billion¹¹ in agricultural products. The highest-value areas are the Liverpool Plains and Gunnedah local government areas, with highly fertile black earth, and access to both surface water and groundwater. These areas have the highest agricultural yields per hectare, with production more than 40% higher¹² than state averages.

The Namoi region is also one of NSW's most important mining districts, with mining adding more than \$1.4 billion of economic value to the region annually. It is estimated that Narrabri Shire alone contains more than 12% of NSW's remaining coal reserves. There are plans to grow the mining sector in the region through the approval of several new gas and coalmining operations. This includes the proposed Narrabri Gas Project.

Narrabri Gas Project

The Narrabri Gas Project is a proposed coal-seam gas project being developed in the Gunnedah Basin close to Narrabri, with an interface to the Narrabri Special Activation Precinct. The \$3.6 billion dollar project will include around 850 wells drilled across a 95,000 ha site. The project's footprint will span both private and public lands, including prime agricultural lands, as well as the Pilliga East State Forest and the Bibblewindi State Forest. These, along with other public lands in the area, are currently subject to a native title land claim by the Gomeroi Traditional Owners.

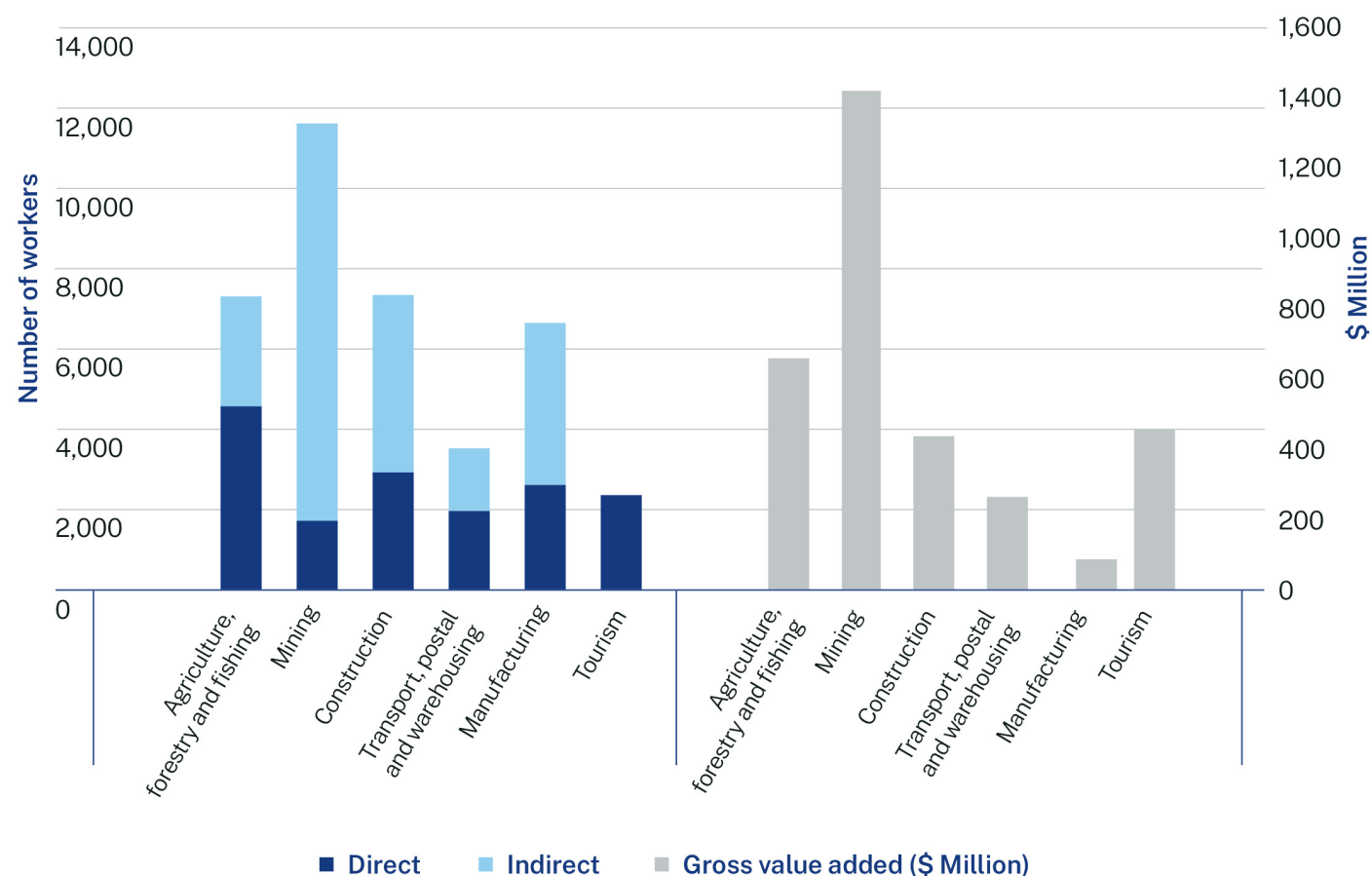
During the development and planning of this project, some landholders, Traditional Owners and peak organisations raised concerns about the impacts that the operations may have on local aquifers, runoff and surface water quality.

These concerns were considered and addressed through the requirements of the development consent. The project is now seeking approval from native title claimants, who have a right to be consulted prior to any decisions about the land.

11. REMPLAN 2022, *REMPAN Economy: custom data*, www.remplan.com.au/economy (data represent gross revenue generated from agriculture, forestry and fishing)

12. NSW Department of Primary Industries 2020, *Agriculture industry snapshot for planning: North West Plains Sub Region*, Department of Primary Industries, www.dpi.nsw.gov.au/_data/assets/pdf_file/0007/1260493/North-West-Plains-Snapshot.pdf

Figure 8. Employment and economic outputs of key industries in the Namoi region



Source: REMPLAN 2019, Economic analysis for the Department of Planning, Industry and Environment, based on 2017-2018 dataset

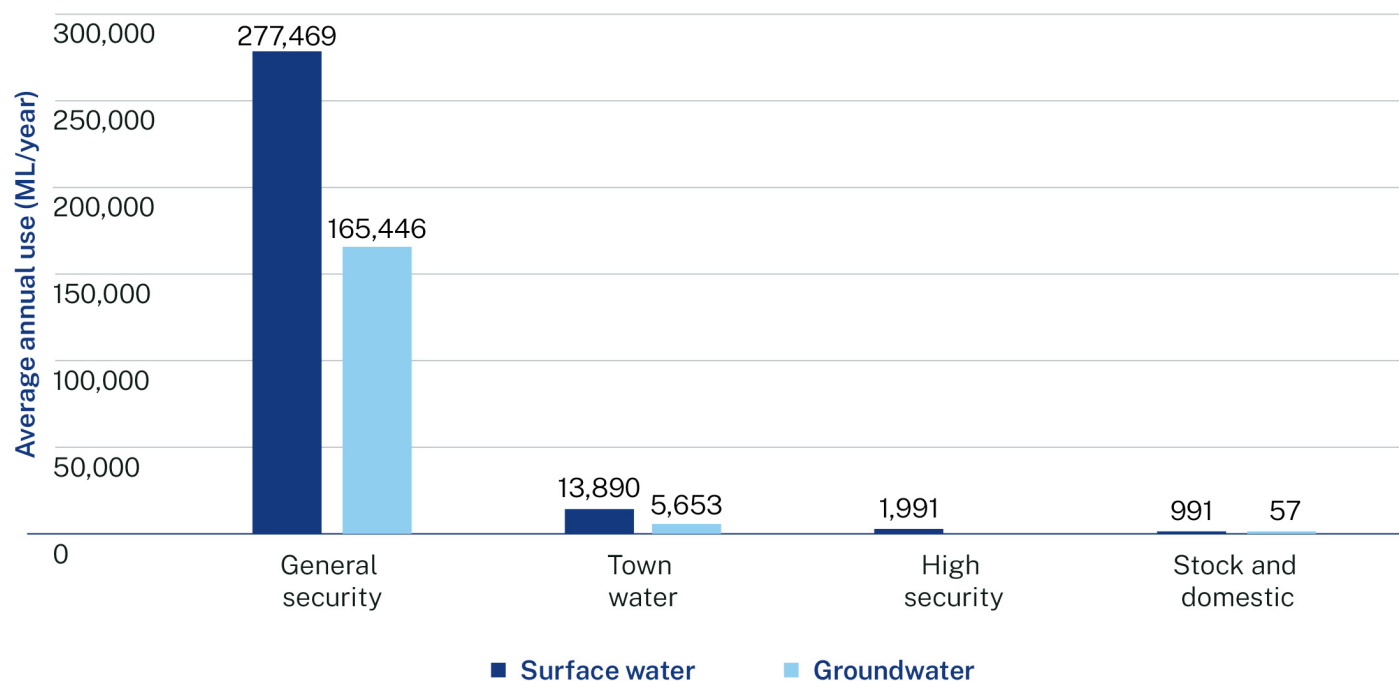
Agriculture and mining rely heavily on water as inputs and at times compete for water with each other and other users. Surface water and most groundwater sources in the region are fully allocated. Water use each year varies, depending on water availability.

On average, agriculture accounts for 94% of all licensed surface water and groundwater use in the region, almost all of which is used to irrigate cotton and grains. Mining accounts for approximately 2%, on average, of the region's licensed water use (See Figure 9).

How is water used in the Namoi region

Water access licence type	Primary users
General Security	Primarily used for irrigation
High Security	Typically used by mines, towns and other industries that need highly reliable water like intensive livestock or permanent plantings
Town water	Used to support towns and connected industries
Stock and domestic	Used to support livestock and domestic water users

Figure 9. Average yearly surface and groundwater use across licence categories, averaged over 2016–21



Because of the high reliance of the region's economy on water, many industries are vulnerable to shocks from droughts. As water availability decreases, so does production and employment. During the most recent drought, there was a decline in productivity across the New England north-west region. Gross domestic product in the period 2018–20 fell almost 15% below average. This resulted in reduced employment, reduced capital use and drought-induced productivity losses across the broader economy.¹³

There is significant potential for growth in high value industries in the region

Agriculture and mining will remain essential industries for the region for years to come.

We have also heard that we need to begin planning for the transition of mining industries. In the Liverpool Plains Shire Council small coal mines will be closing in the coming years. In the Gunnedah Shire Council coal mines are likely to continue operating for the coming decades, however, there will be a stage where the region will need to transition economically and we need to begin planning for this.

There is also potential for new high value industries, which could help grow and diversify the regional economy. This growth could be driven by:

- growth of the intensive agricultural industry, supported by the Namoi Regional Job Precinct – chicken and cattle livestock production is becoming

one of the fastest-growing industries in the region as a result of growing demand from domestic and export consumers

- industries based around natural gas – the Narrabri Gas Project has been approved to produce natural gas from coal seams near Narrabri
- the Narrabri Special Activation Precinct – a precinct around the Narrabri area is being set up to attract investment and will include an energy hub, as well as industries leveraging off the inland rail project
- the New England Renewable Energy Zone – this will coordinate investment in electricity transmission, generation, storage and firming infrastructure
- the inland rail project – a new 1,700 km freight rail line connecting Melbourne and Brisbane via regional New South Wales will include a stop at Narrabri, connecting it with important supply networks.

Reliable water is essential to support these new and future industries. There may also be an overlap in the timing of when water is required for new industries and transitioning industries. Because surface water and groundwater sources are finite, water for new industries will have to come from redeployment of existing water entitlements, or treated reuse of wastewater. This will be challenging because only a small proportion of licences in the region are of the high reliability needed for these industries, and these licences are difficult to buy and redeploy. We need to identify ways to obtain secure water supplies that ensure that future industries entering the region can operate in times of reduced water availability.

13. Wittwer G (2020) *Estimating the regional economic impacts of the 2017 to 2019 drought on NSW and the rest of Australia* (CoPS Working Paper No. G297), Centre of Policy Studies. www.copsmodels.com/ftp/workpaper/g-297.pdf

A long-term reduction in surface water could impact the regional economy

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

Irrigators have adapted to the region's variable climate by producing annual or seasonal crops, investing in on-farm storages to capture water during wet periods for use later, and setting aside funds for years when cropping is not possible or greatly reduced. They have also invested in technology and improved management practices to maximise benefits from the available water. For example, the cotton industry has improved whole-farm irrigation efficiency, so producers now achieve almost twice as much cotton from the same amount of water as 25 years ago.

Some agricultural businesses use groundwater, or a combination of surface water and groundwater, to allow production to continue during the frequent times when surface water is scarce.

Mines typically have multiple water sources. They maximise use of local runoff and wastewater and can use water of lower quality than many other industries.

During dry periods, mines and agricultural processing facilities often look to the water market to secure additional water for their operations. We have heard from some parts of the community that this can sometimes drive-up prices, making it harder for other water users to buy water on the market.

Despite this adaptability, during recent record droughts, many of these businesses were placed under significant stress due to unanticipated low inflows for 3 consecutive years. Historically, general security water licences in the Upper Namoi Regulated River have had very high reliability compared with general security licences in the Peel and Lower Namoi, and users of these licences have adapted accordingly. However, during the last drought in 2017–20, even these licences received zero water allocation and had access to carried-over water allocations suspended, which was a severe shock to local businesses.

Through our consultation we have heard that consistent zero or low general security water availability for 4 or 5 years will impact the viability of many of the region's irrigated agricultural operations and will start to have flow-on impacts on regional towns placing the regional economy and jobs at risk. It will also impact the ability of new high value or diversified industries to enter the region.

Recent improvements in our understanding of the region's climate suggest that there is a possibility of multiple consecutive years of low or no water availability for general security licences even without a dry climate change scenario. This risk is lowest in the Upper Namoi and highest in the Peel (Table 4).

Table 4. Probability of general security licences being below 20% allocation for 4 consecutive years

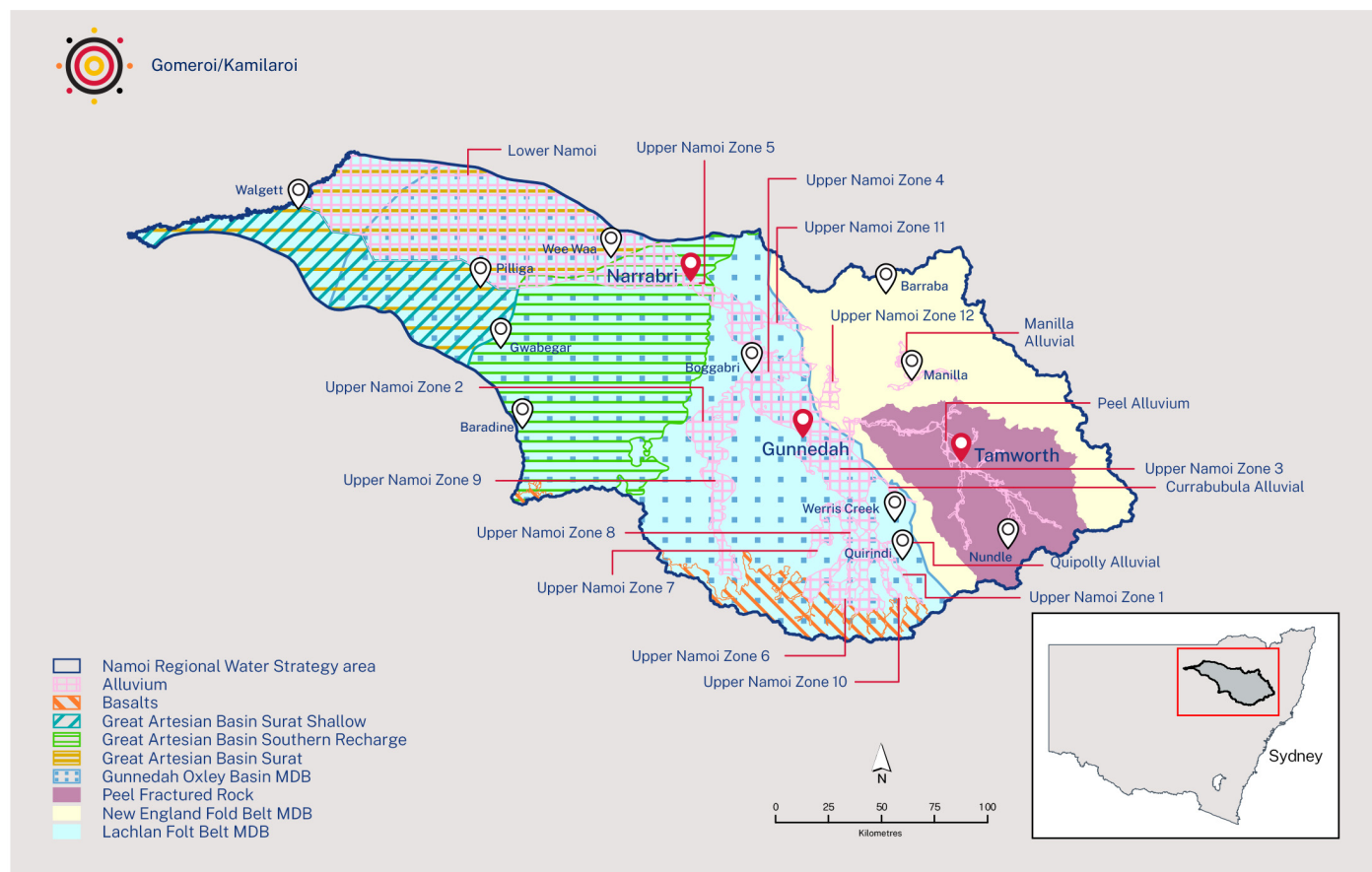
	Peel Valley general security		Lower Namoi general security		Upper Namoi general security	
	Long term historical climate projections (Stochastic)	Worst case dry climate change scenario (Stochastic + NARCLiM)	Long term historical climate projections (Stochastic)	Worst case dry climate change scenario (Stochastic + NARCLiM)	Long term historical climate projections (Stochastic)	Worst case dry climate change scenario (Stochastic + NARCLiM)
4 consecutive years below 20% allocation	1 in 62 years	1 in 22 years	1 in 131 years	1 in 32 years	1 in 2450 years	1 in 272 years
4 consecutive years of 0% allocation	1 in 109 years	1 in 24 years	1 in 891 years	1 in 110 years	1 in 2450 years	1 in 272 years

Note: NARCLiM = NSW and Australian Regional Climate Modelling.

While these scenarios may not occur, and the probability of some of these scenarios is very small, we will need to identify innovative ways to provide water to support existing and future industries that enter the region and ensure that they can operate at times when water is scarce.

Groundwater levels are declining in some areas, putting economic production at risk

Figure 10. Groundwater resources in the Namoi region



Groundwater extraction from alluvium in the Namoi region is one of the highest in the Murray–Darling Basin. Groundwater sources support stock and domestic uses and town water supplies. They are also critical in supporting some of the state’s highest levels of agricultural productivity, particularly in the Gunnedah and Liverpool Plains local government areas. The mining industry also uses groundwater from the Upper Namoi Zones 4, 5 and 11 (See Figure 10).

The amount that can be taken sustainably from these groundwater sources is closely linked to the rate at which they are recharged. Yearly recharge is a very small proportion of the total volume that is in storage in a large alluvial ground water sources like the Lower Namoi. The large volume in storage in many major alluvial aquifers provides a buffer for years of drought and low recharge, making these aquifers very reliable water sources. However, if the average extraction continues to exceed the average recharge over many years, it can lead to extensive and long-term declines in water levels which can reduce groundwater supplies and potentially cause land subsidence.

We are seeing long-term declines in some parts of the Upper and Lower Namoi groundwater sources. From pre-1990 until 2021, groundwater levels declined by:

- 2-5 m across most of the Upper Namoi
- up to 10 m north east of Gunnedah (Upper Namoi Groundwater source Zone 4 and Zone 12)
- up to 10 m near Breeza (Upper Namoi groundwater Source Zone 3 and Zone 8)
- more than 10 m in the Upper Namoi Groundwater Source Zone 12 and east of Carroona in the Upper Namoi Groundwater Source Zone 8
- between 5 and 10 m in the area north of Wee Waa in the Lower Namoi.

More recently (from 2006 to 2021), water levels have improved north of Breeza (Upper Namoi Groundwater Source Zone 3) and near Mullaley and Boggabri (Upper Namoi Groundwater Source Zone 2). However, the water levels have continued to decline across most of the Upper Namoi by around 2 m, with the Upper Namoi Groundwater Source Zone 12 (north-east of Gunnedah) and the area near Carroona (Upper Namoi Groundwater Source Zone 8) showing up to a 10 m decline.

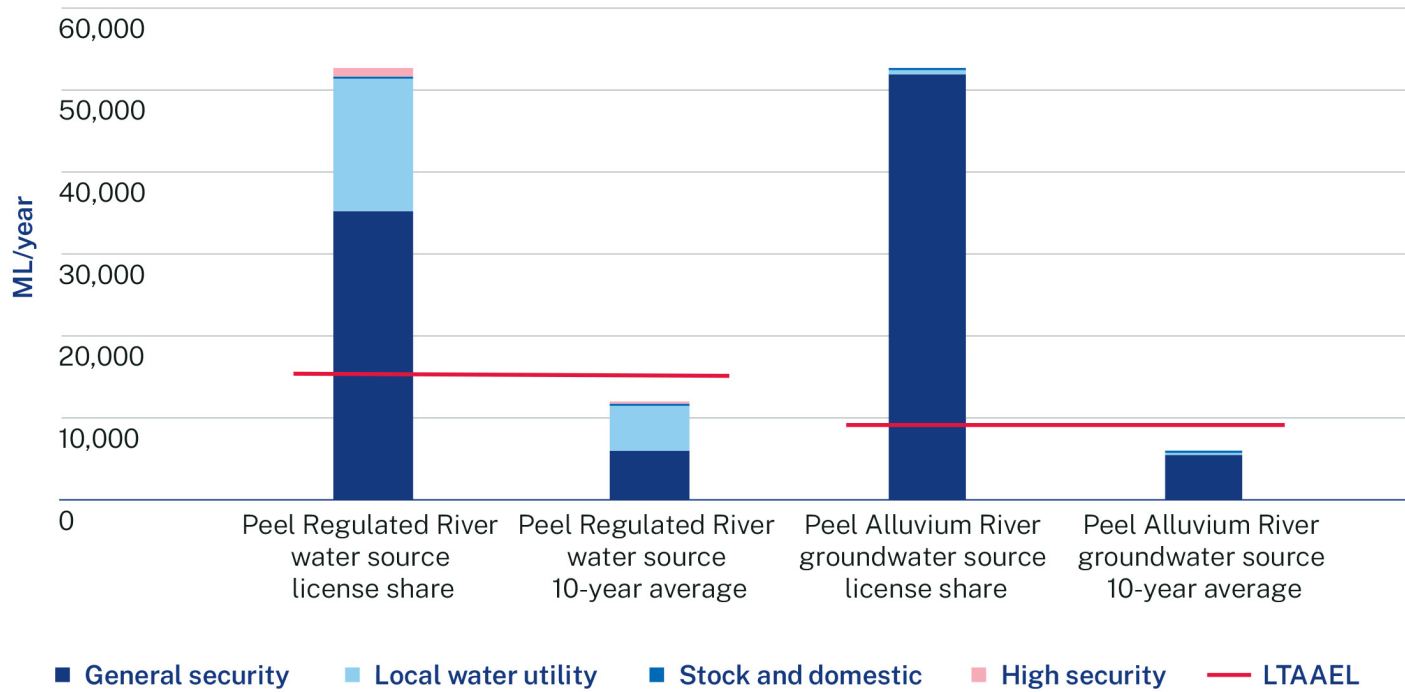
If these declines continue, restraints on water extraction are likely to be introduced in these areas to provide ongoing viability of the resource for all uses. If the climate becomes drier in the longer term, this problem will become worse.

Activation of unused irrigation water licences in the Peel could impact on existing irrigation businesses

Water sources have long-term extraction limits that set the volume of water that can be taken sustainably from the water source. The amount of water that can be taken is often divided into entitlements that are held by water users through licences. Under the *NSW Water Management Act 2000* entitlements that were previously expressed as megalitres per year were changed to the same number of shares in the available water, to show clearly that the entitlement is not a right to a specific volume.¹⁴

In the Peel Regulated River system and the Peel Alluvium groundwater source, the number of shares is significantly higher than the megalitres set in the long-term average annual extraction limit – approximately 5 times higher in the Peel Regulated River and approximately 6 times higher in the Peel Alluvium. However, average use remains below the extraction limit. Despite this, active irrigators in the Peel can presently access 1 ML per share in a large proportion of years because there are currently many licences that are underused or not used at all (Figure 11).

Figure 11. Water use by licence holders in the Peel Valley



Note: LTAAEL = long-term average annual extraction limit.

Some stakeholders are concerned about the water supply and financial risks that activation of unused licences represent to established irrigation enterprises. If the unused licences become activated and average

water use goes beyond the long-term extraction limit, irrigators could have their water allocations reduced. It is essential to maintain extraction within the long-term extraction limit.

14. Exceptions to this include specific purpose licences – for example for town water supply



Challenge: Improving the health and resilience of aquatic ecosystems

The Namoi region supports a rich and diverse range of water-dependent plants, animals and ecosystems. Platypus are abundant in the Peel Valley. The Namoi Valley is home to more than 40 waterbird species and 20 native fish species (including 5 threatened species), as well as floodplains, wetlands and endangered ecological communities.

The region is also home to a range of groundwater-dependent ecosystems, such as river red gums, which have been in decline in the Murray–Darling Basin and the wetlands surrounding Lake Goran. These ecosystems provide habitat for migratory birds that are protected under international migratory bird agreements.

Flows in the river at different times of the year help support the life cycles of fish, animals and plants – providing cues for movement, growth and reproduction. Recharge of groundwater sources supports groundwater-dependent ecosystems.

Water flows to the end of the system are declining

Landholders, the environment, and communities across the Namoi region and in connected downstream communities rely on water flowing along the length of the river and downstream. Flows along connected river catchments provide water for:

- basic landholder rights
- critical human needs
- protecting and enhancing riverine habitats and aquatic species, including drought refuges and movement corridors for fish
- town water supplies for communities along the Barwon–Darling system
- cultural needs.

On average, approximately 82% of the inflows in the Namoi catchment flow downstream to the Barwon–Darling river system.¹⁵ This makes up approximately 23.5% of the water in the Barwon–Darling river system.¹⁶ The Namoi is one of the largest flow contributors to downstream reaches of the Barwon–Darling at the Menindee Lakes.

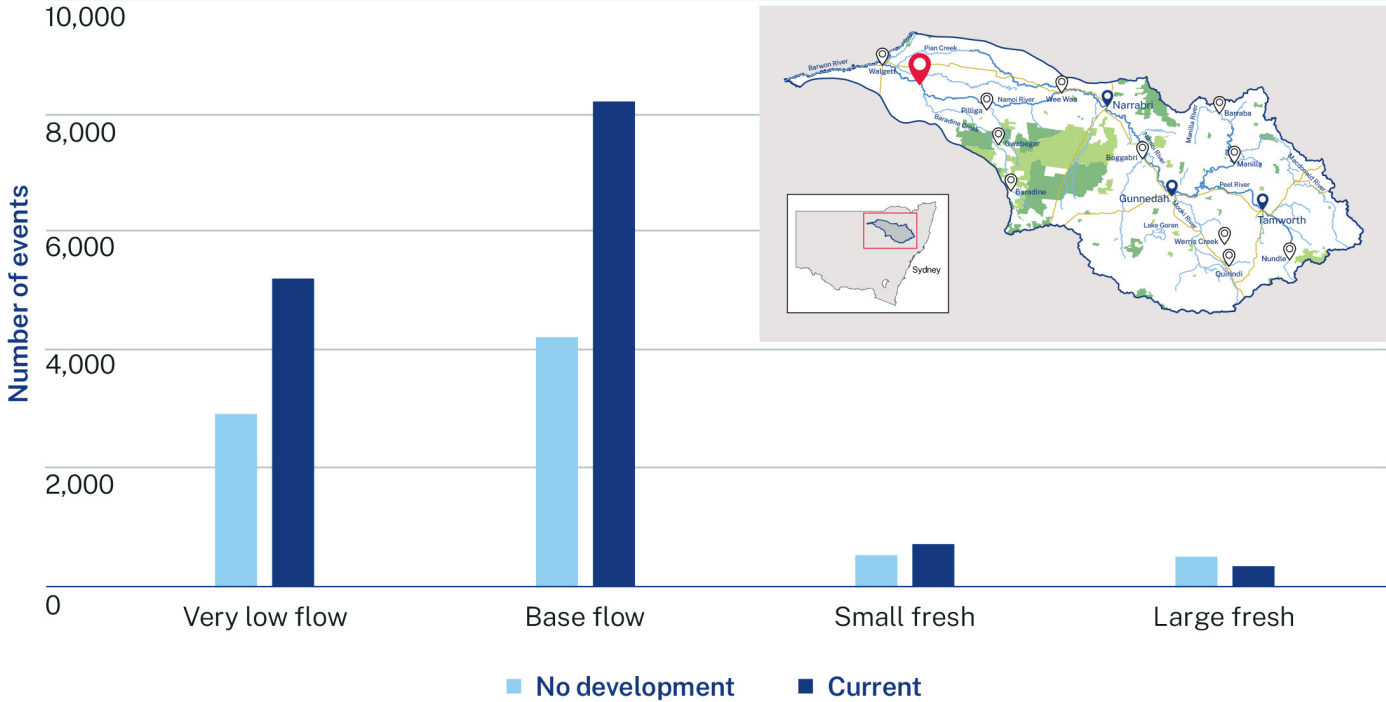
During the past 60 years, river flows across the Namoi catchment have changed significantly in response to the construction of 3 major dams – Keepit Dam (1960), Chaffey Dam (1979) and Split Rock Dam (1987) – as well as weirs, floodplain infrastructure, and industry and town development.

Modelling analysis has shown that there has been an increase in the number of base flows and small freshes in the lower end of the Namoi (Figure 12), supporting the critical needs of the environment during average and wet periods. However, the frequency of large freshes has decreased (Figure 12). Aquatic populations need all types of flows at certain frequencies, duration and timing to maintain their health and resilience. On average there is less water flowing to the end of the system (Figure 13) and cease-to-flow periods have increased in the mid and end of the system (Figure 14 and Figure 15).

15. This is the proportion of the average inflow from the Namoi catchment into the Barwon–Darling system as a proportion of long-term average modelled mid system flows in the Namoi. Further information is available in the report Stocktake of northern Basin connectivity rules – analysis of implementation and effectiveness, www.industry.nsw.gov.au/water/environmental-water-hub/outcomes

16. Without-development and baseline scenarios under the historical climate, July 1895 to June 2009

Figure 12. Modelled frequency of flow events¹⁷ in the Namoi River at Goangra (end of system stream gauge 419026) with and without development for the period 1892 to 2020



Replenishment flows from dams that provide for essential supplies and consumptive water orders also support the needs of the environment; however, during dry periods replenishment flows cannot always be delivered especially to the river reaches in the Lower Namoi, because of very high seepage and evaporation in the river channel and the need to preserve water in

dams for essential needs. For the same reasons, end of system flow rules are currently not designed to operate during dry conditions¹⁸ when the need for water is greatest. This impacts on the ability to sustain critical human and environmental needs, especially in dry years, when the need is highest.

17. The categorisation of flow events in Figures 11, 16 and 17 has been adopted from the environmental watering requirements at the relevant location as identified in the Namoi Long-Term Water Plan. Categorisation of events was only based on the volume of the flow over the specified number of days being met and not time of the year it occurred. The duration and timing of these events is important in maximising ecological outcomes of these events. For more information on environmental watering requirements see NSW Office of Environment and Heritage 2018, Namoi Long-Term Water Plan–Parts A and B– Namoi catchment, www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/namoi

18. During the 2017–20 drought, the end-of-system flow rule was not triggered 8 out of 9 months that it could have been triggered because of low storage levels

Figure 13. Modelled median monthly flow in the Namoi River at Goangra with and without development for the period 1892 to 2020

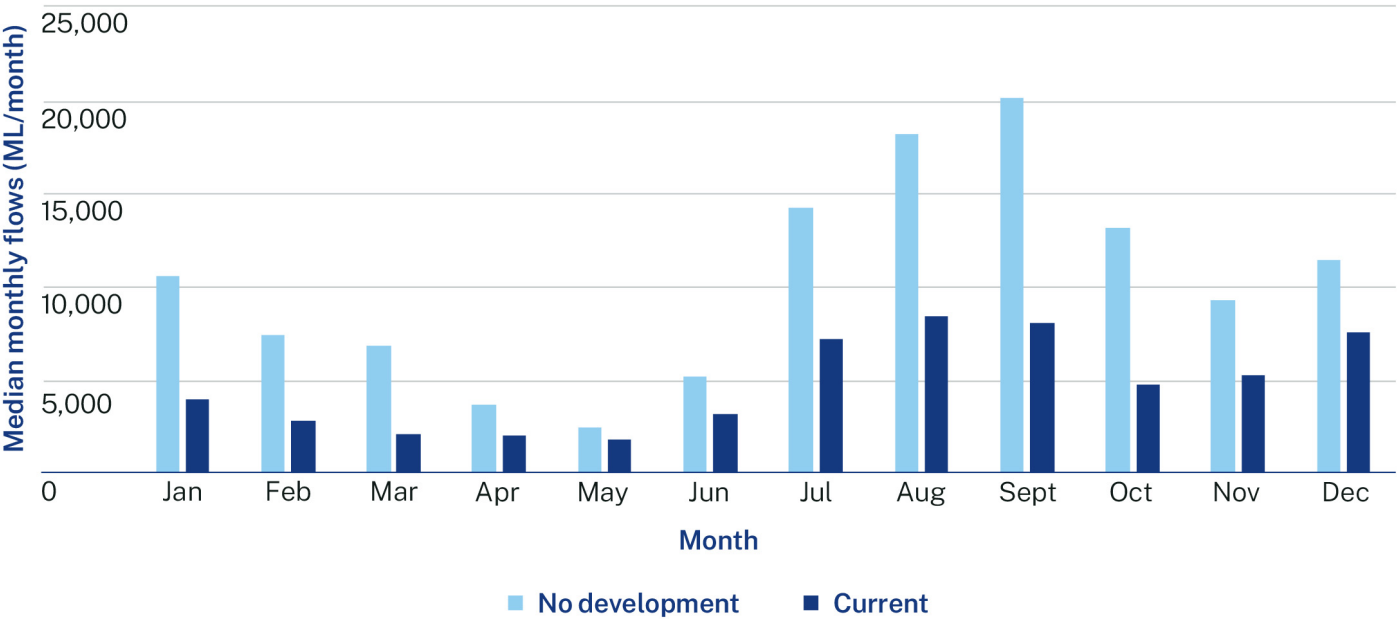


Figure 14. Modelled cease-to-flow periods (<5 ML/day) in the Namoi River at Goangra (stream gauge 419026) with and without development for the period 1892 to 2020

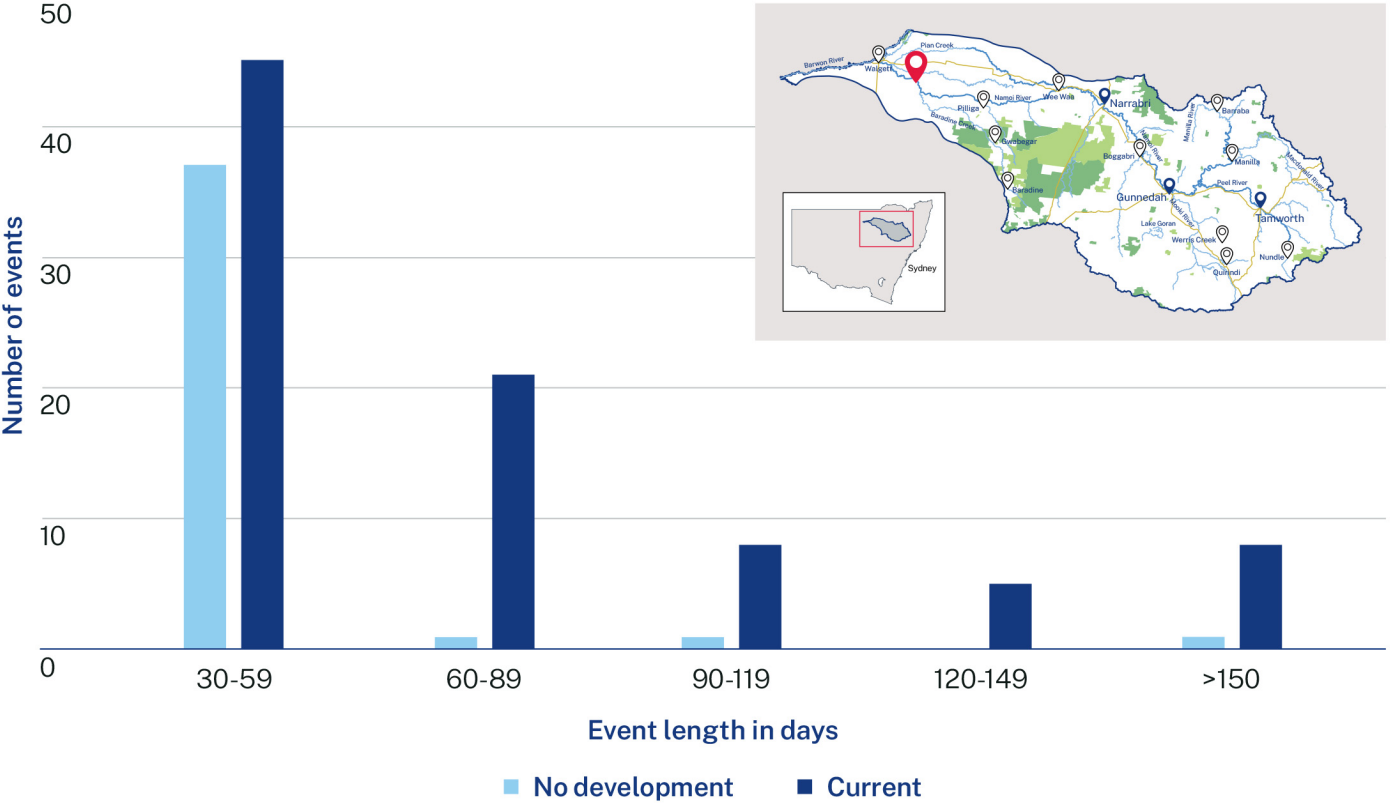
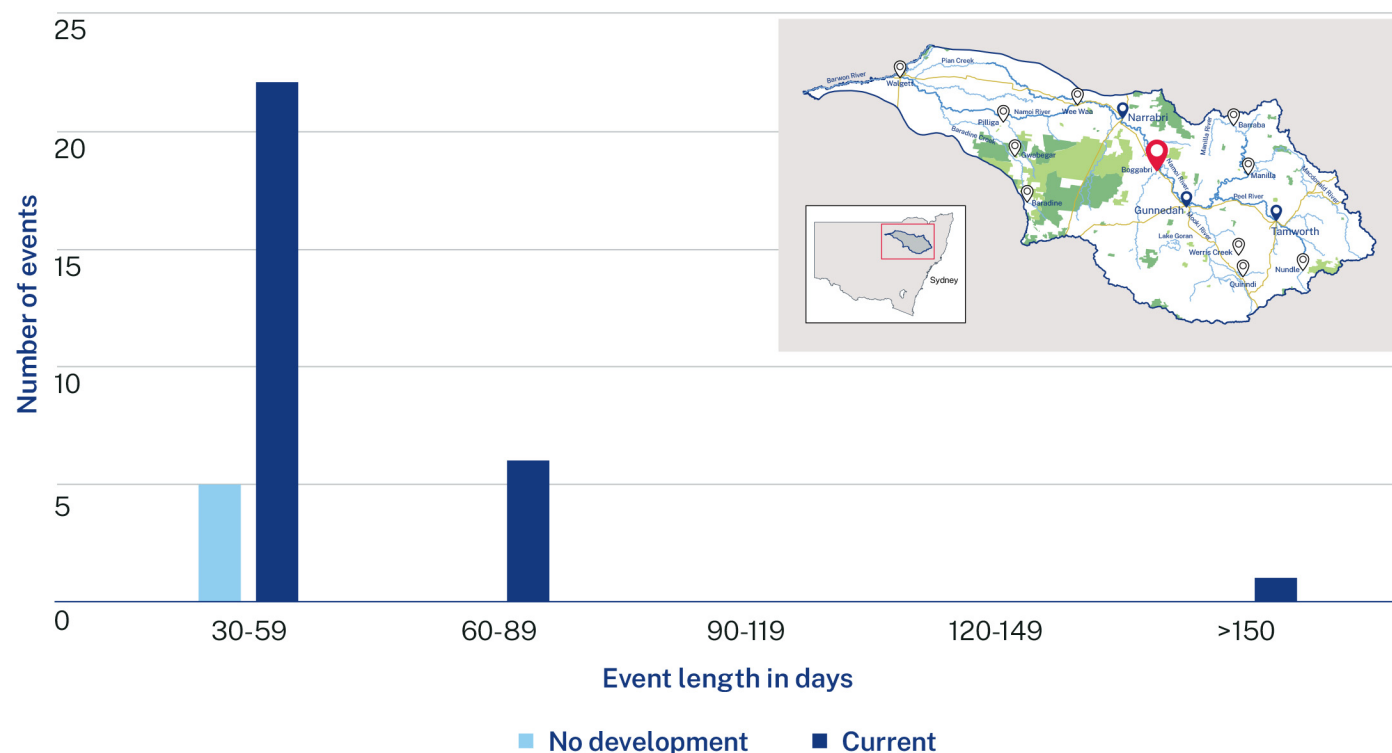


Figure 15. Modelled cease to flow periods (<5 ML/day) in the Namoi River at Boggabri (stream gauge 419012) with and without development for the period 1892 to 2020



The past 20 years have been a dry period in our climate. If our future climate is similar to our long-term historical climate, end-of-system flows between the Namoi and Barwon catchments are unlikely to change significantly. If the dry climate change scenario from our modelling eventuates, in 40-80 years we could see:

- an overall decline in flows to the Barwon River – median flows into the Barwon–Darling River system may decrease by 60%, and there may be no flows at Walgett for 40% of the time
- a change in the seasonality of flows to the Barwon River, with a significant reduction in flows in winter, and a delay in peak flows from summer to autumn.

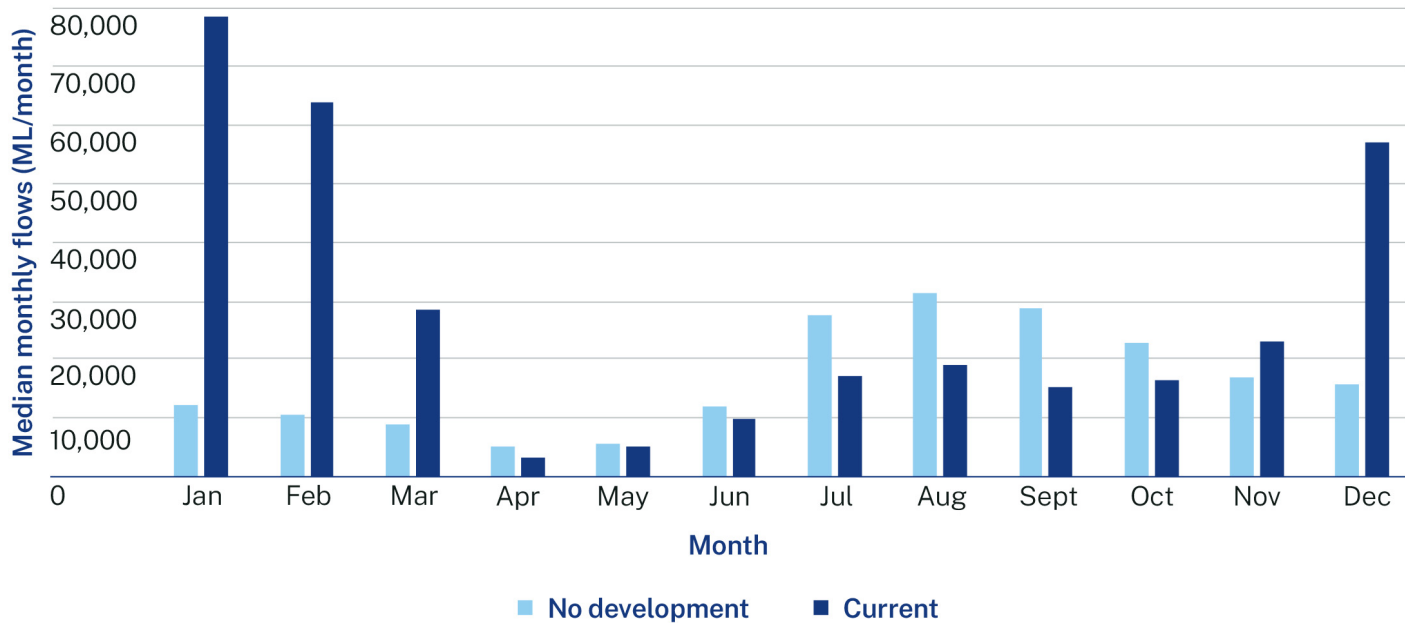
These changes could lead to longer periods when it is more difficult to meet critical human and environmental needs at the end of the system.

The timing and variability of flows are changing

Towards the middle of the Namoi catchment where there are large irrigation demands, modelling analysis shows there has been an increase in median flows during the summer months irrigation season (Figure 16),

but a decrease in median flows during the winter months and less water flowing to the Lower Namoi. Our river system models suggest that if there was no extraction or infrastructure, there could be higher median flows during winter than summer. Changes in flow patterns and seasons can impact on food resources from the riparian zone and disrupt natural cues of fish and aquatic plants and animal populations.¹⁹

Figure 16. Modelled median monthly flow in the Namoi River at Boggabri for the period 1892 to 2020



The gap between large freshes has increased, particularly at the end of the system (Figure 17). The Namoi Long-Term Water Plan²⁰ recommends that small freshes should occur no more than 1 year apart, large freshes should occur no more than 2 years apart and

overbank flows should not occur more than 4 years apart. Figure 17 shows that when compared to a no development scenario,small freshes have increased in frequency, but the time between large freshes and overbank flows has increased.

19. NSW Department of Planning, Industry and Environment 2020, *Namoi Long Term Water Plan*, www.environment.nsw.gov.au/research-and-publications/publications-search/namoi-long-term-water-plan-part-a-catchment
 20. NSW Department of Planning, Industry and Environment 2020, *Namoi Long Term Water Plan*, www.environment.nsw.gov.au/research-and-publications/publications-search/namoi-long-term-water-plan-part-a-catchment

Figure 17. Modelled frequency of large time gaps between freshes in the river at Goangra for the period 1892 to 2020

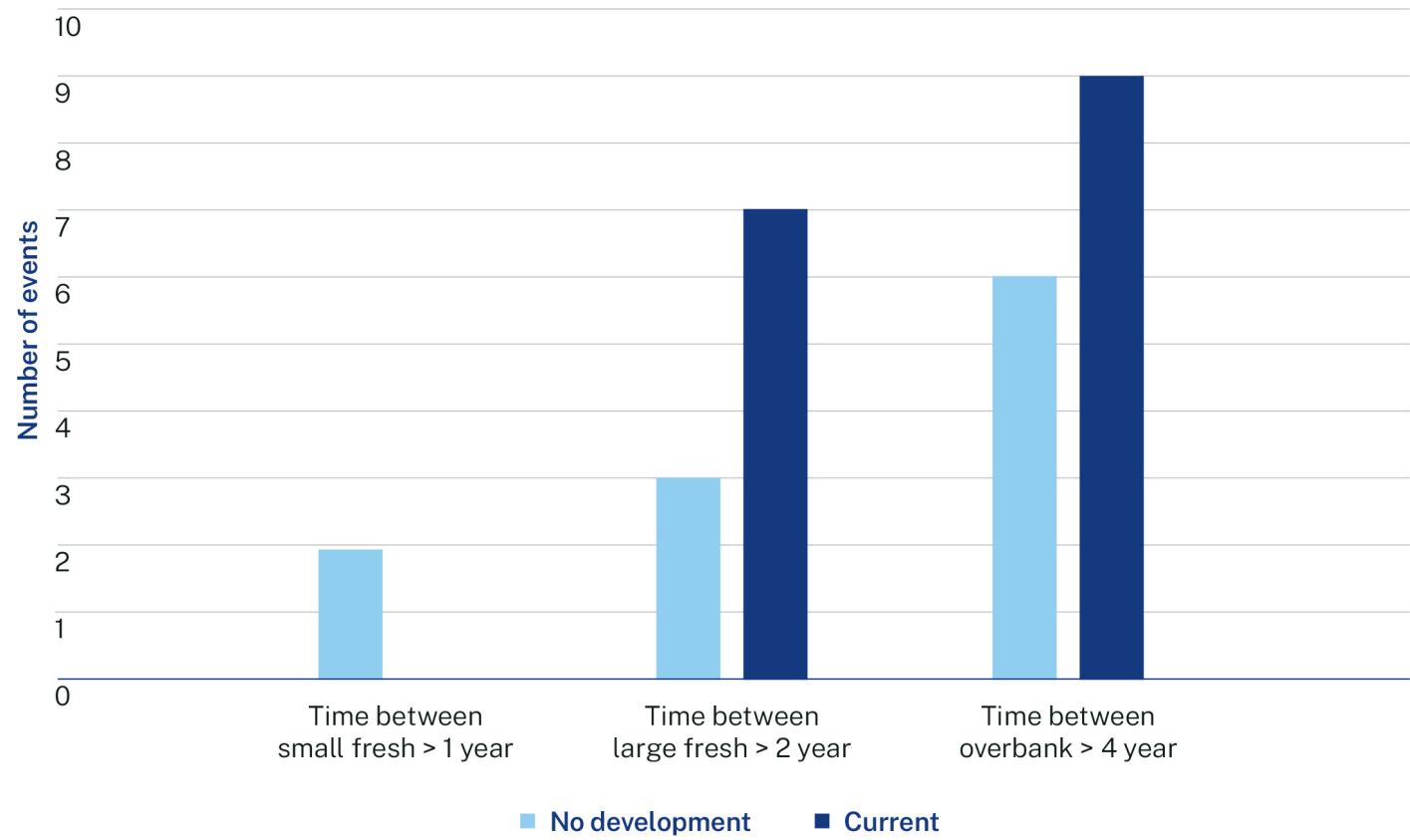


Image courtesy of Nicola Brookhouse, Department of Planning and Environment. Pilliga National Park.

Aquatic species are under stress from degraded habitat and declining water quality

Water quality and habitats have been changed and impacted by modified flows, land clearing, modification of riparian vegetation, river channelisation and bank erosion in parts of the Namoi system.

More than 60% of the riparian vegetation in the Namoi Valley has been substantially modified from its natural condition, and 21% has significantly less vegetation (severely impaired).²¹ The most impacted areas are the Peel River, Mooki River and Cocks Creek catchments and the upper Manilla River near Barraba, which have extensive reaches with less than 20% native woody riparian vegetation.

Water quality is an important driver of ecological processes. Changes in water quality have resulted from a combination of factors including introduced species, loss of riparian vegetation, changes in river flows, river regulation infrastructure and change in land use. High flow from rainfall and run-off can result in more soil and nutrients being washed into waterways. This can make water less clear and prone to excessive algal growth when flows reduce, impacting on the quality and quantity of refugia during dry times.²² Dams and weirs in the Namoi catchment often have algal bloom events.

During the recent drought, fish deaths were reported in the Namoi and Peel rivers. These deaths were attributed to very low water availability and an associated decline in water quality. Fish deaths were also triggered by short sharp increases in river flow that flushed organic material and deoxygenated water (hypoxic blackwater) from pools along the waterway, leading to larger scale 'blackwater' events.

Dams can also cause cold water pollution downstream, as well as impeding the movement of fish, altering habitats, and affecting spawning, recruitment and riverine productivity. Keepit Dam can cause cold water pollution for over 100 km downstream of the dam. This impacts the quality of the water for town and household use, as well as affecting on the amenity of the rivers and increasing the stress on aquatic species.

Increased groundwater demand, particularly during drought periods, is causing a decline in groundwater levels in some areas, making it difficult for groundwater-dependent ecosystems such as river red gums to access their water needs.²³ Reduced recharge from surface water and rainfall in the Upper Namoi tributaries, Peel Alluvium and Manilla water sources exacerbates these impacts.

The combination of these factors has resulted in:

- very poor condition of fish communities²⁴
- poor condition of riverine vegetation communities²⁵
- declining health and abundance of groundwater-dependent ecosystems²⁶
- decline in some waterbirds; for example, between 1983 and 2016, duck numbers declined by 23%, herbivore numbers by 61% and large wader numbers by 71%.²⁷

21. Norris, R.H., Liston, P., Davies, N., Coysh, J., Dyer, F., Linke, S., Prosser, I. and Young, B., 2001, *Snapshot of the Murray–Darling Basin river condition*, Murray–Darling Basin Commission, Canberra

22. Refugia are sites that provide permanent fresh water or suitable habitat for plants and animals to survive until the drought breaks

23. Thurtell, L., Wettin, P.D., Barma Water Resources Consulting, Commonwealth Environmental Water (Australia) 2012, *Environmental water delivery: Namoi River*, Commonwealth Environmental Water Office, Canberra

24. NSW Environment Protection Authority 2021, *NSW state of the environment 2021*, Environment Protection Authority, Sydney

25. Murray–Darling Basin Authority 2012, *Sustainable Rivers Audit 2: the ecological health of rivers in the Murray–Darling Basin at the end of the millennium drought (2008–2010)*, Summary, MDBA, Canberra

26. NSW Department of Primary Industries – Water 2013, *Water Sharing Plan Namoi Unregulated and Alluvial Water Sources 2012: background document* Sydney

27. NSW Department of Planning, Industry and Environment 2020, *Namoi Long Term Water Plan 2020: Part A*, Sydney

There is limited ability for environmental water holdings to mitigate these impacts

Water sharing plan rules set aside water to protect the basic health of the environment, and water reform processes over the last few decades have recovered water entitlements for the environment.

The water sharing plan for the Namoi Regulated River helps to ensure that approximately 73% of the long-term average annual flow in the water sources remains in the river to help maintain the basic health of the ecosystem.²⁸ Provisions in the Peel catchment water sharing plans include similar rules that set extraction limits and require the remaining inflows to be left in rivers for the health of the environment.

The water not subject to these protection provisions is allocated to licences with 3.5% of water entitlements²⁹ in the Peel and Namoi being held by the Commonwealth Environmental Water Holder in the form of general security licences. An additional 5 GL Environmental Water Allowance (EWA) in the Peel is provided through the water sharing plan, which accrues water when general security allocations are made.

There is restricted flexibility at times in the Namoi and Peel catchments, which can lead to challenges in meeting the needs of the environment using the environmental water holdings. Environmental water managers have limited capacity to intervene and provide flows to support environmental water needs at critical times, such as during extended drought periods and when unregulated inflows are not available.

Additionally, there is no ability for water held under general security licences and the environmental water allowance in the Peel to be carried over as unused water allocations from one year to the next so that it can be used when most needed.³⁰ The environmental water allowance is subject to extraction once the Peel River reaches a flow threshold,³¹ and any held environmental water from the Peel that makes it into the Namoi can be reallocated for extraction.

Climate change could exacerbate these challenges

Our new climate modelling shows that climate patterns in the region could change, with consequences for rainfall patterns and associated water flows. Climate change impacts are uncertain. Some scenarios suggest wetter periods and wetter climates, whereas others suggest drier climates. We have analysed a worst-case dry climate change scenario. While the scenario may not occur, if it does occur in 40 years' time, we could expect more extreme wet events and more extreme dry events. Our modelling of this scenario indicates that the total volume of water flowing each year, on average, could decrease in the long term by 44% in the Peel River and 47% in the Namoi River, with fewer high-flow events and more cease-to-flow events.

This would place stress on platypus populations; result in fewer events that trigger fish movement and spawning, and waterbird breeding; and dry up key habitats. While these scenarios may not occur, analysing these data sets can help us understand how we may need to prepare.

Measures to support the resilience of ecosystems and improve overall waterway health include adjusting operations to better support environmental flows, increasing the flexibility for use of environmental water holdings, rehabilitating habitats, mitigating cold-water pollution and remediating fish passage.



Image courtesy of Gerhard Koertner, Department of Planning and Environment. Nobbi dragon on rock.

28. Clause 13 of the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016

29. Percentage compared with all regulated licences in the Namoi and Peel valleys

30. The Water Sharing Plan for the Peel Regulated Water Sources 2010 may be amended to allow for carry-over of EWA before 1 July 2024

31. Clause 41(4) of the Water Sharing Plan for the Peel Regulated River Water Source 2022



Challenge: Dismantling barriers to Aboriginal water rights

‘We can’t sing our song no more, we can’t live on the river no more to look after her, for you all’. (Gomeri Water Engagement Committee)

‘Yaama Nginda Gomeri Wunnungulda. We are Gomeri, we have our way of doing business. You have to be invited to sit around our fire. We share language and we engage together. You are asked to identify who you are and what you represent and be clear in your intent. Then, and only then can we do business together.’

Aboriginal people have lost access to water and Country

Gomeri/Kamilaroi people have occupied the Namoi Valley for at least 60,000 years. They have always been closely linked to rivers, groundwater, billabongs and wetlands, and this relationship is essential to culture, community and connection to Country.

The historical dispossession of land and the effect of colonial era settler laws continue to impact Aboriginal people’s rights and access to water. After European settlement, large areas of land were converted to private property, and Aboriginal people were forced onto missions and reserves. Private land, fences and locked gates prevent Gomeri/Kamilaroi people from accessing Country and water, carrying out cultural practices, and using traditional knowledge to care for and manage waterways.

We heard during consultation with the region’s Aboriginal people and communities that access to waterways is critical to providing a purpose and pathway for young people to connect to culture; providing a space for healing; and for food, medicine and teaching.

In addition, accessing water entitlements now requires Gomeri/Kamilaroi people to seek water from often highly competitive water markets. We know from consultation undertaken regionally and for the NSW Water Strategy that there is strong community support for Aboriginal water rights and access. The small amount of water under Aboriginal ownership is frequently identified as a key area for improvement.

Consultations for the NSW Water Strategy and the draft Namoi Regional Water Strategy indicate that there is strong community support for Aboriginal water rights and access.

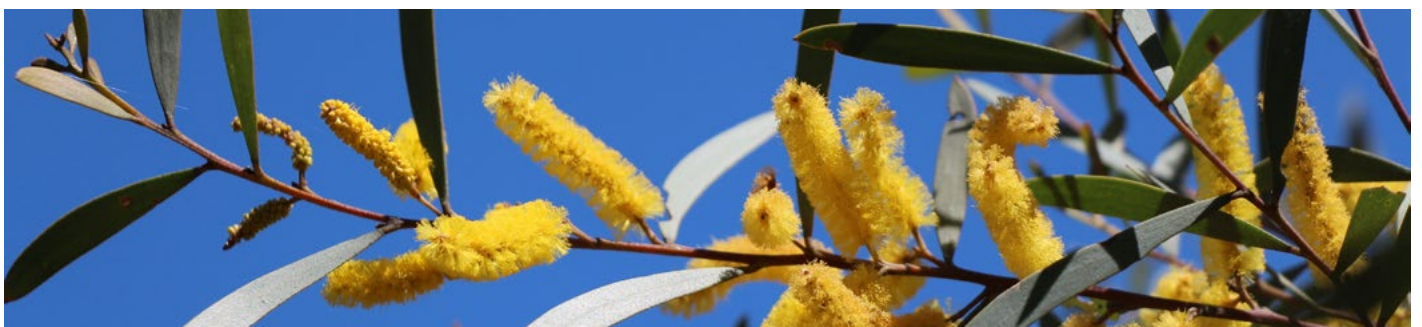


Image courtesy of Jessica Stokes, Department of Planning and Environment. Yellow flower branch, Salt Caves dam walking track.

Aboriginal water values are not well-supported by water management

Current water legislation and water management frameworks have evolved over the last 130 years but do not fully reflect Gomeroi and Kamilaroi water values. This is exacerbated by the limited involvement of Gomeroi and Kamilaroi people in water policy and planning processes, which is the result of:

- changes to Aboriginal water programs
- consultation timeframes and processes around water policy changes not allowing the time needed for Gomeroi/Kamilaroi cultural governance processes, leading to erosion of trust
- Gomeroi/Kamilaroi people not being informed or having a say in when and where environmental and cultural water is delivered
- the complex set of state and national laws and systems around water management, which is often not explained in plain English or in a visual manner (taking into account levels of water literacy)
- inadequate resources and support for Gomeroi/Kamilaroi people to engage in water management
- Gomeroi/Kamilaroi people now having to buy rights to water that they once had from a fully allocated market
- structures around water management not providing for Gomeroi/Kamilaroi people's cultural governance structures or shared management.

Changing this system and empowering Aboriginal communities to make decisions on water requires the NSW Government to 'flip the model on its head' and develop an approach to engagement that works for Gomeroi/Kamilaroi people. For many years, the government has committed to models around committees and advisory bodies that are not made up of local Aboriginal people with cultural connection to, or authority to speak about, their Country. We need an innovative approach that allows Gomeroi/Kamilaroi people in their Nation area to get the right people involved or appointed to seats at the table where decisions about water are being made.

Gomeroi/Kamilaroi people would like to have a direct line of contact with regional water managers, compliance officers and decision makers, and have their knowledge and science actively sought, respected and heeded. To do this, water policy makers, planners and managers need to 'sit at the fire', listen to the knowledge holders and develop a cultural governance structure that is familiar to Gomeroi/Kamilaroi people, supported by the time that is needed to engage, consult and listen genuinely.

We need an innovative approach that allows Gomeroi/Kamilaroi people in their Nation area to get the right people involved or appointed to seats at the table where decisions about water are being made.



Image courtesy of Destination NSW. Len Waters Aboriginal Cultural Tours, Tamworth.



Image courtesy of Destination NSW. Len Waters Aboriginal Cultural Tours, Tamworth.

Addressing the challenges

4

Image courtesy of Robert Cleary, Department of Planning and Environment.
Sub alpine grasses on the summit of Mount Kapure National Park.

To address the key challenges in the Namoi region, we have set 3 priorities and identified a range of proposed actions to help achieve these priorities.

The 3 priorities for the Namoi region are:

- supporting the long-term water needs of Tamworth and other towns in the region
- supporting a growing regional community under a more variable and uncertain future climate
- improving the health and resilience of water-dependent ecosystems.

These priorities and shortlisted actions can improve the region's readiness to adapt to a more variable climate and make the decisions and changes needed to secure healthy, reliable and resilient water resources into the future.



Image courtesy of Destination NSW. Manager Brendan North at his Paradise Fresh farm, Tamworth.

Priority 1

Supporting the long-term water needs of Tamworth and other towns in the region

Record drought conditions in the northern Murray–Darling Basin from 2017 to early 2020 highlighted that we need to change the way we think about and plan for our future water needs. We now understand that the drought was not unusual when compared with the region’s longer historical climate and that potential changes in rainfall patterns, warmer conditions and increased evaporation could impact future water availability.

Over the coming decades, towns across the Namoi region will face increasing risks to the security of water supply. This is particularly the case for towns that are growing.

For Tamworth, the proposed new Dungowan Dam will support the needs of town water users for years into the future. However, as Tamworth’s water demand grows, water security will deteriorate if we do nothing else to manage demand or increase supply. For most other towns across the Namoi region, groundwater is essential. Having reliable and sustainable access to groundwater allows communities to endure extreme climates.

To reduce the risk of severe restrictions and costly emergency water supply measures, the actions under this priority focus on a mix of demand management, efficiency, information, policy and infrastructure initiatives (Table 5). These will help towns in the region to make the best use of the available water resources and better respond to the needs of a growing population and the risks associated with climate change.



Image courtesy of Destination NSW. Countryside, Tamworth.

Legend				
				
Addressing Tamworth's long term water security risks	Addressing water security risks of regional towns across the Namoi Valley	Supporting a growing regional economy in a future of potentially reduced water availability	Improving the health and resilience of aquatic ecosystems	Dismantling barriers to Aboriginal water rights

Table 5. Overview of proposed actions to support the long-term water needs of Tamworth and other towns

Proposed action	Summary	Challenges addressed
Government commitment New Dungowan Dam and pipeline	The proposed new Dungowan Dam project will replace the existing 6.3 GL dam with a 22.5 GL dam and construct a new pipeline connecting the dam with Tamworth.	 
Immediate measures		
Action 1.1 Confirm the level of water security needed to support large regional towns	Develop guidelines on whether water security planning for large regional towns should be guided by an 'enduring level of supply' approach.	 
Action 1.2 Improve drought management planning for towns	Update planning and preparation for how to respond when droughts occur.	  
Action 1.3 Adopt a stronger focus on water efficiency and demand management for towns	Support local water utilities in investing in measures to improve the efficiency of supplying water for domestic, commercial and industrial water uses, and encourage water users to minimise demands for water.	  
Action 1.4 Progress advanced water treatment facilities for industries reliant on town water supplies	Progress water treatment facilities to support growth of industries connected to town water supplies without increasing overall water demand on existing water sources.	  
Action 1.5 Reduce uncertainty in groundwater security for regional towns	Support local water utilities undertake local level investigations to understand and improve the security of groundwater supplies using the latest data.	  

Proposed action	Summary	Challenges addressed
Longer term planning		
Action 1.6 Plan for the next long term water supply augmentation as Tamworth grows	Assess in detail the following options for which only high level investigations have been completed to date: • additional water treatment facilities • pipeline from Namoi valley to Tamworth with an increased reserve • pipeline from Manning Valley to the Peel Valley • increase the water reserved for Tamworth in Chaffey Dam.	
Action 1.7 Addressing water related skills shortages in small councils	Support councils to address key training and skills gaps that can support delivery of water for communities.	



Image courtesy of Destination NSW. Scenic drive, Tamworth.

Government commitment: new Dungowan Dam and pipeline

The proposed new Dungowan Dam and pipeline is being developed to improve the water security of Tamworth and its surrounding towns. This project will see the existing 6.3 GL dam replaced with a 22.5 GL dam and will include the construction of pipeline from the new Dungowan Dam to the Calala Water Treatment Plant, as well as a modest change to the town water reserve in Chaffey Dam to 28 GL.

The NSW and Australian governments have made provision for the proposed new dam and pipeline.

Stage 1 of the pipeline, from the Calala Water Treatment Plant to Dungowan Recreational Reserve, is already under construction. This section of the pipeline is being progressed before the dam as it replaces the section of the current Dungowan Dam pipeline most prone to failure, resulting in water loss and maintenance costs.

Once built, the new dam and pipeline will significantly improve the security of Tamworth's water supply and improve the resilience of Tamworth's water security in droughts worse than what we have experienced in our lifetimes. The new dam will reduce the frequency and duration of water restrictions by up to 50%.³² The dam will also reduce the chance of level 5 water restriction by 70% – from 3.5% of the time to 1% of the time. As Tamworth grows the new Dungowan Dam will also help to support an increase in demand of up to 20% without impacting on average allocations for general security.

The environmental impact statement for the new Dungowan Dam and stage 2 of the pipeline will go on public exhibition before the end of 2022.

Final ownership arrangements are being finalised in consultation with WaterNSW, Tamworth Regional Council and NSW Treasury. Once the Dungowan Dam is completed, adjustments will need to be made to water sharing plans to accommodate the new dam.³³



Image courtesy of Gerhard Koertner, Department of Planning and Environment. Rocky creek, Warrabah National Park.

32. Figures sourced from Water Infrastructure NSW analysis

33. Works commenced on the Dungowan Dam to Tamworth pipeline in January 2022. More information about the proposed new Dungowan Dam and pipeline project are available here; water.dpie.nsw.gov.au/water-infrastructure-nsw/dam-projects/dungowan-dam

Proposed action 1.1: Confirm the level of water security needed to support large regional towns

This proposed action aims to develop guidelines on whether water security planning for large regional towns should be guided by an “enduring level of supply” approach – i.e. delivering a level of demand that we can be confident of supplying indefinitely, irrespective of the intensity and duration of drought.

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

Large water utilities such as Sydney Water and the Hunter Water have moved away from the concept of an ‘acceptable level of risk of running out of water’ recognising that running out of water is not a risk that governments and communities will tolerate for Sydney and the Lower Hunter, regardless of the probability of that risk. Instead they have moved to understanding the minimum amount of water needed for the cities to keep running (an enduring level of supply), how long residents and businesses are willing to endure extended water restrictions, and the willingness of

communities to pay for increased water security.

This action proposes to investigate whether a similar approach should apply to water planning for large regional centres where last resort options such as carting is not a realistic option.

Progressing this would include understanding the minimum amount of water required to meet business and social needs for a long period of time after water restrictions have reduced demand as much as possible and until our storages refill. This level of supply needs to consider the needs of all segments of the economy and community to ensure we can maintain the right level of health, economic, social and environmental outcomes.

Guidelines would be developed to guide decisions on when the next water supply augmentation should be implemented, and at what cost. The timing for large infrastructure investments can also be pushed back by taking smaller incremental measures to reduce growth in water demand such as reducing pipe leakage, adopting more water efficient technologies and practices, and substituting recycled water for some purposes.

The results of this analysis will help identify when to trigger the next large water augmentation. With the new Dungowan Dam, our analysis shows that additional measures may need to be in place before Tamworth's water demand reaches 11 GL/year (20% increase from current levels) to ensure that the risk of restrictions and emergency measures does not rise again to the levels that occurred before the new Dungowan Dam.



Image courtesy of Destination NSW. Oxley Scenic Lookout, Tamworth.

Proposed action 1.2: Improve drought management planning for towns

Climate change could result in droughts occurring more often. Local and state government have invested in a raft of emergency drought measures that helped to stretch out water reserves during the last drought. These included investment in bores, pipelines and water treatment facilities. Additional longer-term measures are also being investigated and implemented to support the long-term water security of towns across the region. However, there is still a real risk that a drought worse than the 2017–20 drought could occur at any time, and the additional measures being investigated may not be implemented before the next drought occurs. Robust emergency drought measures will still likely be required for many towns.

For example, in Tamworth, the proposed new Dungowan Dam is set to significantly improve Tamworth's ability to endure droughts, including under drier climate change scenarios. To ensure that Tamworth is prepared for drought before the new Dungowan Dam is complete, other short-term measures need to be ready to put in place if required.

It is critical that these measures are thoroughly planned for and costed, even if they are not needed in our lifetimes, because there is a chance that they will be needed at any time. These emergency measures are typically very expensive and appropriate for use over short periods, rather than ongoing, so we delay implementing them as long as possible.

To manage these risks, town water managers need to develop plans now that identify the best drought management measures for the towns across the region. Preplanning and approvals processes need to be completed so that the measures are ready to be implemented when drought occurs again. The NSW Government will work with local water utilities to improve drought planning and response by supporting the development and implementation of drought management and emergency response plans.

What we have heard so far



Stakeholders responded overwhelmingly in support of options that relate to being better prepared for droughts and a potentially drier future.

Proposed action 1.3: Adopt a stronger focus on water efficiency and demand management for towns

Water managers use a range of water efficiency and demand measures to help reduce their demand on water sources. For large regional centres like Tamworth and Narrabri, these measures can be vital for sustaining water supplies through the region's regular dry periods and droughts and can support population and industry growth without increasing risks to water security.

During the public consultation on the draft Namoi Regional Water Strategy, we heard strong support for water conservation by communities and businesses, and across government. These measures include:

- water restrictions to limit town water use during dry periods and prolong water supplies
- community water conservation schemes, such as installation of rainwater tanks and greywater systems, and encouraging water-efficient appliances
- reducing leakage from pipes
- 'smart' metering and pricing
- improved reuse and recycling of wastewater and stormwater
- requiring large industrial water users to make significant investments in measures to reduce water demand
- using price as a signal to reduce water demand for industrial use

- designing and implementing water-use practices that minimise the amount of groundwater extracted
- We have also heard that the NSW Government should consider a residential property water consumption target that could guide urban water efficiency and demand management action across the State. If this is progressed, any target would need to consider how the climate and other local factors may influence water demand.

Local water utilities play an important role in managing water demand and improving water efficiency. Councils in the region have invested significantly in demand management measures that have helped to improve the resilience of water for towns facing increased pressures from growth and recent droughts. For example, over the last 10 years Tamworth's population has grown every year but water demand has remained constant as a result of the concerted community and industry engagement (supported by incentives and rebates) and demand management strategies of the council. The next stage of water conservation requires harder conversations with industry and potentially greater costs. Realising additional savings will require collaboration across the private and public sectors.

The NSW Government will support councils to implement our new state-wide Water Efficiency Framework, which is designed to increase the capacity and capability of local water utilities to plan and implement measures and programs to improve water-use efficiency. The framework focuses on building capacity for water-use efficiency, gaining a greater understanding of water use, improving the evaluation of initiatives for water-use efficiency and identifying opportunities for increasing private sector involvement.

Tamworth demand management actions over the last 10 years

Unrestricted residential demand in Tamworth was estimated to be around 350 kL/year per property in 2007. It is now estimated to be around 280 kL/year. Residential savings can be primarily attributed to: community awareness and education programs targeting both indoor and outdoor usage; permanent water conservation measures; and a substantial residential rebate program that has evolved over time.

Significant savings have also been achieved with non-residential usage as a result of: large user audits; Council irrigation efficiency savings; and substitution of potable water with bore water for some public space watering.

Proposed action 1.4: Progress advanced water treatment facilities for industry reliant on town water supplies

A large proportion of Tamworth's town water supply is used to support agricultural processing and manufacturing facilities – major meat processing industries alone currently use around 25% of Tamworth's total water supply. These industries are an important part of the region's supply chain and are significant regional employers. They are expected to grow, with corresponding growth in their water demand.

For example, the Baiada chicken abattoir, which is one of the largest livestock processing facilities in Australia, processes more than 700,000 birds per week. This facility is the town's biggest water user, requiring around 2 ML per day to operate. Plans are currently in place to grow the facility so that it can process 3 million birds per week. The increase in production will significantly increase the demand on town water supplies, reducing the overall water security for Tamworth.

Narrabri and Gunnedah Shire Councils are likely to have increased commercial demand attached to their town water supplies in the coming decades.

Alternative water supplies such as advanced water treatment facilities for commercial/industrial water users connected to town water supplies will be critical for supporting the long-term growth and water security of Tamworth, Gunnedah and Narrabri.

Tamworth Regional Council is currently investigating opportunities to develop advanced water treatment facility to recycle wastewater from large commercial/industrial users to meet a large part of their water needs. This would allow a large expansion in industries without placing further demands on Tamworth's treated water supply. If implemented, this action would also result in a net reduction in Tamworth's current raw water demand of around 5%, postponing the need for additional water supply infrastructure, above and beyond the proposed new Dungowan Dam and Pipeline, as Tamworth grows.

The NSW Government will work with local water utilities to identify, promote and provide incentives for water reuse and recycling for commercial and industrial water needs.

What we have heard so far



Stakeholders showed strong support for options that relate to water reuse, recycling and stormwater projects for towns and industry. This included feedback on the benefits of water savings and reduced reliance on regulated potable water supplies. In many areas recycled water is already being used to support agricultural users.



Pelicans, Lake Keepit.

Proposed action 1.5: Reduce uncertainty in groundwater security for regional towns

Most towns in the Namoi catchment rely solely on groundwater for water supply. We have heard from councils that there is uncertainty about how long the town water bores will be able to sustain the towns during droughts.

Where there is a high density of irrigation bores, the local groundwater level can decline during the pumping season. This makes it harder to extract the same amount of water from nearby bores, including those used for town water. The problem is exacerbated during severe droughts because more water is extracted during the pumping season. In addition, strategic regulatory and policy actions are needed to improve groundwater certainty for towns, along with investigations at the local level.

At the local level, the critical factor in supporting groundwater-dependent towns in the region is to understand whether local town water bore infrastructure is sufficient to sustain town water supply during droughts. This includes ensuring:

- there are an appropriate number of bores that are sufficiently deep and well constructed so that bore yield is not affected by declines in the groundwater level during drought
- the bores are constructed to a quality that can sustain the needs of the local water utility over an extended period of time
- there are suitable water treatment facilities to support the long-term treatment and use of groundwater sources for towns.

The site-specific nature of this issue means that investigations at the local level are the best way to understand risks to water supply. This work is already progressing in the Namoi region. With support from the NSW Government, Namoi Unlimited, a joint organisation of councils, has commissioned a detailed investigation of current and future water supply vulnerabilities of 17 towns. This investigation includes detailed assessment of groundwater supply risks at town bores. The work will inform long-term integrated water cycle management plans for these towns, which will lay out cost-effective plans for long-term town water security. Narrabri Council is also undertaking similar investigations.

In the Walgett Shire Council area all towns are reliant on groundwater as either their primary water source or as an essential back up. For the township of Walgett surface water will continue to be unreliable and so access to reliable good quality groundwater is essential.

During the most recent drought, a portable reverse osmosis groundwater treatment facility was installed in Walgett to help treat saline groundwater for domestic use. This action would investigate the potential for the development of a more permanent groundwater treatment facility. As these facilities are costly and technically very difficult to operate, this action would also consider ways to support the council to operate the facility in the long term through technical and training support for Council staff.

At the strategic level, the NSW Government can provide clear guidance around how high priority groundwater needs such as town water supply will be managed in the Namoi region. This includes:

- determining how to ensure critical needs and high priority uses such as local water utility licences are prioritised when considering impacts on the aquifers and other users
- exploring the option of granting temporary licences to access groundwater during drought
- reviewing the regulation of basic landholder rights (including stock and domestic) to assess whether new rules are required to better manage this type of water take when water restrictions are in force.

The NSW Government will continue to support councils in the Namoi region to plan and implement long-term water security measures through current funding programs, and by providing access to the latest water resource and climate data and modelling information.

Proposed action 1.6: Plan for the next long term water supply augmentation as Tamworth grows

As Tamworth grows over the coming decades, so will demand on its water sources. Demand reduction can push back when the next augmentation needs to occur, but demand management alone may not prevent Tamworth's augmented water system from running out of water in a severe drought.

To support longer-term growth, additional investment will be needed to maintain security of the water supply and provide confidence for people and businesses to live and work in the region. Actions may need to be taken before Tamworth's demand grows to 11 GL/year, to ensure that Tamworth's water security does not fall to current levels.

The Namoi Regional Water Strategy needs to remain adaptive as the region's circumstances, climate and the population all change over the next 20–30 years. Adaptive strategies typically do not rely on a single solution; rather, they identify a range of feasible solutions. This can allow decision makers over the coming decades to choose the most appropriate options to implement, based on the information, technology and conditions at the time.

We have shortlisted a number of options that could help support Tamworth's long-term water security in the future (noting these are not in any prioritised order):

- additional water treatment facilities
- pipeline from Namoi Valley Dams to Tamworth with an increased storage reserve
- pipeline from Manning Valley to Peel Valley
- increase the water reserved for Tamworth in Chaffey Dam.

Each of these options merit further investigation and planning, and each has its own advantages, disadvantages and costs (see Table 6). Each option can be implemented as a package with other options and will require more detailed investigations and community consultation to identify the optimum way to implement the option. There may be additional options that are identified as information and evidence evolves over time that should be compared against this shortlist if found to be viable.

The analysis presented below assumes that the proposed new Dungowan Dam is in place.

Table 6. Summary of options that could support Tamworth's long term water needs

	Additional water treatment facilities	Pipeline from Namoi Valley Dams to Tamworth with an increased storage reserve	Pipeline from Manning Valley to Peel Valley	Increased water reserved for Tamworth in Chaffey Dam (14 GL assessed)
Reduces time Tamworth spends in restrictions?	Yes	Yes	Yes	Yes
Supports Tamworth through worst case drought scenarios in paleo-stochastic dataset?	Yes	Yes	Yes	No
Potential for impacts on other users?	Yes Current wastewater users	Yes Namoi GS users	Yes Coastal water users	Yes Peel Valley GS users

Positive impact

Negative impact

Additional water treatment facilities

Tamworth's water security is particularly vulnerable to climate change because Tamworth relies on surface water and water in dams. Investing in water reuse and recycling initiatives will help to reduce Tamworth's reliance on potable water in dams and rivers and will help diversify Tamworth's water sources. This supply could allow Tamworth to expand its water demand without increasing take from the dams.

The NSW Government supports all options for diversification of the water supply. Over the next 5 years the NSW Water Strategy commits to progressing regulatory reform, guidelines and community acceptance campaigns to make the development and use of advanced water treatment facilities easier.

Advanced water treatment facilities can provide a small or large increase to available supply. However, a number of barriers to implementation are likely in the Namoi region, including regulatory processes and standards, costs and the need to achieve community acceptance. In addition, the contribution of water from a purified recycled water scheme during drought could be lower than at other times, because less wastewater will be produced and available for treatment (although this also depends on how water is used at the time).

The NSW Government will continue to investigate ways to address these limitations at the state and local levels. We will work with local water utilities to identify policy and regulatory barriers to recycled water use and we will begin developing a policy framework for regulation of purified recycled water. No decision on purified recycled water will be taken without extensive community consultation and stringent government approvals.



Dungowan Dam near Tamworth.

Proposed pipeline from Namoi Valley Dams to Tamworth with an increased reserve

Keepit Dam is the Namoi region's largest dam with a capacity of 425 GL and is operated in combination with Split Rock Dam (397 GL). The two dams support irrigation in the Namoi Valley as well as water for towns including Walgett which is over 350 km away. These dams and catchment areas are significantly larger than the Chaffey and Dungowan dams that Tamworth relies on for water.

Town water supply needs are the highest priority during droughts. To support the needs of Tamworth, this action would look at transferring water from Keepit Dam or Split Rock Dam to Tamworth via a pipeline to top up Tamworth's water supply during droughts.

If the pipeline is operated on an as needed basis it will likely only be required for 4 years in 100, when Chaffey Dam and the new Dungowan Dam both reach below 20% capacity. During these dry years, our modelling shows that Tamworth would be expected to take up to 6,800 ML/year to support town needs. To support this action an extra reserve of water would need to be set aside in Keepit and Split Rock dams.

Our analysis suggests that a reserve of 41 GL could secure Tamworth's water supply in the worst drought in the 10,000 year paleo informed data set. This worst case drought would extend for 6 years at a point in the future when Tamworth's water demand has increased by 20%. This additional 41 GL reserve could have the dual benefit of removing Manilla's water supply shortfall risks. However, the trade-off is that this option reduces supplies to general security agricultural water users in the Namoi Valley.

The water sharing plan for the Namoi valley requires that 95% of any growth in Tamworth's water use above the extraction limit be absorbed by the Namoi Valley.³⁴ The impacts on Namoi water users could be mitigated by reducing the reserve set aside in the dams in the Namoi Valley and implementing additional measures, such as advanced water treatment facilities or demand management activities, that could reduce Tamworth's water security risk.

Additional analysis would be required to identify the most suitable level of reserve to balance the needs of water users and the essential needs of towns. Further investigation would also be needed to confirm the best location of the pipeline and how to optimise the water set aside in both Keepit and Split Rock dams to support multiple town needs.

While this option helps reduce water security risks for Tamworth, it continues to rely on surface water and does not diversify water sources for Tamworth. Surface water could become less reliable under climate change risks.

During the public consultation process, we heard some opposition to proposals to connect the Namoi and Peel valleys. Progressing this option would require more detailed engagement with a range of water users and the community.

Additional investigations will need to further assess the cost and feasibility of constructing, maintaining and operating the pipeline, any environmental and cultural heritage impacts, the water transfers needed as Tamworth grows over time, the adjustments needed to water sharing plans, implications for Namoi water users and ways to mitigate any impacts.

34. Clause 31 (3) of the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016

Pipeline from Manning Valley to the Peel Valley

This option would transfer water from the Manning Valley on the mid north coast of NSW into the Peel Valley – an inland diversion scheme. This option could virtually remove the risk of Tamworth running out of water depending on how much water is transferred, would greatly reduce time under restrictions, and has the potential to create additional high security entitlements in the Peel which could support industries in the Namoi Regional Job Precinct. However, this option is likely to reduce water available to users and environment in the Hunter or Manning systems, and these impacts have not yet been assessed.

There is an existing transfer scheme from the Barnard River into the Hunter River catchment. The Barnard River Scheme was developed in 1985 to help mitigate drought risks for the Bayswater Power Plant in the Hunter region. The scheme consists of a system of weirs and pipelines to transfer water from the Barnard River over the Mount Royal Range into the Hunter River catchment above Glenbawn Dam, allowing it to be used by the power plant.

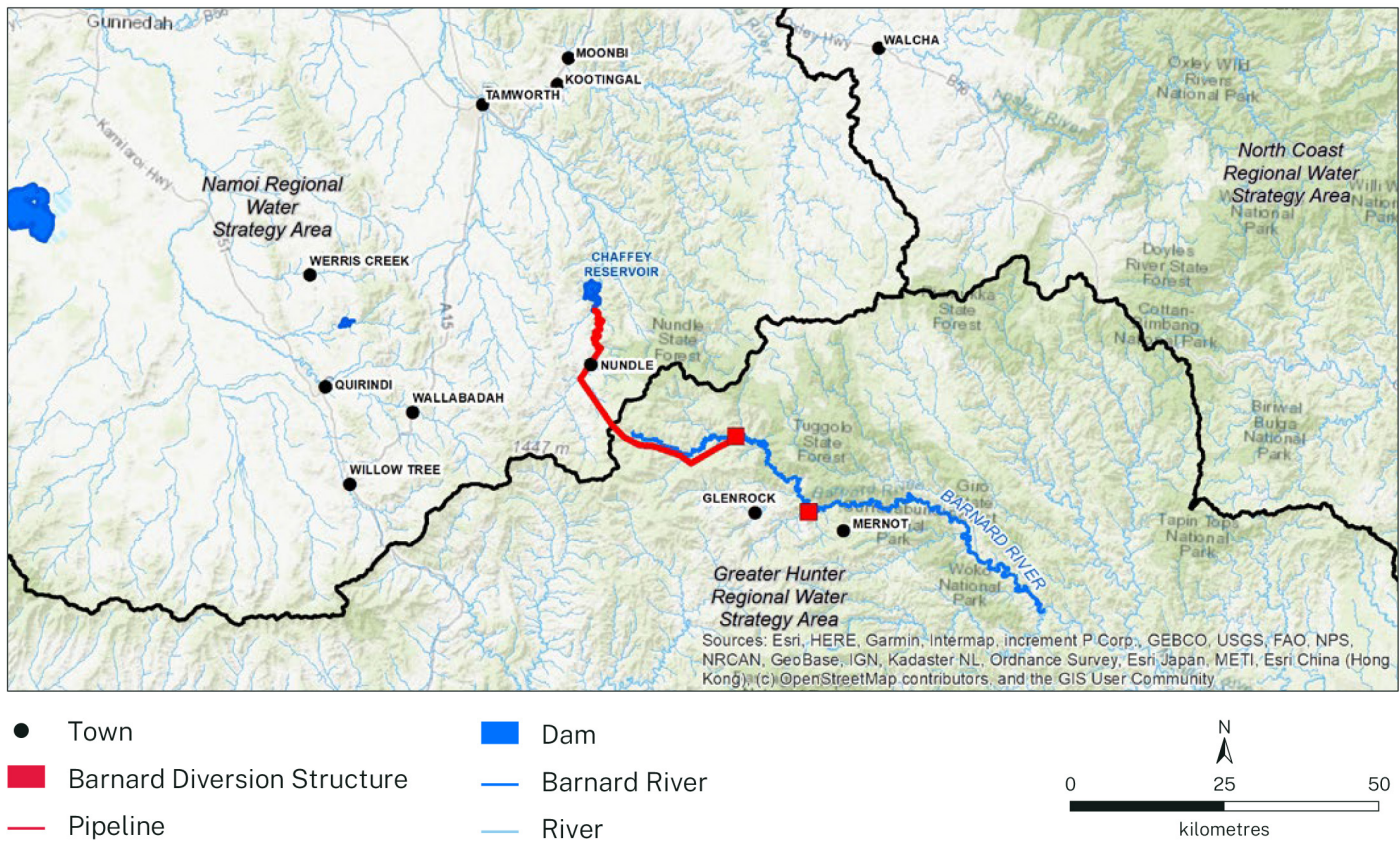
AGL Macquarie, the operators of the Bayswater Power Plant, has not used the Barnard River Scheme to transfer water since acquiring it from the NSW Government in 2014. The last transfer occurred in 2011. With the closure of Liddell Power Plant underway and the Bayswater Power Plant due to close by 2033, this entitlement for water from the Manning Valley could be reused for needs in the Namoi or in the upper Hunter catchments depending on where the need is greatest. This would need to include a comparative analysis of the benefits, impacts and costs of:

- Ongoing use of the water in the Upper Hunter to support regional diversification as the mining and power generation industries transition
- Transfer to the Peel to improve reliability for Tamworth Town Water security
- Leave entitlements in the Manning system for town water security, industry benefits and environmental outcomes.

Any impacts on users in the Manning system and the environment from transferring the water into the Peel need to be considered and mitigated. Modelling currently being undertaken to inform the Final Business Case for the Lostock Dam to Glennies Creek Dam two-way pipeline will assess the water security benefits for current and future water users (including towns, agriculture and mining) in the Hunter Valley. Future water demand in the Hunter Valley will be a key input into this analysis.

Under this action some of the water currently committed to the Barnard River Scheme would be redeployed for transfer to the Peel Valley. This would require a new small weir upstream of the current Barnard River Scheme weir and a new pipeline system to transfer the water into the Peel Valley before it flows into the Hunter catchment (See Figure 18). It assumes that the water would be used for the Peel, rather than for town water security or competing potential new uses in the Hunter or Manning catchments. During the last drought, towns in the Manning catchment faced unprecedented water security challenges and this option will need to weigh up competing priorities for water across different catchments.

Figure 18. Map of proposed Barnard River scheme redeployment to Chaffey Dam in the Peel Valley



In addition to providing water security for Tamworth Regional Council, this option could help create an additional 4-5 GL/year of high security water to support the projected growth in high value industries around Tamworth. It could also be used as a pumped hydroelectricity scheme to support the state's

energy system. However, the impacts of this proposal on the environment, Aboriginal cultural heritage and the Hunter or Manning regions have not been assessed and would need to be considered in detail in the next stage of analysis.

Increase the water reserved for Tamworth in Chaffey Dam

Chaffey Dam is the largest dam in the Peel Valley with a storage capacity of approximately 100 GL. The dam plays an important role in providing water for Tamworth, as well as supporting the needs of agricultural water users and the environment in the Peel Valley. Chaffey Dam is the main source of water for Tamworth. On average around 60% of Tamworth water is sourced from Chaffey Dam; the remaining 40% is sourced from the council-owned Dungowan Dam (at its current 6.3 GL capacity).

As Tamworth grows, so will its demand for water from Chaffey and Dungowan dams. One option to support this growth is to increase the reserve set aside in Chaffey Dam for Tamworth, in addition to the changes required to support the proposed new Dungowan Dam.

We have analysed how an additional 14 GL set aside in Chaffey Dam could help reduce, but not eliminate Tamworth's future water security risks. The results suggest that increasing the reserve could improve Tamworth's water security but this would be at the expense of the general security agricultural water users in the Peel.

Increasing the town water reserve in Chaffey Dam would result in a reduction in the reliability of allocations from Chaffey Dam to Peel irrigators (Table 7). There is a possibility some of the lost allocations could be offset through increased access to tributary inflows below the dam but further modeling would need to be undertaken to understand if this is possible and, if so, the size of the offset, and the impacts of this on the environment and planned environmental water.

This option is not as effective as other options in reducing Tamworth's risks in severe droughts, simply because general security licence holders currently do not receive allocations when Chaffey Dam is below around 45%. It also does not diversify the types of water sources Tamworth can rely on. This option may have greater benefits if it is progressed in parallel with other options to improve Tamworth's water security. The optimum change to the reserve level in Chaffey Dam will depend on which other longer-term actions are progressed in the region.

A change to the town water reserve in Chaffey Dam will also occur as part of the proposed new Dungowan Dam project. This change will increase the town water reserve in Chaffey Dam to 28 GL over a two year period which will not have a significant impact on Peel water users' average annual allocations.

Table 7. Effect of Manning pipeline on Tamworth water security at a future time when Tamworth's water demand has increased by 20%

	Chaffey Dam and new Dungowan Dam in place	Addition of 14 GL to reserve for Tamworth
Town water demand (unrestricted)	11,000 ML/year	11,000 ML/year
Time under restrictions	11%	6.4%
Time under Level 5 restrictions	2.50%	1.4%
Frequency of shortfalls	1 in 820 years	1 in 1,400 years
Average end of year allocation to Peel Valley general security licences	73%	63%

Further work is needed to realistically compare this option with the other alternatives. This includes understanding the potential for Peel irrigators to offset reduced allocations through increased use of rights to

uncontrolled flows from tributaries below Chaffey Dam, implications for the environment, and the impacts on economic productivity in the Peel Valley.

Proposed action 1.7: Addressing water related skills shortages in small councils

Attracting and retaining skilled staff to operate water treatment plants is a significant challenge for many small local water utilities across the Namoi region and NSW more broadly. During consultation with councils in the Namoi region we have heard that this is an ongoing and widespread issue that can impact on the ability of council to maintain water and sewerage treatment operations and maintenance.

In places like Walgett water treatment facilities can be offline due to a lack of skilled staff to operate it. Over the next 4 years there is an expected deficit of 1,476 water operators' qualifications and a shortfall of up to 21 trainers and assessors to deliver training in regional NSW. This limits the capability of local water utilities to operate and maintain water infrastructure.

This is a state-wide priority and work has already begun to help address this. Working with Training Services NSW, 200 fully funded training places for new trainees each year were made available from December 2021, with 80 places filled between December 2021 and June 2022. Under this action the NSW Government will continue to work across the training and water sector to help address the skills and training gaps.



Image courtesy of Destination NSW. Hydroponically grown red coral lettuce at Paradise Fresh, Tamworth.

Priority 2

Supporting a growing regional community under a more variable and uncertain future climate

The Namoi region is one of the most productive agricultural and mining regions in Australia. Agriculture and mining will continue to underpin the regional economy in coming decades; however, declining water availability could reduce productivity and have flow-on impacts on the regional economy. There will also need to be preparation for a transition to an economy less dependant on coal mining in the decades beyond the timeframe of this regional water strategy.

The actions shortlisted under this priority focus on strengthening the resilience of the regional economy. These actions will help to prepare local communities and industry for a drier, more severe future climate. This includes supporting towns and industry to better use and manage water.

In addition to supporting existing industries and businesses, the NSW Government is taking steps to help diversify the Namoi region's economy and reduce the vulnerability of communities to changing economic and climate conditions. The NSW Government's Net Zero Plan is the foundation for NSW's action on climate change and achieving the state's goal to reach net zero emissions by 2050. It outlines the NSW Government's plan to grow the economy, create jobs and reduce emissions over the next decade.

In the Namoi region, investments to help diversify the economy focus on leveraging and value-adding to the region's agricultural base through the Narrabri Special Activation Precinct and Namoi Regional Job Precinct, as well as encouraging investment in industries less dependent on water such as the New England Renewable Energy Zone, Inland Rail and the visitor economy. These investments have the potential to provide more stable employment, attract investment and maintain liveability, particularly in the face of more extended droughts.

To support these future industries and investments, the actions shortlisted under this priority (Table 8) will:

- improve the evidence and information base to support decision making, risk management and innovation
- explore opportunities to make sure the water entitlement and access framework can cater to the development of emerging industries, facilitating access to higher security water while observing legislated limits to take
- support Aboriginal people to be more involved in water management by sharing their traditional knowledge and contributing to decision making.

Supporting economic prosperity in a capped system

The Murray–Darling Basin Plan and NSW water sharing plan rules limit how much water can be taken from river and groundwater systems in the Namoi region. The long-term average annual water use in the regulated river system is already at or exceeding the limit. This means that we cannot progress any action that may increase the total amount of water extracted. Any measures that increase the reliability of regulated water supply or encourage an increase in water use by one class of licence holder will mean that we need to reduce the amount of water available to other users to keep total water use within the allowable limit.

Supporting economic prosperity in a capped system will require using water more efficiently, or in innovative new ways.

Legend				
				
Addressing Tamworth's long term water security risks	Addressing water security risks of regional towns across the Namoi Valley	Supporting a growing regional economy in a future of potentially reduced water availability	Improving the health and resilience of aquatic ecosystems	Dismantling barriers to Aboriginal water rights

Table 8. Overview of proposed actions to support a growing regional community under an uncertain future climate

Proposed action	Summary	Challenges addressed
Better information to support decision making and risk management		
Action 2.1 Invest in continuous improvement to surface water system modelling in the Namoi region	Continue to improve and expand the river system models that underpin water management planning in the Namoi region.	   
Action 2.2 Accelerate investment in groundwater modelling in the Namoi region	Fast track the development and expansion of the groundwater system models that underpin water management planning in the Namoi region.	   
Action 2.3 Improve the participation of Aboriginal people in water management in the Namoi region	Investigate ways to improve the participation of Aboriginal people in water management through new approaches, programs, partnerships and funding.	
Action 2.4 Improve public access to climate information and water availability forecasts	Design and deliver suitable training and information products and communication platforms.	  
Action 2.5 Undertake research to inform reviews of groundwater extraction and condition limits	Increase our knowledge of groundwater resources to inform future decisions on sustainable groundwater extraction and condition limits.	 
Action 2.6 Review the water allocation rules for licences in the Peel alluvium	Review the water allocation rules for aquifer licences in the Peel Regulated River Management Zone of the Peel Alluvium water source, to address concerns about sharing of water between surface water and groundwater users during droughts.	

Proposed action	Summary	Challenges addressed
Action 2.7 Understand risks associated with potential future activation of underused licences in the Peel Valley	Investigate the risk of unused licences being activated in the Peel and plan a response to this risk, so that current water users will have time to make adjustments if this proves necessary.	
Increased flexibility to support existing and future industries		
Action 2.8 Make provision for voluntary licence conversions	Enable licence holders to change a portion of general security licences to high security licences.	
Action 2.9 Support the development of new Aboriginal business opportunities in the Namoi region	Invest in Aboriginal run businesses and initiatives that address water access needs or identify new water-related business opportunities.	 
Action 2.10 Improve outcomes for Aboriginal people through place base initiatives	Support the continued development of tailored, place-based initiatives to improve water and other outcomes for Aboriginal people in the Namoi region.	  
Making existing water go further		
Action 2.11 Support increased investment and research into industry climate adaptation	Continue to invest in research and technology that supports more efficient use of water by industries.	
Action 2.12 Increase transparency in the management of groundwater resources in the Namoi region	Publish guidance on how and when the NSW Government will make decisions about risks associated with activation of inactive licences and declines in groundwater levels in this region.	 
Action 2.13 Investigate managed aquifer recharge in the Namoi region	Develop a regulatory framework for Managed Aquifer Recharge and provide guidance on the feasibility of locations in the Namoi region.	 
Action 2.14 Ensure the water management framework can support sustainable economic diversification and transitioning economies	Work across government to understand the water supply and demand needs of emerging industries and begin planning for the long-term transition away from coal dependant economies.	 

Proposed action 2.1: Invest in continuous improvement to surface water system modelling in the Namoi region

The NSW Government uses river system models to inform decisions around changing water sharing rules, developing infrastructure and making policy changes. The models also provide information to support local water utilities in planning for future water supply and to inform water users generally about the risks and reliability of water entitlements.

River system models are computer-based tools that simulate the way water flows and behaves in a system over time, the operation of infrastructure and the demands for and use of water by towns, irrigators and other water users. These models can produce detailed information on water availability and how changes in policy, rules or infrastructure can change the amount of water that flows in the river at different times, and the water available to different users.

The NSW Government has well developed models of the Namoi Regulated River system and the Peel Regulated River system. Recent improvements to the Namoi system model include a major review to better represent the take and use of water, including take by floodplain harvesting, and updating the model to the Source hydrological modelling platform. We have incorporated newly developed long-term climate datasets into the Namoi and Peel surface water models to give us a better understanding of how climate variability and climate change could impact catchment inflows and water availability.

Continuing to improve and expand the capabilities of these models as new data and information becomes available will be particularly important for managing and sharing limited water resources and predicting and mitigating the impacts of increasingly variable and extreme conditions. This could include:

- investigating ways to represent how we change river operations as we go into and recover from drought – being able to simulate drought contingency measures and better represent evaporation and groundwater seepage can help us to better assess the impacts and benefits of different actions during droughts
- investing in updated data and improved river system models for the region's unregulated river catchments
- reducing model uncertainty to better account for different components of water take once sufficient floodplain harvesting and unregulated river non-urban water take measurement data is available
- combining our models with analysis from hydraulic models and remote sensing to better estimate floodplain inundation extent and duration and consequent environmental outcomes, as well as improving our representation of floodplain return flows under different floodplain harvesting rules
- collaborating across different disciplines to explore how hydrologic models could be linked or combined with other models, such as economic and ecological models, to better understand ecological vulnerability to future conditions including climatic variation.

Improved modelling will give stakeholders and the broader community greater confidence that water sharing and management decisions are made using the latest scientific knowledge and a strong and credible evidence base.

Collecting more data and better data

The NSW Government is undertaking a range of programs aimed at improving our understanding of water flows and water use in the Namoi region. The data collected by these programs will improve modelling capabilities.

Non-urban water metering framework

Under the framework, water supply works in the Namoi Region will be subject to the new metering rules to install meters on their pumps. As of December 2021 69% of works larger than 500 mm were compliant with the new rules. Of those not fully compliant with the rules, the majority had accurate meters installed that had been independently certified. But were not yet connected to telemetry.

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

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

Murray–Darling Basin Compliance Compact

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



Image courtesy of Jessica Stokes, Department of Planning and Environment. Yellow flower branch, Salt Caves dam walking track.

Proposed action 2.2: Accelerate investment in groundwater modelling in the Namoi region

The Namoi region is one of the most groundwater-dependent catchments in inland NSW. The ability to understand and forecast how groundwater sources will respond to changes in use, rainfall and recharge is critical to ensure that water management decisions are based on the best available information.

Groundwater levels fall and recover seasonally with annual pumping cycles and over multi-year periods where they decline in dry years and recover in wet years. Groundwater models are the only way we can assess the long-term (decadal and multidecadal) trends in aquifer behaviour in the highly used aquifers, such as the Lower Namoi Groundwater Source, taking account of the impact of water extraction. The models simulate the behaviour of aquifers over time including recharge, the movement of water and the take of water through bores, and are critical for defining long-term sustainable levels of extraction for future reviews of water sharing plans.

Groundwater models can also:

- provide regional information to support local water utilities in planning for future water supply
- provide a better understanding of the impacts of groundwater extraction on other users of a groundwater source to improve the assessment of licence applications
- help to understand the potential risks to groundwater-dependent ecosystems and to water quality

- take into account the potential impacts of climate change and how that will influence the behaviour of groundwater resources into the future.

Continuing to update groundwater system models will need to be a priority. This action will fast-track the development and expansion of these models by:

- ensuring there are up to date, calibrated and peer reviewed numerical models of the Upper Namoi, Lower Namoi and Peel Alluvium – the most used aquifers in the region
- upgrading and expanding the monitoring bore network to fill in data gaps that are essential for improving our models. Additional and replacement monitoring bores are critical to ensure there is sufficient data to build and calibrate models
- incorporating shifts in demand and changes to rainfall patterns that are likely driven by climate variability
- incorporating new understanding on interconnectivity between surface water and groundwater. This is underway as part of the development of the Peel Alluvium groundwater model which will be used to inform future management decisions about this highly used groundwater source.
- developing multi-disciplinary models incorporating socio-economic and physical data, as well as groundwater volume, level, and quality data
- developing approaches to help use the models to inform future water level and quality management practices.

By investing in improved groundwater modelling, we will have better tools to identify and manage risks to one of the most highly used and valuable groundwater sources in New South Wales.



Horses at sunset.

Proposed action 2.3: Improve the participation of Aboriginal people in water management in the Namoi region

We heard from Aboriginal people that consultation with their communities on water issues has been sporadic 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. During consultation in the Namoi region, Aboriginal groups told us that government had to earn the trust of the community as the first step in building a strong lasting relationship with them.

To address this now and over the next 20 years, we need an approach that allows Aboriginal people in each local area and region to get the right people involved or appointed to seats where decisions about water are being made. Aboriginal people need to have a direct line of contact with regional water managers, compliance officers and decision makers. Aboriginal knowledge and science should be actively sought, respected and listened to.

An effective governance, engagement and knowledge sharing arrangement is the first step in fundamentally improving Aboriginal people's involvement in water management. For it to be successful, the makeup and function of groups need to be led by local communities – experience has shown that government dictated governance models for Aboriginal communities do not work.

The NSW Government will work with and fund existing or new Aboriginal groups to develop a governance approach for involvement in water management processes. The success of this action will be driven by the extent to which it enables self-determination and provides an adequate level of support for these groups.

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

Local Aboriginal groups in the Namoi could be involved in:

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

What we have heard so far



Feedback provided in earlier consultation showed support for Aboriginal traditional knowledge and science to support healthy water ways.

We have also heard that ongoing consultation requires government to provide administrative funding and support and work in partnership with local Aboriginal communities and organisations.

Proposed action 2.4: Improve public access to climate information and water availability forecasts

All parts of the community and government need access to reliable and timely information to make informed decisions and participate effectively in water planning.

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

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

The NSW Future Ready Regions strategy recognises that providing clear and accessible information on surface water and groundwater availability allows industries to forward plan with certainty. Access to good climate information ahead of time, and sound risk management and business planning are significant determining factors in the ability of farming businesses to weather prolonged droughts. However, this information is often not accessible or available to water users in a format that is useful to their needs or preferences, which can result in suboptimal business decisions, particularly during drought periods.

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

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

- 12-month climate outlooks and how these could influence water allocation decisions and other operational water sharing decisions, which could help water users make informed decisions on managing their allocations using carryover or trading water on the market
- potential implications of long-term climate data for:
 - surface water availability and water quality
 - the likelihood of consecutive years of low or no water availability
 - periods when access to water allocations may be restricted by delivery problems in the regulated river system
 - groundwater availability.
- improvements over time in flow forecasting capabilities
- how future use may affect the condition of groundwater resources
- a decision framework for how available water determinations are made based on use, compliance triggers, and carryover
- information about groundwater resources and how they are managed to assist councils and other water users to make more informed decisions about their water supply security
- take a proactive approach to understanding the water quality and quantity requirements of emerging industries in order to inform policy development and planning decisions
- deliver upfront education and clarity to new industries and government on potential water sources, given that the surface water sources, and some groundwater sources are already fully allocated and there is potential for reduced water availability in the future
- encouraging new industries to have comprehensive drought management plans as they set up in the region.

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

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

What we have heard so far



Feedback provided in earlier consultation showed support for:

- climate data and modelling being made available to assist communities and councils in their planning, including their development of integrated water cycle management strategies
- helping communities to understand what long-term climate assessments can tell us about future water availability. They also need an enhanced understanding of how water allocation decisions are made
- giving local industries better information on forecast water availability over the next 12 months to inform planning decisions about cropping and business management. Water allocation announcements should be more timely, predictable and transparent.

Have your say



What kind of information and information products do you need to make decisions for your business or water use?



Image courtesy of Destination NSW. Farming Barraba, farmer looking back at mountains.

Proposed action 2.5: Undertake research to inform reviews of groundwater extraction and condition limits

Groundwater use in the Namoi region is one of the highest in NSW. The region has experienced long-term water level declines in some sections of its groundwater sources. For example, the area south of Breeza has experienced a decline between 2 and 5 m in water levels over multiple decades. Further declines may lead to a reduction in use by irrigators and a subsequent impact on economic activity in the region.

The 2005 Achieving Sustainable Groundwater Entitlements program aimed to address long term water level declines in alluvial sources such as the Upper and Lower Namoi Groundwater Sources by reducing entitlements. The NSW Government needs to analyse the effect of these reductions in extractions. This is a complex process because of the normal seasonal and wet/dry year fluctuations in groundwater levels. This historical impact needs to be combined with new information to provide evidence for the review of the sustainable diversion limit for the Murray–Darling Basin Plan in 2026.

Also important is reviewing the resource conditions limits – that is, what is considered acceptable water levels and quality parameters. This is becoming more

of a concern in the alluvial aquifers of the Lower Namoi Groundwater Source and Upper Namoi Groundwater Source Zones 3,4, 8 and 12. In these areas, the concentration of groundwater extraction is causing water level declines or creating interference effects between users. For such areas, we need to look at not only the larger-scale extraction limits but also the smaller-scale resource condition limits.

This action will:

- undertake field investigations and desktop analyses to provide up-to-date information on current and predicted long term trends in water levels, recharge rates and connectivity (with surface water and between groundwater systems)
- consider the impacts of climate variability/ change using new climate information and updated modelling
- establish what groundwater extraction limits will need to be set in the future to ensure sustainable access to groundwater by consumptive users and the environment, considering the sustainable diversion limit review for the Murray–Darling Basin Plan in 2026
- establishing the groundwater condition limits we need to ensure fair and ongoing access to groundwater for towns, industries and the environment.

What we have heard so far



Feedback provided in earlier consultation showed strong support for improving understanding of groundwater processes, especially in the context of climate change.

Proposed action 2.6: Review the water allocation rules for licences in the Peel Alluvium

The Peel Alluvium groundwater sources is highly connected to the Peel River, meaning that much of the water from the river bed seeps into the groundwater source. Some community stakeholders have raised concerns that during severe droughts groundwater users near the Peel River can still access water even though surface water users cannot, arguing that the groundwater they are drawing is from the river.

Under current water allocation rules, aquifer licences in the Peel Alluvium near the Peel Regulated River receive an allocation each year where 51% is linked to the groundwater allocation and 49% is linked to the allocation to general security licences on the regulated river. If the groundwater allocation is 100% (as it is mostly) and the regulated river general security allocation is 50%, these licences would have a 74.5% allocation; when the regulated river allocation is 0%, these licences still receive a 51% allocation. This rule was based on a modelled long-term pumping scenario

at a rate equivalent to that permitted by the long-term average annual extraction limit, which showed that 49% of water pumped could be traced to the Peel Regulated River.³⁵

However, we have heard that during a drought, when there is minimal rainfall, nearly all the recharge comes from the river, meaning groundwater users are effectively using water from the Chaffey Dam when it is unavailable to many surface water users.

The NSW Government is developing an enhanced model of the Peel Alluvium that includes a much better representation of the interchange of water between the alluvium and the river. This will be used to support a review of the water allocation rules for licences in the Peel Alluvium. If changes are recommended, they will be implemented through the review of the Namoi Alluvial Groundwater Sources water sharing plan in 2030.

What we have heard so far



Feedback provided in earlier consultation showed strong support for the review of water accounting and allocation processes. Sustainable allocation and water sharing were deemed a critical issue in the Namoi region.

35. www.industry.nsw.gov.au/_data/assets/pdf_file/0006/166875/peel-valley-background.pdf

Proposed action 2.7: Understand risks associated with potential future activation of underused licences in the Peel

This action would investigate the risk of unused licences being activated in the Peel and, if needed, develop a response to the risks associated with the activation of inactive licenses should this occur in the future.

Under the water sharing plans, if the large number of unused licences in the Peel become activated and average use exceeds the long-term average annual extraction limit in a water source, the available water to all general security licences (regulated river water source) or aquifer access licences (groundwater source) is reduced. To maintain current levels of allocation in such circumstances, water licence holders have the ability to purchase entitlements or annual allocations from willing sellers.

Initial desktop analysis suggests it is unlikely that water demand in the Peel Valley will exceed the extraction limit in the short to medium term, given the current average risk tolerance of farmers in the region.

However, as populations and affluence grow across key markets in south east Asia, it is likely that demand for agricultural products from the Peel will continue to grow. This growth may drive the increased use of underused licences across the Peel Valley, impacting on the amount of water shared between general security licence holders. This analysis needs to be confirmed and discussed with licence holders.

Clarifying the risks and planning a response now will give current water users time to make adjustments if this proves necessary in the future.



Mount Kaputar National Park.

Proposed action 2.8: Make provision for voluntary licence conversions

A number of economic activation schemes and projects are planned in the Namoi to help grow local economies, improve supply chains and attract new businesses into the region. These include the new Namoi Regional Job Precinct, the Narrabri Special Activation Precinct and the inland rail project, which are set to drive investment and jobs across much of the region. In particular, we have heard there is a desire for additional poultry farms in the region to support the growing intensive livestock industry.

For growth to be successful new high value industry will need access to high reliability water sources that can withstand droughts and severe weather. As the Namoi is a capped system, this will have to come through the redeployment of existing water entitlements. However, it will be difficult to find willing sellers of the existing small number of high reliability surface water entitlements. Suitable groundwater entitlements are difficult to move from current locations because of the existing density of bores in high yielding aquifers.

The majority of the river licences in the region are the 245 GL of low reliability general security entitlements in the Lower Namoi Regulated River. These entitlements receive 100% allocation at the start of the year in around 45% of years. This is suitable for annual crops, but not reliable enough for many high value industries that rely on continuous operation. If some of this large quantity of general security entitlement could be converted to high security on request of the entitlement holder, this could open up a much larger pool of potential sellers.

Additional opportunities to purchase high security licences may support new intensive agricultural industries entering the region, or support existing users.

Licence conversion was permitted from 2009 to 2019 but there was limited interest at that time, and it was discontinued across the Murray-Darling Basin in 2019 largely due to concerns about conversion rates leading to third party impacts. However, initial modelling in the Namoi indicates that 5% of general security entitlements could be converted with no material effect on the remaining licences (under 1% change) and environmental water licences, provided there is a suitable conversion factor. Initial modelling suggests a conversion factor of 2-3 units of general security entitlement to 1 unit of high security entitlement.

During the public exhibition of the draft Namoi Regional Water Strategy, we heard some concerns about voluntary licence conversion, including:

- further investigation and community consultation are required to fully assess impacts on all entitlement types, storage management, Murray-Darling Basin Plan, planned environmental water and allocation processes
- considerations on how to make the licence conversions equitable while balancing risks for providing high security water to remote locations.

To progress this action, the NSW Government will undertake detailed modelling, consultation and impact assessment to further develop the conversion factor and any rules needed to mitigate impacts on other licences, basic landholder rights and environmental outcomes. There may also need to be restrictions on where in the river system the high security licences can be converted. High security licences may need to be in close proximity to dams to reduce the risk of not being able to deliver water to those licences during dry periods. Progressing this action will require changes to the water sharing plan.

Have your say



Are you a licence holder and if so, are you interested in converting your general security licences to high security licences? Why?

Proposed action 2.9: Support the development of new water related Aboriginal business opportunities in the Namoi region

During our consultation on the draft Namoi Regional Water Strategy, we heard about the need for economic development and business opportunities in the region that are led by Aboriginal communities and allow for local Aboriginal people to be employed.

Investing in regional Aboriginal run businesses and initiatives can help diversify incomes in the region, create employment for local Aboriginal youth and deliver social and economic outcomes for Aboriginal people.

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

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



Pilligia Cave, Pilligia Nature Reserve.

Proposed action 2.10: Improve outcomes for Aboriginal people through place-based initiatives

The draft Namoi Regional Water Strategy identified options to improve Aboriginal people's access to water and water rights. While there was a significant amount of support for these options, preferences on how they should be prioritised or implemented varied across communities. The needs and priorities of Aboriginal communities in different parts of the region are different.

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

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

In the Namoi, this could include:

- developing a cultural watering program that supports cultural, economic, social and recreational outcomes for Aboriginal communities and people across the Namoi region. This could involve working with the Department of Planning and Environment-Water, WaterNSW and environmental water holders to identify whether cultural water access licences or water for the environment could help deliver water to these locations
- improving access to Country, including locations that have local significance. This would include opening up local parcels of land that have access to waterways that are otherwise gated or locked – such as travelling stock reserves or Crown roads
- a restoration reach, which would use cultural knowledge and science to rehabilitate riparian land, through planting of native species and caring for Country
- programs that engage Aboriginal youth in water and landscape management, with the aim to build cultural awareness and give a sense of ownership and cultural connectivity
- locally run programs that identify and record significant water dependent sites in the Peel and Namoi valleys. Information would be stored in a culturally appropriate way.

To receive government funding or support, these initiatives would need to have local champions, effective local governance arrangements and a strong capacity building component.

Aboriginal Communities Water and Sewerage Program

The Aboriginal Communities Water and Sewerage Program was developed to improve water supply and sewerage services in eligible Aboriginal communities in NSW. The program began in December 2008 and is a joint initiative of the NSW Government and the NSW Aboriginal Land Council.

Together, the government and the NSW Aboriginal Land Council are investing more than \$200 million over a 25-year period to provide funding for the maintenance, operation and repair of water supply and sewerage systems in 62 eligible Aboriginal communities.

In the Namoi region, the program delivers location-specific solutions to local challenges at Walgett and Walhallow. Since its inception, the program has delivered a range of solutions for these communities including the installation and maintenance of water infrastructure, the development of water management plans and initiatives to deliver improved potable water. The program is continuing to investigate and respond to a number of challenges to improving water for these communities.

Have your say



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

Proposed action 2.11: Support increased investment and research into industry climate adaptation

Industry associations, research institutions and government have worked together for decades to support industry adapt to the variable climate in the Namoi region. This has included improving the water use efficiency and productivity of traditional crop and livestock production systems. Grower-led irrigation research has been underway in the region for more than a decade and we heard during earlier consultation that new land use activities, including carbon and biodiversity farming are increasing in some areas of the region.

Farm businesses in the Namoi region are considered early adopters of best practice management and new technology.³⁶ 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 20 years ago.³⁷

Continuing critical research and development will set industry up for the future and may go a significant way to mitigating future climate risks and adapting to climate change. There are opportunities to fast-track research and development into new practices and enterprises that are best suited to the warmer and drier conditions projected for regional NSW. This research would build on the climate vulnerability assessment being undertaken by the Department of Primary Industries and help agricultural businesses to diversify their incomes and ensure their long-term sustainability.

There are also opportunities for further improvements to on-farm water use efficiency. Options that reduce evaporation from on-farm storages appear to offer the greatest potential in the Namoi catchment but would ideally form one component of a whole farm water efficiency program.

Through this action, the NSW Government will build on behaviour change and efficiency gains by continuing to support research, trials and demonstration projects for:

- evaporation mitigation technology, particularly suspended and floating covers, building on the significant amount of research already undertaken by the cotton industry, the Cotton Research and Development Corporation and the NSW Department of Primary Industries
- smart sensors and automated irrigation systems
- reconfiguration of on-farm storages to reduce the surface area-to-volume ratio
- limiting deep drainage by increasing the soil's water holding capacity using novel compounds such as hydrophilic polymers.

This work could be progressed through:

- the NSW Government's \$48 million expanded Farms of the Future program, which will support on-farm connectivity and encourage farmers to adopt agricultural technology (AgTech) to boost productivity including water efficiency and drought preparedness. In 2022, a grants program will be delivered to help farmers purchase AgTech devices and applications
- research programs of the Department of Primary Industries – Agriculture, which will lead efforts to translate world-leading research into practical improvements, including drawing on research to develop and coordinate local pilots, and information and training programs
- the One Basin Cooperative Research Centre program, a collaboration between government, research institutions and industry that will develop policy, technical and financial solutions to support and reduce exposure to climate, water and environmental threats in the Murray–Darling Basin.

What we have heard so far



Feedback provided in earlier consultation showed support for:

- the regional water strategy to focus on reducing and managing water demand and prioritising suitable efficiency measures to improve or maintain water reliability and deliverability
- managing land within the catchment to increase soil carbon and absorb more of the rain that falls allowing it to be released more gradually to sustain stream flows and enable better production from those soils.

36. Roth, G., Harris, G., Gillies, M., Montgomery, J. and Wigginton, D., 2013, *Water-use efficiency and productivity trends in Australian irrigated cotton: a review*, Crop and Pasture Science, 64(12), pp.1033-1048

37. Australian Cotton Sustainability Report 2019

Helping primary producers adapt farming systems to climate change

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

The assessment is being conducted in two stages:

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

The impact assessment for cotton is nearing completion and suggests that warmer temperatures could benefit cotton production and quality. The next steps are to assess water related risks and how we might be able to respond to negative impacts. This could include providing direction for industry research and development; for example, by developing new cotton varieties or other farming systems more suited to a drier climate.

The rangeland component of the vulnerability assessment project is looking at the impact of existing livestock production systems. The project will focus on the suitability of adaptation options including changing management systems and shifting the focus of livestock enterprises to include carbon farming or an increased focus on goat production.

Primary Industries Productivity and Abatement Program

As part of the Net Zero Plan, the NSW Government will develop a Primary Industries Productivity and Abatement Program to help producers and landowners commercialise low-emissions technologies and maximise their revenue from carbon offset programs. The program will help farmers meet the growing demand for sustainable products and ensure that the productivity of primary industries in NSW is not tied to emissions intensity in the global transition to a net zero economy. Some abatement opportunities, such as soil carbon sequestration, can also enhance the sustainability of farming systems and reduce their susceptibility to dry periods.

Identifying and mapping important agricultural lands

The Department of Primary Industries – Agriculture has been undertaking a 3-year program to identify and map important agricultural lands. Knowing where this land is situated and understanding its location, value and contribution will assist in making decisions about current and future agricultural land uses and their water needs. This project is currently on hold while the government considers any recommendations from the NSW Agricultural Commissioner. A comprehensive and consistent approach to collecting water statistics information will greatly help this process.

Have your say



What should be the focus of future research and investment in water-use efficiency?

Proposed action 2.12: Increase transparency in the management of groundwater resources in the Namoi region

Groundwater users in the Namoi region have raised concerns about the transparency of government decisions about the risks associated with activation of inactive licences and responses to ongoing groundwater level declines. Improving the transparency of groundwater management will give users more confidence in decision-making processes and outcomes.

This action will:

- look at ways to proactively manage groundwater systems where the entitlements plus basic landholder rights exceed the extraction limit. Risks associated with inactive licences will be investigated with the view to providing clarity to water users about how fully committed groundwater systems will be managed if licence activation and use further increases over the next 30 years
- prepare a guideline with a series of escalating management actions corresponding to stages of groundwater level decline. This will provide certainty to all water users about what actions the NSW Government will take and when in areas where groundwater extraction is causing declines in water levels and help towns, stock and domestic and industry users plan for more extreme droughts when groundwater may not be a viable backup.



Image courtesy of John Spencer, Department of Planning and Environment. Freshwater and reeds, Werrikimbe National Park.

Proposed action 2.13: Investigate managed aquifer recharge in the Namoi region

Managed aquifer recharge – also known as groundwater replenishment, water banking or artificial recharge – is the purposeful recharge of water into aquifers for environmental benefit or future use, including during drought. A range of water sources can be used in aquifer recharge, including stormwater, treated wastewater, river or dam water, or industrial water. Water can be artificially injected into the aquifer with pumps or infiltrated naturally through ponds or purpose-designed wetlands.

Progressing managed aquifer recharge is a NSW Government priority. Potential benefits from managed aquifer recharge include:

- minimising evaporation, compared to storing water aboveground
- providing additional recharge to groundwater sources to increase water reliability for groundwater-dependent users, including ecosystems
- reducing pressure on surface water supplies during drought, which could improve environmental outcomes for riverine environments.

Our initial assessment has suggested that there is potential for managed aquifer recharge to be undertaken in several locations in the region, particularly by using an injection method to store water in the deep sandy and gravelly aquifers beneath the Namoi River. While a site may be viable from a hydrogeological perspective, other issues such as the availability of water for storage and operational costs are potential constraints that require further investigation.

Liverpool Plains Shire Council has raised potential opportunities for water recycling and emergency back-up supplies which demonstrates demand for additional water that could be supplied through managed aquifer recharge.

The NSW Government is currently developing the regulatory framework for managed aquifer recharge. As it is a new way of managing and storing water in NSW, stakeholder consultation will be needed.

This action would support investigations into local place based managed aquifer recharge projects in the Namoi region.

What we have heard so far



There was general support for ongoing investment for research on managed aquifer recharge, but some stakeholders pointed to the need to better understand potential environmental risks, impacts to aquifers and surface water systems.

Proposed action 2.14: Ensure the water management framework can support sustainable economic diversification and transitioning economies

The NSW Government is making significant place-based investments in the region and surrounding areas to build strong communities and support industry development and diversification through a focus on intensive livestock and agriculture, renewable energy, gas industries and expansion of the Gunnedah coal mining industry.

Many of the new industries will require access to water, which will need to come from trading of existing water entitlements, groundwater sources that are not fully allocated, or recycled and re-used water sources. We need to make sure our water entitlement and access framework can cater to these new industries by supporting sustainable access to water.

Coal mining will continue to be a significant contributor to the local economy in the coming decades. However, over the long term it is an industry that will be directly affected by the global transition to lower carbon sources of energy. This is an immediate issue in some local government areas where small mines are closing down in the coming years, and a longer term strategy for areas in the region where coal mining is expanding in the short term. We need to begin work now to prepare for the transition, particularly in places like Gunnedah where the economy has been reliant on coal mining industries for many decades. Transition will be a long term process and may involve an overlap in the water needs of new industries entering the region while existing industries are transitioning.

This action will:

- begin investigations and preparation for the long term transition away from coal dependent economies including how water will be needed to support the transition
- address water-related policy and regulatory barriers around supporting new and diverse industries setting up in the region
- encourage new industries to have comprehensive drought management plans
- use evidence from this regional water strategy when informing future industrial and land use planning strategies, to ensure there are sustainable water sources available to support new industries.

Priority 3

Improving the health and resilience of water dependent ecosystems

Changes to rivers flows and land use have impacted the health and resilience of water-dependent ecosystems across the Namoi region. The potential for longer and more severe droughts will increase the risk of ecosystem damage and decline in connectivity.

Managing these risks will need coordinated and cooperative action across all parts of the community, as well as a better understanding of how potential future climate scenarios might impact on different parts of the environment.

The actions shortlisted (Table 9) under this priority will:

- achieve shared benefits from water delivery and maximise environmental, social, cultural and economic outcomes when water is used
- limit or remove pressures and impacts directly related to water infrastructure. The proposed actions recognise that complementary catchment management activities are often needed to achieve environmental watering outcomes
- improve the health of water resources through better land management
- build knowledge and understanding of the region's surface water-dependent and groundwater-dependent ecosystems and assets and the impacts of climate change on their health and resilience
- improve connectivity with the Barwon–Darling River on a multi-valley scale.

What we're already doing



The NSW Water Strategy contains actions for improving environmental monitoring, evaluation and reporting programs. This includes:

- finalising a monitoring and evaluation framework for water sharing plans, and initially targeting locations with high environmental risk
- monitoring and reporting on environmental water delivery and management to inform adaptive management and reporting
- maintaining a water science strategy and prospectus that provides sector-wide guidance on future science, research and development
- initiating, developing and delivering science partnerships in support of enhanced water resource management outcomes with universities, research organisations, industry and the community.

These initiatives provide a strong foundation for actions taken in the Namoi Regional Water Strategy.

Legend



Addressing
Tamworth's
long term water
security risks



Addressing
water security
risks of regional
towns across the
Namoi Valley



Supporting a
growing regional
economy in a future
of potentially
reduced water
availability



Improving
the health
and resilience
of aquatic
ecosystems



Dismantling
barriers to
Aboriginal
water rights

Table 9. Overview of proposed actions to improve the health and resilience of water-dependent ecosystems

Proposed action	Summary	Challenges addressed
Action 3.1 Assess gaps in the flow regime that are preventing achievement of environmental watering objectives and identify cooperative actions to improve ecological outcomes	Investigate opportunities to: - review relevant water sharing plan rules to improve flexibility and certainty of environmental water in changing climate conditions - achieve more natural flow patterns and protect important flows down the system - coordinate dam releases with unregulated tributary flows to promote higher flow events, within system constraints.	
Action 3.2 Identify regionally significant riparian, wetland and floodplain areas to protect or rehabilitate	Strategically target on-ground activities at high-priority locations to restore, conserve and protect critical riparian, wetland and floodplain habitat and species, or areas of high cultural value in the Namoi region.	
Action 3.3 Mitigate the impacts of water infrastructure on native fish	Take action to: - improve fish passage at priority sites in the Namoi region - identify priority river reaches for installation of diversion screens to protect native fish - progress cold water pollution mitigation measures.	
Action 3.4 Fully implement the NSW Floodplain Harvesting Program	Finalise floodplain harvesting access licenses and works approvals in the Upper and Lower Namoi Valley floodplain.	
Action 3.5 Remediate unapproved floodplain structures	Undertake an accelerated compliance program for unapproved floodplain structures in high priority areas of the Upper and Lower Namoi Valley floodplain.	

Proposed action	Summary	Challenges addressed
Action 3.6 Improve understanding of water use and water quality at priority locations in the Namoi	Review existing monitoring programs and invest in technologies and monitoring that can provide additional information about water quality and water flows at priority locations to improve future planning and management for these systems.	
Action 3.7 Investigate ways to improve connectivity with the Barwon–Darling River on a multi-valley scale	Develop the most effective coordinated options to improve connectivity across all Barwon Darling tributaries through the Western Regional Water Strategy.	
Action 3.8 Continue investment in groundwater science in the Namoi region	Address gaps in our knowledge of groundwater dependent ecosystem water requirements, groundwater quality risks and aquifer compaction risks.	



Image courtesy of Department of Planning and Environment. Flooding, Tamworth.

Proposed action 3.1: Assess gaps in the flow regime that are preventing achievement of environmental watering objectives and identify cooperative actions to improve ecological outcomes

All water, including water from natural events and consumptive (irrigation and town) water, has the potential to contribute to the ecological condition of rivers, wetlands, and floodplains. The way the river is operated to deliver consumptive water can either enhance environmental outcomes or worsen environmental impacts.

The water sharing plan for the Namoi Regulated River helps to ensure that approximately 73% of the long-term average annual flow in the water sources remains in the river to help maintain the basic health of ecosystems.³⁸ Provisions in the Peel catchment water sharing plans include similar rules that set extraction limits and require the remaining inflows to be left in rivers for the health of the environment.

The water not subject to these protection provisions is allocated to licences. Of the water entitlements issued to licence holders in the Peel and Namoi, 3.5%³⁹ are held by the Commonwealth environmental water holder as general security licences. There is also up to 5 GL of an environmental water allowance in the Peel depending on general security allocations. A further 9.5 GL still needs to be recovered for the environment in the Namoi catchment under the Basin Plan. Environmental water provisions often do not allow environmental water holders to use this water to meet some of the flows needed to support ecosystem needs.

As a result, we need to rely on how water is released from the dams for irrigation use to maximise environmental watering benefits and minimise water quality impacts.

There may be fewer opportunities to use environmental water licences to support environmental outcomes in the region under a more variable or changing future climate. We need to make sure the mechanisms are in place to allow water for the environment to go as far as possible.

This proposed action would investigate opportunities to provide flexibility to manage environmental flows in changing climate conditions, better coordinate the management of consumptive flows and water for the environment and achieve more natural flow patterns without impacts on water users. This could include:

- reviewing relevant water sharing plan rules around carryover of the environmental water allowance in the Peel Valley and protection of environmental water to improve flexibility and certainty of environmental water
- working with water users to protect important flows down the system without having major impacts on water users
- coordinating dam releases with unregulated tributary flows to promote higher flow events, within system constraints
- assessing system constraints and developing a program to address them where possible
- refining water releases from dams and weir pools to mimic more natural rates of rise and fall and minimise water quality impacts
- planning water releases from water storages to better consider environmental impacts, damage to riverbanks, risks to public safety and operational efficiency.

Workable solutions could be included in guidance developed by the Department of Planning and Environment for the coordinated management of water for the environment and consumptive (irrigation) flows.

38. Clause 13 of the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016

39. 14805 environmental shares — percentage compared with all regulated licences in the Namoi and Peel valleys

Proposed action 3.2: Identify regionally significant riparian, wetland and floodplain areas to protect or rehabilitate

The health and resilience of rivers and the ecosystems they support are 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 ecological responses and benefits from environmental watering.

The Namoi region includes wetlands and lagoons of national, state and regional significance including Lake Goran, Gulligal Lagoon and Barbers Lagoon as well as a series of lagoons that stretch between Boggabri and Narrabri along former channels of the Namoi River. When inundated, these water bodies provide important habitat for migratory birds and a range of flora and fauna. They are also important drought refuges.⁴⁰

Land use changes and land clearing for urban and agricultural development have had adverse impacts on the health of the rivers and water bodies 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. The degradation of native riparian vegetation along water courses is recognised as a key threatening process under the *Fisheries Management Act 1994* (NSW).

This action would deliver targeted, on-ground activities at high priority locations to restore, conserve and protect critical riparian, wetland and floodplain habitat

and species, or areas of high cultural value in the Namoi region. It could build on existing land management programs and other local initiatives to coordinate a whole-of-catchment program of works to improve river health, connectivity and ecosystem resilience. Works could include instream structures – for example, appropriately designed and approved large woody habitat structures – as well as improved instream vegetation to slow and filter water flow. These works improve water quality by removing sediments and nutrients. Improved riparian management, including controlling stock access, could provide bank stability, protecting banks from erosion and reducing sediment loss during floods.

Delivering this more focused and prioritised approach would require:

- mapping existing programs and potential overlaps
- developing a system to prioritise areas to protect or rehabilitate – for example, based on detailed habitat mapping data, native fish conditions, threatened species distribution, the River Styles Framework, severity of land degradation and environmental management outcomes
- establishing a program of management measures
- identifying funding models, including landholder incentives
- developing a clear governance framework for decision making and program delivery
- understanding and integrating local Aboriginal knowledge and expertise in delivering river improvement works – for example, through a River Rangers program
- developing a monitoring and evaluation framework based on the outcomes and targets identified through the Namoi Long Term Water Plans.

What we have heard so far



Feedback provided in earlier consultation showed support for conservation and restoration of riparian wetland and floodplain vegetation to improve water quality, river health and habitat. It was also noted that broader community benefits could be realised through enhanced environmental outcomes.

Have your say



What do you see as the key challenges that need to be addressed to improve the management of the region's rivers?

40. Eco Logical Australia 2008, *Namoi Wetland Assessment and Prioritisation Project*, Project No. 125-005, Draft report prepared for Namoi Catchment Management Authority, Gunnedah

Proposed action 3.3: Mitigate the impacts of water infrastructure on native fish

Many native fish species in the Namoi region require unimpeded access through waterways to move upstream and downstream daily to access food, avoid predators and find shelter, and seasonally to spawn, migrate and recruit. Enabling native fish to move across the region will improve the resilience of fish species in a changing climate and also help to maintain and replenish native fish stocks across the northern Murray–Darling Basin.

Improve fish passage at priority sites in the Namoi region guided by the *NSW Fish Passage Strategy*

Physical barriers to fish passage such as weirs and dams can limit fish movement, leading to a decline in the health and viability of native fish populations. Removing barriers to fish movement and allowing fish to breed and find food and ideal habitat are critical to supporting native fish populations in the Namoi region.

Good progress has been made in remediating 2 priority fish barriers in the Namoi region. The temporary town weir on the Lower Namoi River has been removed as a requirement of the 1 m raising of Walgett Weir on the Barwon River. A fishway at Gunidgera Weir is included in the WaterNSW Dam Safety Upgrade Fishway Offset program and is funded for delivery over the next 5 years. Remediation of the priority barriers will restore catchment-wide connectivity from the Barwon River junction to Keepit Dam. This will improve fish access to habitat across an additional 561 km of the Namoi River and sections of the Peel River.

An additional 6 fish barriers with medium to high priority across the Namoi and Peel rivers and Halls Creek could be considered for remediation in the future.

Implement fish diversion screens at priority sites in the Namoi region

Large numbers of native fish are sucked into pumps and diverted into irrigation channels along with debris such as sticks and leaves. This impacts the sustainability of native fish populations because these fish are taken out of the system. It also causes significant damage to irrigation infrastructure.

Approximately 2,300 pumps are distributed across the Namoi and Peel river systems. The highest concentrations of pumps are found on sections of the Macdonald, Peel and Mooki rivers, Cox's Creek, the mid-Namoi River; and below Narrabri.⁴¹

Modern screens are available to solve these problems, by stopping fish and debris entering pumps and diversions. Modern screens can reduce fish losses at water diversions by over 90% and protect native fish during upstream and downstream migrations, helping more fish survive to maturity and boosting native fish populations. The protection extends to other aquatic species such as crayfish and turtles. Screening infrastructure also improves pump operation, water delivery and extraction efficiency for asset owners through fewer blockages caused by debris.⁴²

This action could identify priority reaches in the Namoi region to install diversion screens and seek funding for the installation.

Progress cold water pollution measures

Cold-water pollution has damaging impacts on riverine ecological function, particularly in summer when biological cues such as fish spawning are disrupted. The water released from dams is typically 5 °C colder than the ambient river temperature, and the cold-water pollution can affect the river for more than 100 km downstream of the dam.

Chaffey and Split Rock dams have variable-level offtakes to mitigate cold-water pollution, Keepit Dam has no mitigation infrastructure. While variable-level offtakes can be operated to reduce cold water pollution risks, in warmer months, the presence of potentially toxic surface algae often means that it is not possible to use the variable-level offtake to take warmer surface water. As it is not currently possible to remove the risk of algal blooms in these dams, additional actions to manage cold-water pollution need to be taken.

Though this action, WaterNSW and the NSW Department of Primary Industries–Fisheries would:

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

What we have heard so far



Feedback provided in earlier consultation showed support for improving fish passage, mitigating cold water pollution and using diversion screens to improve populations of native fish and other aquatic species. It was also felt that options to address these issues would positively contribute to tourism in the region.

41. NSW Department of Primary Industries 2007, *The effects of selected irrigation practices on fish of the Murray–Darling Basin Fisheries*, Sydney
42. Boys, C., Baumgartner, L., Rampano, B., Robinson, W., Alexander, T., Roswell, M., Fowler, T. and Lowry, M., 2012, *Development of fish screening criteria for water diversions in the Murray–Darling Basin*, Fisheries Final Report Series No. 134, NSW Department of Primary Industries, Sydney

Proposed action 3.4: Fully implement the NSW Floodplain Harvesting Program

Floodplain harvesting happens when water spills from a river during a flood or on the way to the river after a rain event. It is a historically legitimate form of water take that has not been fully transitioned into the licensing framework provided by the *Water Management Act 2000*. Floodplain harvesting is a significant farm management practice in the Namoi region. Approximately one quarter of all surface water used in the region comes from water diverted from the floodplain and intercepted before it enters rivers and creeks.

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

Floodplain harvesting across the NSW northern Basin has been growing, and can result in total diversions in a water resource exceeding the legal limits. Floodplain harvesting reform will reduce take so that total diversions within each valley will not exceed legal limits.

This action would ensure that a regulatory framework is in place to manage floodplain harvesting in the Namoi Valley. This would result in the issuing of floodplain harvesting licences for regulated and unregulated water sources in the Namoi region.

Unless the NSW Healthy Floodplain Policy is implemented, uncertainty for water users, the regulator and communities will continue. Without implementing these reforms, we cannot measure or monitor floodplain harvesting; this may mean that other licence categories are penalised to meet legal limits.

Proposed action 3.5: Remediate unapproved floodplain structures

Extensive floodplain development exists on the Namoi Valley floodplain, including levee banks, earthworks, on-farm storages, raised roads and water supply channels. Flows that extend to the floodplain can be constrained by these structures, which are referred to as flood works. Flood works can significantly alter the flow of waters across the floodplain and impact on the flood connectivity that is essential for sustaining ecological and cultural assets and allow water to move unimpeded through the valley.

This action, taken through the Improving Floodplain Connections program (which commenced in January 2022), would accelerate the remediation or removal of 20 unapproved works in the Upper Namoi Valley floodplain and six in the Lower Namoi Valley floodplain that are altering the flow of floodwaters in the region and potentially impeding the delivery of water to floodplain areas and to the end of the system. A large proportion of wetland and floodplain ecosystems in the Namoi region would benefit from this option. The program also has the potential to enhance cultural sites and values held by local Aboriginal people.

Proposed action 3.6: Improve understanding of water use and water quality at priority locations in the Namoi region

Currently, water management across regional NSW is impaired by gaps in real-time and long-term information on streamflow, water extraction and water quality. Telemetered river gauges are limited in the region because of operational costs, and water taken from many unregulated rivers is poorly metered.

Under the NSW Non-Urban Water Metering Policy, the extraction of water will be accurately measured and reported on all unregulated rivers, giving a better understanding of water use over the next few years.

Water quality is important for ecological processes, recreation, amenity and industry use. Changes in water quality are due to a combination of factors, including changes in river flows and land use. For example, high flows from rainfall and runoff often result in higher turbidity, whereas low-flow and cease-to-flow events increase the risk of algal blooms in reservoirs and weirs. Rainfall following extended dry periods can also increase the risk of blackwater events, which can result in fish deaths.

Improved information about water quality and water use at priority locations could be used to inform future planning and management for these systems, such as developing environmental watering requirements, developing access and trade rules, identifying flow components for protection, and preventing environmental harm.

This action would review existing monitoring programs and data to identify key information gaps and investigate how they could be addressed. Areas that have already been identified include:

- improving understanding of water use in unregulated water sources, particularly in the Lower Namoi and near Lake Goran, which is an important site for migratory birds
- improving telemetered monitoring of water quality parameters such as dissolved oxygen, turbidity and conductivity on regulated and unregulated systems to inform management of water quality during regulated releases and extreme events such as droughts, floods and bushfires.

Once identified, information gaps could be addressed through investment in technologies and monitoring that can provide additional information about water quality, flows and use.

What we have heard so far



Feedback provided in earlier consultation showed support for improving information about water quality during normal and drought operations and water use in the unregulated system.

Proposed action 3.7: Investigate ways to improve connectivity with the Barwon–Darling River on a multi-valley scale

The Namoi catchment is one of several NSW and Queensland catchments that play a critical role in providing water to the Barwon–Darling River system. We have heard that many stakeholders outside the Namoi region expect additional actions in the Namoi Valley to help meet needs downstream and improve connectivity. We have also heard that it may not be possible to improve connectivity when the river dries

up naturally from time to time. The NSW Government is reviewing whether rules should be amended to improve the flows of water between catchments at certain times. Importantly, we need to consider whether we have the tools to deliver the intended outcomes without significant impacts. This work will be covered through a more coordinated, system-scale approach as part of the Western Regional Water Strategy.

A set of options to improve connectivity has been released for public consultation through the draft Western Regional Water Strategy from June–July 2022.⁴³

Rule changes that significantly affect the amount of water available to water licence holders may trigger compensation under the *Water Management Act 2000* (NSW).

What we have heard so far



Feedback provided in earlier consultation showed support for:

- restoring connectivity, which is crucial in supporting ecosystems and improving riverine productivity, water quality, and populations of native fish and other aquatic species
- improving connectivity, which has significant cultural, social and recreational benefits
- connectivity actions that are feasible and able to be implemented practically.

Have your say



- What are the relative benefits and impacts of options to improve connectivity with the Barwon–Darling River system?
- Are there other actions in the Namoi region that we should analyse?

43. Available for download at: water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/public-exhibition/western-regional-water-strategy

Proposed action 3.8: Continue investment in groundwater science in the Namoi region

Over the decades, the NSW Government has invested in understanding groundwater systems.⁴⁴ However, these systems change over time in response to changes in groundwater use and the climate. There are also emerging threats to these systems and the ecosystems they support, such as pollution from different land uses. We need to better understand these changes and threats to protect and manage the resource for the future. Continuing to invest in groundwater science and increasing our knowledge of groundwater sources and their dependent ecosystems, water quality and changes to aquifers is critical to future management of this important resource.

Priority areas of research include:

- **Groundwater-dependent ecosystems:** The Namoi region is home to many important groundwater-dependent ecosystems such as river red gum, coolibah, black box, river cooba and lignum communities. They support a range of species and important ecosystem services, supplying drought refuge for fish, waterbirds and foraging species during dry periods. Degradation of habitats, a decline in groundwater levels due to water extraction, land clearing and changes in land use have had severe impacts on the health of these systems. Our current knowledge of the locations and water requirements of these ecosystems is very limited.

- **Groundwater quality:** Groundwater quality information in the Namoi is generally out of date and has many gaps. Quality can change over time; for example due to declining groundwater levels that can draw in saline groundwater from surrounding aquifers. Improving groundwater quality monitoring through auditing the current bore network (and expanding the network if required), implementing regular sampling programs and collating groundwater quality data from industry and government sources into one database can help to identify groundwater quality risks early.
- **Sediment compaction risks:** Declining groundwater levels in some areas of the Lower and Upper Namoi means there is a risk of sediment compaction. This can lead to land subsidence, reduction in groundwater storage capacity and water quality degradation over time. Appropriate scientific and modelling work can help to clarify these risks.

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

What we have heard so far



Feedback provided in earlier consultation showed support for:

- improving research and information about groundwater-dependent ecosystems to increase our understanding of potential impacts to these systems from development and climate change
- improving understanding of groundwater quality to inform appropriate use of water, and to help identify risks and impacts on the environment
- improving understanding of groundwater processes especially in the context of climate change.

⁴⁴. Read more about groundwater science undertaken by NSW government here:
www.industry.nsw.gov.au/water/science/groundwater/document-library

How to have your say

5

Image courtesy of Jessica Stokes, Department of Planning and Environment.
Rocky hills, Mount Kaputar summit.

When will the actions be implemented?

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

Following public consultation, we will develop an implementation plan that will set out when we plan to commence each action and what we plan to achieve by when. The implementation plan will also identify key partners in delivering these actions, including local councils, other government agencies, local community groups and local Aboriginal communities. Figure 19 provides an overview of the strategy development process and where we are currently up to.

Not all actions will be commenced at once, and funding 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 seeking funding as future opportunities arise.

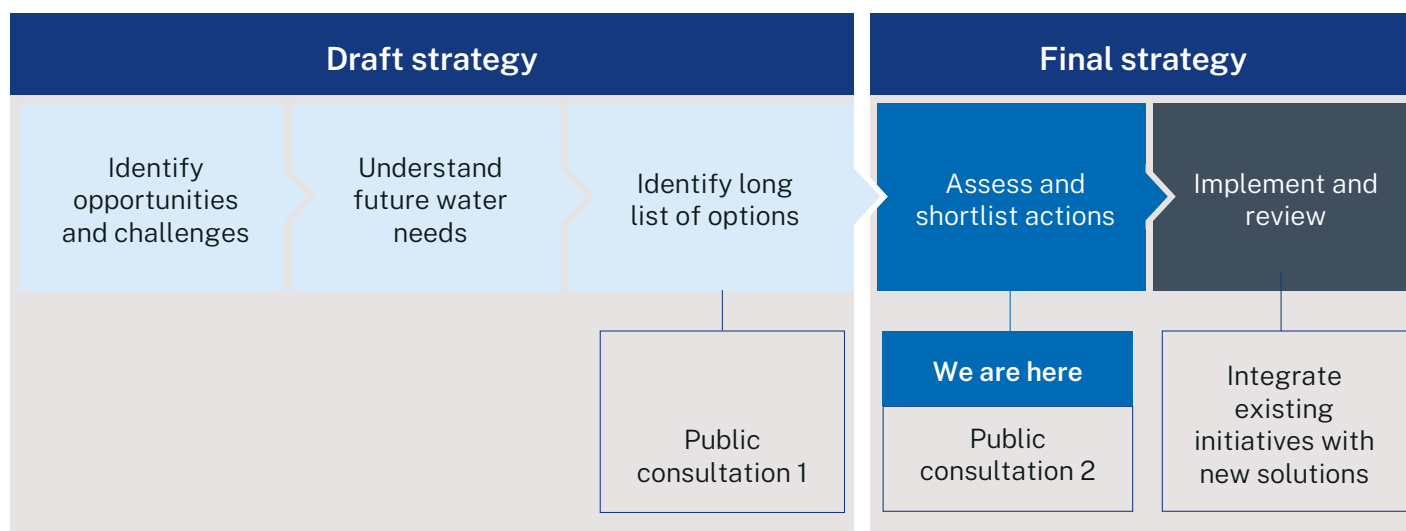
The water security actions in this strategy have a strong focus on drought security following the experience of the 2017–2020 drought. However, this drought has been closely followed by major flood events from 2020–2022.

Some of these proposed actions may mitigate low to moderate flooding events. A more detailed assessment of the flood mitigation benefits of these options will be vital to progressing the shortlisted actions from the strategy to on-ground implementation. Analysing the flood benefits of many of the proposed actions in this strategy will require whole of government input, as well as additional investment in flood modelling and mitigation works.

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

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

Figure 19. Namoi Regional Water Strategy delivery timeline



Attachments

6

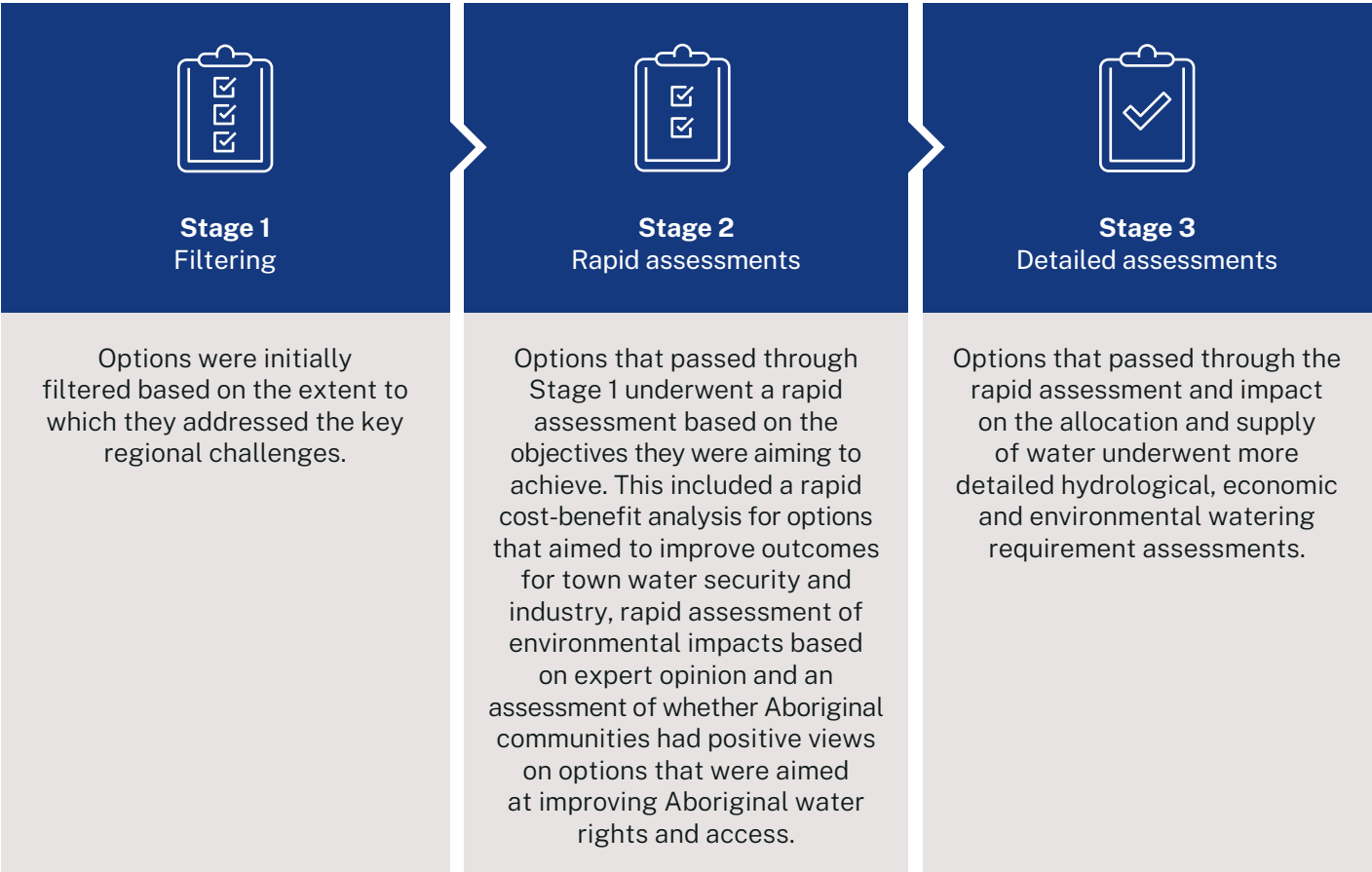
Attachment 1: Summary of the options assessment

The Draft Namoi Regional Water Strategy identified 56 draft options. During community consultation on this draft long list, we received feedback from a broad range stakeholder groups including councils, agriculture and industry groups, local communities, conservation groups and Aboriginal stakeholders. Based on this feedback as well as further analysis of

the long list of options we have amended a number of options and developed 8 new options to form the proposed shortlist.

The process we followed to move from the long list to the short list is summarised in Figure 20 and described in the *Options assessment process: Overview*.

Figure 20. Going from a long list to a final strategy of actions



At each step of the assessment, we narrowed down and filtered out the long list of options from the draft Namoi Regional Water Strategy, based on the evidence we gathered and the analysis we undertook. Based on our analysis, several options were consolidated, refined and converted into actions. Others were not progressed.

This attachment summarises the outcomes of our options assessment (see Table 10). Results from the cost benefit and environmental watering requirement analyses is presented in Attachment 2.

The analysis we have undertaken is a high-level assessment process, appropriate for a strategic document, and is not designed to consider all possible

impacts on the environment, water users or Aboriginal people in detail. However, it does provide enough detail to understand if an option is likely to make a net positive contribution to the regional water strategy’s objectives. More detailed environmental, economic and cultural assessments are required and will be undertaken in any subsequent business case development or planning processes for options that proceed to implementation stage.

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



Options progressed to next step



To be considered in other NSW processes



Option not progressed

Table 10. Assessment of the long list of options

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
Government commitment 1: New Dungowan Dam and pipeline	Assessed separately through a detailed business case and environmental impact statement.			Government commitment to be progressed in the Namoi Regional Water Strategy.
2a. Inter-regional pipelines: inland diversion of water from the Macleay to the Namoi region and pipelines from the great artesian basin				The options around pipelines from the Great Artesian Basin to Namoi Towns were not shortlisted as these did not meet the key regional challenge. Instead, proposed action 1.5: Reduce uncertainty in groundwater security for regional towns. The option of a pipeline from the Macleay catchment to Namoi was not progressed because it did not pass the rapid cost benefit analysis. Refer to Attachment 2 for details.
2b. Inter-regional pipelines: diversion of water from the Barnard rivers to the Peel				See proposed action 1.6: Plan for the next long term water supply augmentation as Tamworth grows. Rapid assessment demonstrated it was effective at meeting its objective to reduce Tamworth's water security risks.
3a. Intra-regional pipelines: pipeline from Dempsey Bridge to Pian Creek (Near Walgett Weir)				Rapid and detailed analysis showed that the benefits were marginal and did not outweigh the costs. Refer to Attachment 2 for detail.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
3b. Intra-regional pipelines: pipeline from proposed new weir at Blue Hole (Option 32) to Split Rock Dam	⊗	⊗	⊗	Rapid cost-benefit analysis showed that costs outweighed benefits. There was also significant community opposition to this option. Refer to Attachment 2 for details.
3c. Intra-regional pipeline: pipeline from the end of the Peel River to Keepit Dam with a small weir on the Peel River	⊗	⊗	⊗	Rapid cost-benefit analysis showed that costs outweighed benefits. Refer to Attachment 2 for details.
3d. Intra-regional pipeline: pipeline between Keepit Dam and Tamworth Calala Lane Water Treatment Plant for an emergency water supply	✓	⊗	✓	See proposed action 1.6 : Plan for the next long-term water supply augmentation as Tamworth grows.
3e. Intra-regional pipeline: operating the Chaffey to Tamworth pipeline constantly. This pipeline is currently only operated during temporary drought periods	⊗	⊗	⊗	Analysis of this option by Water Infrastructure NSW showed it will not effectively reduce Tamworth's water security risk.
4. Suspension of water sharing plan provisions for planned environmental water for critical needs in the Peel River	⊗	N/A	⊗	Analysis of this option by Water Infrastructure NSW showed it will not effectively reduce Tamworth's water security risk.
5. Investigate the use of advanced water treatment technologies for towns	✓	⊗	✓	Incorporated into proposed action 1.4 : Progress advanced water treatment facilities for industries reliant on town water supplies.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
6. Reuse, recycling and stormwater projects	✓	N/A	✓	Incorporated into: proposed action 1.3: Adopt a stronger focus on water efficiency and demand management for towns proposed action 1.4: Progress advanced water treatment facilities for industries reliant on town water supplies proposed action 1.6: Plan for the next long-term water supply augmentation as Tamworth grows.
7. Connect the Peel Regulated River System to Quipolly Dam	✗	N/A	N/A	There was no support for this option through the public consultation process. This option also did not meet a key regional challenge.
8. Managed aquifer recharge investigations and policy	✓	N/A	✓	See proposed action 2.13: Investigate managed aquifer recharge in the Namoi region.
9. Reliable access to groundwater by towns	✓	N/A	✓	Incorporated into proposed action 1.5: Reduce uncertainty in groundwater security for regional towns.
10. Investigate opportunities for dual water systems	✓	N/A	✓	This option was incorporated into proposed action 1.3: Adopt a stronger focus on water efficiency and demand management for towns. Dual water systems are being considered further at the local water utilities level as part of regular planning processes. The NSW Government will provide support on programs to meet the criteria of action 1.3.
11. Investigate the development of a water access licence for critical human needs	✗	N/A	✗	There was no stakeholder support for this option. Alternative proposed actions in the shortlist aim to support water for critical human needs.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
12. Investigate groundwater desalination for industry	✓	N/A	✗	Did not meet the key challenges and there was no support expressed for this option during public consultation.
13. Joint exploration for minerals and groundwater with the NSW Geological Survey	✗	N/A	✗	Did not meet a key regional challenge.
14. Water security for small communities	✓	N/A	➤	This will be progressed through the Aboriginal Water and Sewerage Program .
15. NSW Fish Passage Strategy	✓	N/A	✓	Incorporated into proposed action 3.3 : Mitigate the impacts of water infrastructure on native fish.
16. Providing incentives to landholders to conserve and rehabilitate riparian, wetland and floodplain vegetation	✓	N/A	✓	Amended into proposed action 3.2 : Identify regionally significant riparian, wetland and floodplain areas to protect or rehabilitate.
17. Cold water pollution mitigation measures	✓	N/A	✓	Incorporated into proposed action 3.3 : Mitigate the impacts of water infrastructure on native fish.
18. Riparian habitat restoration and re-establishing threatened species	✓	N/A	✓	Incorporated into proposed action 3.2 : Identify regionally significant riparian, wetland and floodplain areas to protect or rehabilitate.
19. Diversion screens to prevent fish extraction at pump offtakes	✓	N/A	✓	See proposed action 3.3 : Mitigate the impacts of water infrastructure on native fish.
20. Modification and/or removal of floodwork structures causing adverse impacts	✓	N/A	✓	See proposed action 3.5 : Remediate unapproved floodplain structures.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
21. Implementation of surface water quality mitigation measures	✓	N/A	✓	Incorporated into proposed action 3.6 : Improve understanding of water use and water quality at priority locations in the Namoi region.
22. Improve connectivity with downstream systems	✓	N/A	✓	See proposed action 3.7 : Investigate ways to improve connectivity with the Barwon–Darling River on a multi-valley scale.
23. Revise water sharing plan provisions for planned environmental water	✓	N/A	✓	Incorporated into proposed action 3.1 : Assess gaps in the flow regime that are preventing achievement of environmental watering objectives and identify co-operative actions to improve ecological outcomes.
24. Improve understanding of water use in unregulated water sources	✓	N/A	✓	Incorporated into proposed action 3.6 : Improve understanding of water use and water quality at priority locations in the Namoi region.
25. Ability to redirect supplementary flows that are in excess of needs	✗	N/A	✗	Did not meet a key regional challenge.
26. Improved understanding of groundwater processes	✓	N/A	✓	Incorporated into proposed action 3.8 : Continue investment in groundwater science in the Namoi region.
27. Implementation of a groundwater quality monitoring program	✓	N/A	✓	Incorporated into proposed action 3.8 : Continue investment in groundwater science in the Namoi region.
28. Reducing risk of sediment compaction due to over-extraction of groundwater	✓	N/A	✓	Incorporated into proposed action 3.8 : Continue investment in groundwater science in the Namoi region.
29. Protecting ecosystems that depend on groundwater resources	✓	N/A	✓	Incorporated into proposed action 3.8 : Continue investment in groundwater science in the Namoi region.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
30. Improving information about impacts from State Significant Development and State Significant Infrastructure projects on water	✓		>	The action is being addressed at a state level in the NSW Groundwater Strategy .
31. Water efficiency projects (towns and industries)	✓	N/A	✓	Incorporate into proposed action 1.3 : Adopt a stronger focus on water efficiency and demand management for towns.
32a. Improve water supply reliability: New weir at Blue Hole Mollee weir raising new re-regulation weir north of Boggabri 10 GL off-river storage near	✗	✗	✗	These options did not pass the rapid cost benefit analysis and there was significant stakeholder opposition to some of the options. A 10 GL off river storage was considered as part of the Dungowan Dam business case. Refer to Attachment 2.
32b. Improve water supply reliability: a new weir and fish ladder on the Namoi River east of the junction with the Barwon River to support Walgett township and water flows in the Barwon-Darling River	✓	N/A	>	Walgett Shire Council has recently installed a new weir on the Barwon River.
33. Review of water markets in the Namoi region	✗	N/A	>	The Australian Government will establish an independent expert panel to develop a road map for implementation of the Australian Competition and Consumer Commission recommendations on Water Markets in The Murray-Darling Basin.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
34. Review urban water restriction policy	✓	N/A	>	Urban water restrictions are being considered as part of a state-wide water restrictions harmonisation project being undertaken by the Department of Planning and Environment.
35. Implementing the Great Artesian Basin Strategic Management Plan	✗	N/A	>	Critical aspects of the GAB Strategic Management Plan will be implemented by the NSW Groundwater Strategy .
36. New drought operational rules (Namoi and Peel rivers)	✓	N/A	✓	Incorporated into proposed action 1.2 : Improve drought management planning for towns and proposed action 3.1 : Assess gaps in the flow regime that are preventing achievement of environmental watering objectives and identify cooperative actions to improve ecological outcomes.
37. Review of water accounting and allocation process	✓	✗	>	This will be progressed through the NSW Water Strategy Action 4.2: Review water allocation and water sharing information in response to new climate information. The assessment undertaken for this regional water strategy will inform work progressed through the NSW Water Strategy. Refer to Attachment 2 for details.
38. Investigation of licence conversions	✓	✓	✓	Incorporated into proposed action 2.8 : Make provision for voluntary licence conversions.
39. Improved data collection	✓	N/A	✓	Incorporated into: proposed action 2.12: Increase the transparency in the management of groundwater resources in the Namoi region proposed action 3.6: Improve understanding of water use and water quality at priority locations in the Namoi region proposed action 3.8: Continue investment in groundwater science in the Namoi region.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
40. Training and information sharing program	✓	N/A	✓	Incorporated into proposed action 2.4 : Improve public access to climate information and water availability forecasts and proposed action 1.7 : Addressing water related skills shortages in small councils.
41. Maintain amenity for regional towns during drought	✗	N/A	>	This would be investigated as part of town Integrated Water Cycle Management Plans through the Safe and Secure Water Program .
42. Improving understanding of low water availability on water dependent industries	✓	N/A	✓	Incorporated into proposed action 2.11 : Support increased investment and research into industry climate adaptation.
43. Sustainable access to groundwater by all users	✓	N/A	✓	Incorporated into: proposed action 1.5: Reduced uncertainty in groundwater security for regional towns proposed action 2.5: Undertake research to inform reviews of groundwater extraction and condition limits proposed action 2.12: Increase the transparency in the management of groundwater resources in the Namoi region.
44. Improved transparency in managing groundwater resources sustainably	✓	N/A	✓	Incorporated into proposed action 2.12 : Increase transparency in the management of groundwater resources in the Namoi region.
45. Land use change and population growth impacts on water resources	✓	N/A	>	This action will be progressed through the NSW Water Strategy Action 4.4 : Better integrate land use planning and water management.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
46. Integrating Aboriginal knowledge into groundwater decision making	✓	N/A	⤵	This will be considered as part of the NSW Aboriginal Water Strategy .
47. Culturally appropriate water knowledge program	✓	N/A	⤵	This will be considered as part of the NSW Aboriginal Water Strategy .
48. Water dependent cultural practices and site identification project	✓	N/A	✓	Incorporated into proposed action 2.10 : Improve outcomes for Aboriginal people through place based initiatives.
49. Secure flows for water dependent cultural sites	✓	N/A	✓	Incorporated into proposed action 2.10 : Improve outcomes for Aboriginal people through place based initiatives.
50. Shared benefit project (environment and cultural outcomes)	✓	N/A	⤵	This will be considered as part of the NSW Aboriginal Water Strategy .
51. Regional Cultural Water Officer employment program	✓	N/A	⤵	This will be considered as part of the NSW Aboriginal Water Strategy .
52. Establish a regional Aboriginal Water Advisory Committee	✓	N/A	✓	See Proposed action 2.3 : Improve the participation of Aboriginal people in water management in the Namoi region.
53. Water allocations for Aboriginal communities	✓	N/A	⤵	This will be considered as part of the NSW Aboriginal Water Strategy .
54. Co-management investigation of Traveling Stock Reserves	✓	N/A	✓	Incorporated into proposed action 2.10 : Improve outcomes for Aboriginal people through place base initiatives.
55. Aboriginal cultural water access licence review	✓	N/A	⤵	This will be considered as part of the NSW Aboriginal Water Strategy .

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments	Shortlisted	Comment
	Meets key regional challenge	Benefit cost ratio greater than 1?		
56. River Ranger Program	✓	N/A	✓	Incorporated into proposed action 2.10: Improve outcomes for Aboriginal people through place base initiatives. See also proposed action 3.2: Identify regionally significant riparian, wetland and floodplain areas to protect or rehabilitate. The NSW Government has committed \$1.1 million to support Aboriginal groups to establish ranger programs, so they can tender for natural resource management contracts with NSW agencies.

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

This attachment summarises the results of the hydrologic, economic and environmental assessment of options in the *Draft Namoi Regional Water Strategy*. It outlines the rapid cost-benefit assessment (CBA) of the long-list of options. It also outlines the results of the detailed CBA that was conducted using the paleo-informed (stochastic) and climate-change adjusted (NARClIM) data sets. These results include

the probability and timing of modelled water system failures for the towns and communities of the Namoi region. They also consider modelled changes to flow regimes and their environmental impacts.

The following options were subject to rapid and detailed quantitative assessments:

Title		Rapid cost benefit analysis	Detailed assessment
Options for the Namoi valley			
Inland diversion (Inter-regional pipelines) (Option 2 in the Draft Namoi Regional Water Strategy)	a) Macleay catchment to Namoi Valley transfer	✓	
Intra-regional pipelines (Option 3 in the Draft Namoi Regional Water Strategy)	a) Pian Creek pipeline (pipeline from Dempsey Bridge to Pian Creek)	✓	✓
	c) pipeline from the end of the Peel River to Keepit Dam with a small weir on the Peel River	✓	
Improve water supply reliability (Option 3 in the Draft Namoi Regional Water Strategy)	New re-regulation weir north of Boggabri	✓	
	Blue Hole weir with a pipeline to transfer water to Split Rock Dam	✓	
Increase the reserve in Keepit Dam for towns in the Namoi valley (Manilla, Boggabri, Walgett) (option 37 in the Draft Namoi Regional Water Strategy)			✓
Investigation of license conversion (option 38 in the Draft Namoi Regional Water Strategy)		✓	

Title		Rapid cost benefit analysis	Detailed assessment
Options for the Peel Valley			
Inland diversion (this was option 2 in the Draft Namoi Regional Water Strategy)	b) Pipeline from Manning catchment to Peel Valley		✓
Intra-regional pipelines	d) pipeline between Namoi Valley Dams (Keepit Dam) and Tamworth with an increased storage reserve		✓
Reuse, recycling and stormwater projects	Purified recycled water for Tamworth		✓
Increase the reserve in Chaffey Dam for Tamworth town water supply (option 37 in the Draft Namoi Regional Water Strategy)			✓

High level results of the cost-benefit assessments are presented below. More comprehensive and detailed assessment outcomes are presented in the detailed economic and environmental analysis report for the Namoi.

Rapid cost-benefit analysis

The rapid cost benefit analyses were modelled against approximately 130 years of data. There were two key limitations of the rapid cost-benefit analysis (CBA) relevant to all options:

- the rapid cost-benefit analyses use the historic instrumental climate record (approximately 130-years). Although this period contains some periods of drought, the models showed very few instances of water supply shortfalls over this period. This will undervalue options aimed at improving reliability
- population growth was not considered in rapid cost-benefit assessment but was considered in the detailed assessment.

Detailed economic and ecological analysis

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

The long-term climate data sets comprise:

- a 10,000-year synthetic data set based on the paleoclimatic analysis (referred to as the stochastic climate scenario in this document)
- a 'worst-case' dry climate change scenario, which is based on the paleoclimatic analysis and a set of scaling factors developed for the NARClIM26 project (referred to as the NARClIM climate scenario in this document).

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

The Namoi regional water strategy is considering actions that address a wide range of objectives. However, the detailed CBA process focusses on those actions that address the reliability of water supply to towns and communities and water for agriculture and industry.

We know that population changes in the Namoi will also have a large impact on future water security. To reflect variability of future population growth, LGA population forecasts have been used in the detailed assessment. If no LGA population forecasts are provided, then the common planning assumptions are used. These are the official NSW Government projections that are consistent with the NSW Treasury recommendations for estimating future populations across the state.

Ecological assessment methodology

The ecological effects of the options were modelled and assessed at 9 and 18 sites in the Peel and Namoi River catchments respectively. The sites were selected based on their relationship to the likely or potential ecological requirements of aquatic flora and fauna.

Flow metrics used for this report's assessment included the frequency and duration of cease-to-flow events and base flows; the frequency of freshes, large and infrequent bankful and overbank flows, and low flows (90th and 95th percentile flows); and the annual volume of flows. These metrics are derived from the Departments risk assessments.⁴⁵

These metrics were assessed for the stochastic and NARcliM scenarios. The results were then categorised as having an impact from extreme improvement to extreme impact. It uses a categorisation system to rate the potential impacts or benefits to the environment. The rapid environmental assessment uses a five-category ranking (stage 1) and the detailed assessment used an expanded 11-category ranking. The table below describes the impact categories used in the environmental assessments and their associated changes in hydrology.

The ecological effects of the options will also be assessed against metrics in the Long-Term Watering Plan for this valley in a subsequent, more detailed document.⁴⁶

Table 11. Explanation of categories used in ecological assessment

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

It is important to note that the environmental assessments presented below are based on generic flow metrics that describe typical components of the flow regimes upon which flow-dependent species and communities rely. Flow-dependent species and communities often have different and complex environmental water requirements that cannot be represented with simple or generic metrics. There are also many external factors and long-term

hydrological and ecological effects associated with river management that the models used for these assessments cannot capture which could affect the viability of aquatic species and populations. The metrics used for these assessments are designed to help eliminate unviable management options and to support identification of a shorter list of options that can undergo more detailed analysis at future stages of development if required.

45. For this valley, see NSW DPIE – Water (2019). Risk Assessment for the Namoi Water Resource Plan Area (SW14). Department of Planning, Industry and Environment - Water

46. NSW Department of Planning, Industry and Environment (2020), Namoi Long Term Water Plan. Parts a and b, as already cited.

Options for the Namoi Valley

Macleay River to Namoi catchment transfer

Purpose	To improve water reliability in the upper and lower Namoi valleys and provide water for increased economic benefit in the Namoi region. This action would connect the Namoi catchment with the more temperate coastal Macleay River catchment. This connection could support the Namoi to have access to more reliable flows during dry periods in the semi-arid Namoi region. This was Option 2 in the Draft Namoi Regional water Strategy.
Description	Diverting the water from the Macleay catchment into the Namoi catchment would involve 2 transfer systems: • the first transfer system would divert a portion of Gara River water from Macleay catchment to Roumalla Creek in the Gwydir catchment • the second transfer system would involve a gravity transfer from the Gwydir to Namoi valleys through a 2 km tunnel with a discharge point into the upper Macdonald River. Infrastructure requirements assessed as part of the analysis included: • new 10 GL dam on the Gara River. 70 ML/d pipeline and tunnel (43.4 km, 1000 mm) and pumping station from Gara River to Roumalla Creek • 70 ML/d pipeline and tunnel (5.3 km, 800 mm) and pumping station from Roumalla Creek to MacDonald River. It was assumed water transferred from the Macleay catchment would not be subject to Basin Plan limits.
Results	Not viable due to low benefit to cost ratio The inter-regional transfer results in a 5% increase in General Security extractions, with an associated small reduction in Supplementary usage. This translates to \$30 million improvement over 40 years in annual agricultural activities under the instrumental climate data. We also analysed how this option could reduce town water supply shortfalls for the towns of Manilla, Walgett or Barraba. We analysed this by assessing the option under the 10,000 year paleo informed data set. The analysis suggested this option could reduce the risk of Manilla, Walgett or Barraba running out of surface water by nearly 40%, providing an estimate economic value of \$0.7 million over a 40 year period associated with the increased town water supply security. Although this option provides some benefits, they are not proportional to the estimated cost of \$867 million. This option did not progress to the detailed assessment.
Limitations	This modelling includes aspirational assumptions about the capital and infra-structure costs of the option. The analysis has not considered the potential impacts of extracting water from the Macleay catchment, or requirements for environmental water releases that would apply to the new dam on the Gara River. If included these impacts would reduce the benefits of the option, and result in a lower benefit to cost ratio.

Summary of modelled results are shown below. These are compared to the base case (i.e. no change)

Change in long-term average water take under licences (GL/year) under historical model (past 130 years)			Change in % of time system storage < 20% full supply level	Change in average end of system flows (GL/year)
General security	Supplementary	High security		
6.6 (+5.3%)	-0.3 (-0.5%)	0	-2.9% Keepit Dam -2.4% Split Rock Dam	3.5 (+0.8%)

Summary of economic results

Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Net present value (\$ million, over 40 years)	Benefit to cost ratio
Towns	Annual Agriculture	Perennial Pasture			
0.7	29.4	0	867	-837	<1

Pian Creek Pipeline (Near Walgett Weir)

Purpose	Reduce the amount of water that evaporates or seeps into the river bed in the Lower Namoi during dry periods. The intention is that reducing those losses during dry periods could help: • reduce water security risks for basic landholder rights during droughts • increase reliability of general security licences. This was part of Option 3 in the Draft Namoi Regional water Strategy.
Description	This would involve construction a new pipeline (56.8 km, 500 mm dia.) with capability to transfer up to 25 ML/day and a new pumping station.
Results	Not viable due to limited benefits The option results in 1 GL less evaporation in Keepit Dam and could lead to moderate improvement in very low and low flows in the Namoi River using the Stochastic modelling, with the greatest improvement being at Bugilbone and Goangra respectively. The Pian Creek pipeline does not significantly improve security reliability. General security extraction increases by less than 1 GL across all climate scenarios, translating to an associated increase in annual agricultural outcomes by \$6.1 million on average over a 40-year period.
Limitations	Analysing the benefits or impacts of options during extreme dry periods in river system models can be challenging as these are at the extremes of the river system model capabilities.

Summary of modelled results

Climate data	Change in end of year allocation		Change in long-term average water take under licences (GL/year)			Change in % of time the combined storage of Keepit Dam and Split Rock Dams are < 20% Full Supply Level
	General security	High security	General security	Supplementary	High security	
Historical (130 years of data)	Lower Namoi: +1% Upper Namoi: N/A	N/A	0.6 (+0.5%)	-0.01 (-0.03%)	0	No change
Long term stochastic (10,000 years)	Lower Namoi: +1% Upper Namoi: N/A	N/A	0.7 (+0.6%)	0.02 (+0.04%)	0	No change
Long term dry climate change scenario (NARClIM, 10,000 years)	Lower Namoi: +1% Upper Namoi: -1%	N/A	0.8 (+1%)	0.02 (+0.05%)	0	No change

Changes to surface water availability for Walgett

Percent of time with a surface water shortfall for Walgett*					
Historical climate		Stochastic (long-term climate record)		NARClIM (dry climate change scenario)	
Base case	With pipeline	Base case	With pipeline	Base case	With pipeline
0.5% (1 in 200 years)	1% 1 in 90 years	2% (1 in 50 years)	2% (1 in 43 years)	10% (1 in 10 years)	11% (1 in 9 years)

* A shortfall in Walgett occurs if the combined volume of Keepit and Split Rock dams is ≤ 72.5 GL for longer than 210 consecutive days

Changes to economic outcomes under different climate data sets

Climate data	Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Average net present value (\$ million, over 40 years)	Average benefit to cost ratio
	Towns	Annual agriculture	Permanent agriculture			
Historical	0	-17.8 (-1.6%)	0.1 (3.3%)	\$258	-\$344.4	<0
Stochastic	0.7 (0%)	-19.4 (-1.8%)	0.1 (4.1%)	\$258	-\$345.3	<0
NARClIM	4.8 (0%)	-11.2 (-1.4%)	0.1 (8.8%)	\$258	-\$332.9	< 0

Environmental effects of the Pian Creek pipeline on the Namoi River

Transfers from Pian Creek are forecast to lead to moderate improvement in very low and low flows in the Namoi River using the stochastic modelling, with the greatest improvement being at Bugilbone and Goangra respectively. There were also minor improvements in base flows, the frequency of low flows and the monthly and weekly coefficients of variation.

The climate change modelling identified eight moderate impacts, and one minor impact. The largest impact was on very low and low flows and low flow standard deviation. The greatest reduction in very low flows was Halls Creek, while for low flows it was at Bugilbone. There were also moderate impacts on base flows, the monthly and weekly coefficient of variation. These impacts on very low, low and base flows would partly be a result of the reserve in the Namoi system being reduced by 7 GL in the pipeline scenario, especially under NARClIM conditions. The impacts on variability across various measures would be because flow variability was generally reduced under the drier NARClIM conditions.

The stochastic modelling suggests that there would be minor improvements associated with the Pian Creek option particularly with low and very low flows in the reach from Bugilbone to Goangra. Fish would be the major beneficiary of these improvements as it would result in slight increases in habitat, but more importantly would help moderate water quality. Low flows are often periods of adverse water quality due to greater fluctuations in temperature and risks of algal blooms and stratification in pools. These effects are likely to be greatest in the reach between Bugilbone and Goangra, but also some of the small, connected creeks that are vulnerable to greater variations in water quality.

This ecological assessment does not consider the impact of extraction on Pian Creek, which is already listed as under ecological risk under the Surface Water Risk Assessment.⁴⁷ However, the hydrological modelling shows Pian Creeks' (at Waminda) mean annual flow is reduced from 52.6 to 52.4 GL per year under historic (observed) conditions.

47. NSW DPIE – Water (2019). As previously cited.

Table 12. Predicted environment effects on the Namoi River from the Pian Creek scenario using Stochastic and NARClIM modelling. The environmental effect is calculated as the percentage change against the base case. Cells are shaded following stage 2 categories in Table 11

	Stochastic	NARClIM
Metric	Average (Min-Max)	Average (Min-Max)
Number of years with greater or equal to one zero flow spell in 130 years	-0.3 (-3.8 to 0.7)	-0.4 (-4.6 to 1.6)
Very low flow rate (ML/d) measured as the 95th percentile discharge of daily flows	11 (0 to 101)	-18 (0 to -77)
Low flow rate (ML/d), measured as the 90th percentile dis-charge of daily flows	12 (-2 to 123)	-15 (0 to 87)
Median annual discharge (ML/y)	-0.2 (-1.7 to 0.3)	1 (0 to 9)
Median days below low flow	2 (0 to 12)	-13 (-54 to 0)
Low flow standard deviation	5 (0 to 36)	-19 (-94 to 0)
Low flow days below the 75 percentile	3 (-1 to 20)	-15 (-83 to 0)
Base flow rate (ML/d), measured as the 80th percentile dis-charge of daily flows	5 (-2 to 39)	-12 (-85 to 0)
Mean annual discharge (ML/y)	-0.1 (-1.1 to 0.2)	0.5 (-0.3 to 5.4)
Fresh flow rate (ML/d), measured as discharge of daily flows	0 (0 to 0)	0 (0 to 0)
Average number of freshes per year	-0.2 (-1.5 to 0.2)	0.8 (-0.4 to 3.6)
Average duration of freshes (number of days)	0.3 (-0.7 to 2.4)	0.9 (-2.6 to 7.5)
High flows - 2.5-year Annual Return Interval	-0.1 (-1.4 to 0.1)	0 (-2 to 0.5)
High flows - 5-year ARI flow rate (ML/d)	-0.3 (-4.5 to 0.7)	0.1 (-0.2 to 1)
Very high flows - 10 year ARI flow rate (ML/d)	-0.1 (-1.4 to 0.8)	0.7 (-0.4 to 10.6)
Monthly flow coefficient of variation	4 (0 to 17)	-16 (-73 to 0)
Daily flow coefficient of variation	3 (0 to 11)	-9 (-34 to 0)
Weekly flow coefficient of variation	4 (0 to 14)	-13 (-49 to 0)

Pipeline from the end of the Peel River to Keepit Dam with a small weir on the Peel River

Purpose	Increase reliability of supply for industries by connecting the Peel and Namoi systems with infrastructure to provide access to more than one water source.
Description	Transferring end of system flows from Peel Valley to Keepit Dam. This option would involve: • new 1 GL weir, 5 m high on the Peel River • new pipeline capable of transferring up to 50 ML/d (600 mm dia.) from new weir to Lake Keepit (10 km) • fish passage.
Results	Not viable due to low benefit to cost ratio Transferring flows from the end of the Peel System into Keepit Dam results in a negligible increase in total diversions, with general security and supplementary diversions in the Namoi increasing by less than 1%. This is because much of the Peel end of system flow is already utilised when it enters the Namoi system, either as a useful tributary contribution to meet regulated orders, or as supplementary flows. The cost of this option does not outweigh the benefits with the option only providing an uplift of 0.2% to annual agriculture outcomes. This option was not progressed to detailed investigations.
Limitations	The modelling is sufficient to demonstrate the impact of this option.

Summary of modelled results

Change in long-term average water take under licences (GL/year) under historical model (past 130 years)			Change in % of time system storage < 20% full supply level	Change in average end of system flows (GL/year)	Changes to town water shortfalls (Manilla, Barraba, Walgett)
General security	Supplementary	High security			
0.1 (+0.1%)	0.3 (+0.6%)	0	-0.5% Keepit Dam -0.2% Split Rock Dam	0.3 (-0.1%)	No change

Summary of economic results

Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Net present value (\$ million, over 40 years)	Benefit to cost ratio
Towns	Annual Agriculture	Permanent Agriculture			
-0.1 (-36.8%)	2.1 (0.2%)	0 (0.3%)	156	-154	<1

New re-regulation weir north of Boggabri

Purpose	The purpose of the weir is to increase reliability of general security licences and improve delivery efficiency for downstream users by providing additional storage capacity and capturing tributary flows that currently bypass Boggabri. This would also have benefits for nearby mine sites. This was Option 32 in the Draft Namoi Regional water Strategy.
Description	This would involve construction of a new 1 GL weir (5 m high) on the Namoi River north of Boggabri including fish passage. Reduce water access to supplementary shares to maintain compliance with diversion limit.
Results	Not viable due to low benefit to cost ratio. The increase in general security access is nearly offset by the reductions in supplementary shares required to keep diversions within legal limits. Coupled with the cost of the infrastructure, the options results in a low benefit to cost ratio. This option was not progressed to detailed analysis.
Limitations	No mines have been included in this assessment, however the benefit to any mines would need to be significant to create a net positive economic outcome.

Changes in water availability for licence holders

Change in long-term average water take under licences (GL/year) under historical model (past 130 years)			Change in town water supply shortfalls	Change in % of time system storage < 20% full supply level	Change in average end of system flows (GL/year)
General security	Supplementary	High security			
7.9 (+6.5%)	-3.1 (-5.8%)	0	-1.5 (-72.7%)	-6.9% Keepit Dam -10.6% Split Rock Dam	-4.3 (-0.9%)

Summary of economic results

Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Net present value (\$ million, over 40 years)	Benefit to cost ratio
Towns	Annual Agriculture	Permanent Agriculture			
0.9	-39.4	0	\$94	-\$132.7	<0

Blue Hole weir with a pipeline to transfer water to Split Rock Dam

Purpose	The option was intended to divert more water into Split Rock Dam that would otherwise flow into Keepit Dam, as Split Rock dam spills much less frequently and has lower evaporation rates than Keepit. It was thought this could result in improved reliability for general security water users in the Namoi Regulated River system. This was part of option 32 and option 3 in the Draft Namoi Regional water Strategy.
Description	New weir at Blue hole with a new pipeline capable of transferring up to 60 ML/d from the weir to Split Rock Dam.
Results	Not viable due to low benefit to cost ratio and limited ability to meet its main objectives. This option does not reduce evaporation in the storages and marginally improves outcomes for agricultural and towns with increase in general security extractions of 2% per year translating to improvements in annual agriculture of \$13.5 million over a 40-year period. Town water supply shortfalls in Manilla, Walgett and Barra are reduced by 13.6% with an associated improvement in 40-year economic outcomes by \$0.4 million. Although this option provides benefits, these are small compared to the estimated \$226 million cost of the required infrastructure. This option was not progressed to detailed analysis.
Limitations	The modelling is sufficient to demonstrate the impact of this option.

Summary of modelled results

Change in long-term average water take under licences (GL/year) under historical model (past 130 years)			Change in % of time system storage < 20% full supply level	Change in average end of system flows (GL/year)
General security	Supplementary	High security		
2.8 (+2.3%)	-0.3 (-0.6%)	0	+3.7% Keepit Dam -6.9% Split Rock Dam	-1.0 (-0.2%)

Summary of economic results

Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Net present value (\$ million, over 40 years)	Benefit to cost ratio
Towns	Annual Agriculture	Perennial Pasture			
0.4	13.5	0	226	-213	<1



Image courtesy of Nicola Brookhouse, Department of Planning and Environment. Salt Caves Tower and visitor area, Timmallallie National Park.

Increase the essential needs reserve in Keepit and Split Rock dams for towns in the Namoi valley

Option a – increasing the reserve by 50 GL

Purpose	Reduce town water shortfall risk for Manilla, Boggabri and Walgett.
Description	Increasing the essential needs reserve of Keepit and Split Rock dams by 50 GL. This additional reserve is enough to provide one additional block release to Walgett at the end of the system plus an additional quantity to ensure Local Water Utility Security for Barraba and Manilla in the Upper Namoi. At the start of each water year the NSW Department of Planning and Environment assesses the water available in Keepit Dam and Split Rock Dam as well as likely inflows to determine how much water needs to be set aside for essential needs and how much can be allocated to water licences. The allocation set aside for the coming year for high priority purposes is called the reserve. It includes water for high priority purposes (local water utility licences, stock and domestic, replenishment flows and minimum releases from dams) plus an amount of water to account for delivery losses as it is sent down river. This reserve includes water to support the needs of Manilla, Barraba and Walgett. Split Rock and Keepit dams have a combined capacity of 817 GL and are run in unison to support the water needs of the upper and Lower Namoi Valley. The reserve levels maintained in Keepit Dam and Split Rock Dam are fixed and is based on the lowest recorded 24-month inflow (June 1918 to May 1920) prior to the development of the water sharing plan in 2004, and average delivery losses. This current reserve to support higher priority licence holders around 60 GL. The most recent drought (2018-2020) was worse than this and saw Keepit Dam and Split Rock Dam falling to below 5% capacity for the first time. As a result, allocations to general security licence holders were restricted as remaining water in the dams were preserved exclusively to support the towns of Barraba and Manilla and other high security users. Walgett, which is located over 350 km downstream of the dams, was unable to access surface water due to large distances water needs to travel from the dam to reach Walgett and the high seepage and evaporation along the way.
Results	Need discussion with community about risk appetite and purpose of the option which will occur through the NSW Water Strategy implementation. We have assessed how far increasing the essential needs reserve could go to reducing the water security risks for towns dependant on surface water. Our Initial analysis shows that increasing the reserve of the dams by 50 GL could: • remove the risk of future shortfalls for Manilla and significantly decrease in the occurrence of shortfalls for Barraba. Barraba has direct pipeline to Split Rock Dam and can access dead storage during times when the dam is unable to support other water users • reduce, but not eliminate the surface water security risks for Walgett • reduce average end of year allocations for Lower Namoi general security licence holders by 4-5%, but increase average end of year allocations for Upper Namoi general security licence holders by 1%. This analysis suggests there is merit in further considering whether changing the essential needs reserve is an effective way of securing water for Manilla and Barraba, however this needs to be assessed against other options in the shortlist that could also improve town water security for Manilla and Barraba.

Results (continued)	For Walgett, even with an increase in reserves, there remains a high risk of Walgett running out of water sourced from dams in the regulated Namoi catchment. The long distances that the water needs to travel to reach Walgett means that Walgett will need to continue to rely on multiple water sources. Walgett has groundwater bores and a water treatment plant that could provide emergency support during drought conditions. This analysis only looked at one option around changing the essential needs reserve in Namoi. A broader assessment of whether changing the essential needs reserve is an effective way to secure water for critical needs in dry periods compared to alternative options needs to be considered through a risk framework and will be assessed as part of the work program implementing the NSW Water Strategy. Using this analysis as a basis, the NSW Water Strategy work program will consider: • options for redefining the period of lowest inflows to the water source • whether different periods should apply to different categories of • access licences • whether the reserve level should be increased during a sequence of dry • years and reduced during a sequence of wet years • the impact of any options for change on planned environmental water • and each category of access licence. The results of the investigation would help to determine whether a change to water allocation rules in the Border Rivers is warranted in response to new extremes in water availability. Any decision on whether to implement a change in the policy on reserves depends on the level of risk that the community is willing to bear around running out of surface water in droughts and associated impacts on licence holders and the environment.
Limitations	The impacts to other user groups will need to be assessed in more detail in combination with other options that may impact or provide benefits to towns, water users and the environment.

Changes in water availability for licence holders

Climate data	Change in long-term average water take under licences (GL/year)			Change in % of time the combined storage of Keepit Dam and Split Rock Dams are < 20% full supply level
	General security	Supplementary	High security	
Historical data	-3 (-2.6%)	0.0 (0.2%)	0.0 (-1.1%)	+0.5% Keepit Dam -37.3% Split Rock Dam
Stochastic	-2.1 (-1.9%)	0.0 (0.1%)	0.0 (-0.5%)	+0.4% Keepit Dam 26.0% Split Rock Dam
NARClIM	-3.4 (-5%)	No change	No change	-4.4% Keepit Dam -36.3% Split Rock Dam

Changes to the risk to town water supply shortfalls under different climate projections

	Percent of time with a town water supply shortfall			
	Stochastic (long-term climate record)		NARClIM (dry climate change scenario)	
Towns	Base case	Change in reserve	Base case	Change in reserve
Manilla and Barraba*	0.21% (1 in 500 years)	0.0%	2.01% (1 in 50 years)	0.8% (1 in 125 years)
Walgett**	1.97% (1 in 50 years)	0.5% (1 in 200 years)	9.95% (1 in 10 years)	4.4% (1 in 22 years)

* A shortfall for Manilla and Barraba occurs if Split Rock Dam is at dead storage volume (the portion of total storage capacity that is equal to the volume of water below the level of the lowest outlet – this water cannot be accessed under normal operating conditions).

** A shortfall in Walgett occurs if the combined volume of Keepit and Split Rock dams is ≤ 72.5 GL for longer than 210 consecutive days.

Summary of economic results

Climate data	Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Average net present value (\$ million, over 40 years)	Average benefit to cost ratio
	Towns	Annual agriculture	Permanent agriculture			
Stochastic	0.9 (79.9%)	-23.7 (-2.1%)	0 (-0.6%)	4.2	-27	<0
NARClIM	4.0 (52.7%)	-24.2 (-3.2%)	0 (-0.6%)	4.2	-24	<0

The variability in the hydrologic record can result in a wide range of benefit cost ratios. Understanding what portion of the hydrologic dataset results in a positive result, or a poor outcome, is important to appreciating how likely the option will add economic value to the region. The range of the benefit to cost ratio is set out in the table below.

Benefit cost ratio (BCR)	Less than 0	Between 0 and 1	Greater than 1
Stochastic	98%	2%	0%
NARClIM	73%	27%	0%

Option b – increasing the reserve by 23 GL

Purpose	Reduce town water shortfall risk for Manilla, Boggabri and Walgett.
Description	Increasing the essential needs reserve in Keepit and Split Rock dams by 23 GL. This additional reserve is enough to provide one additional block release to Walgett at the end of the system.
Results	Need discussion with community about risk appetite and purpose of the option which will occur through the NSW Water Strategy implementation. Our analysis shows that increasing the reserve of the dams by 23 GL could help provide an additional block release to Walgett but is not enough to remove surface water security risks for Walgett. As above, this was one option around changing the essential needs reserve in Namoi. A broader assessment of whether changing the essential needs reserve is an effective way to secure water for critical needs in dry periods compared to alternative options needs to be considered through a risk framework and will be assessed as part of the work program implementing the NSW Water Strategy. This option did not proceed to detailed investigation.
Limitations	This analysis only used the 130 years of historical data to assess town water security risks. This data set does not include potential future droughts that may be worse than what we have experienced in the past, and as such may underestimate future town water security risks. The impacts to other user groups will need to be assessed in more detail in combination with other options that may impact or provide benefits to towns, water users and the environment.

Changes in water availability for licence holders

Climate data	Change in long-term average water take under licences (GL/year)			Change in % of time system storage < 20% full supply level
	General security	Supplementary	High security	
Historical data	-1.58 (-1.35%)	0.0 (0.05%)	0.0 (-0.57%)	-0.62% Keepit Dam -25.58% Split Rock Dam -7.16% combined

Environmental effects of an increased reserve

Whilst increasing the water reserve for the Namoi across Keepit and Split Rock Dams had little impact on the flow regime under stochastic modelling, several notable improvements were seen under NARcliM modelling for base and very low flow volume.

There were extreme improvements in very low flow volume in the middle reaches, at Gunnedah and Mollee, under the NARcliM scenario. A very large percentage improvement can occur when very low flows are replaced by relatively higher base flows. The accuracy of this result will be explored in the detailed assessment. The reserve that is delivered for targeted Town Water Supplies might have caused this marked increase in very low flows.

There were also minor to moderate improvements in low flow standard deviation as well as daily, weekly and monthly flow variations under NARcliM modelling. The increase in low flow days does suggest some impact, which is offset by the higher values for very low and low flow flows.

It stands to reason that if block releases are a more prevalent delivery method during low flow sequences these could lead to more ecologically significant low or cease to flow periods between these releases. These data do not necessarily suggest this effect and are based on flow effects averaged at the gauge level, and so such effects could be explored in the detailed analysis.

Overall, these results suggest the impacts or benefits on environmental values are modest. The improvements in base and low flow rates under the NARcliM scenario could mean that these periods do not put as much stress on the fish community, and these communities will be more resilient when higher flows return. However, the extent to which the increase in low flow events might be episodically impacting aquatic fauna and flora will need exploring in relation to low flow thresholds determined by the Long-Term Watering Plan, and with the time series data.

Table 13. Environmental effects of an increased reserve. The environmental effect is calculated as the percentage change against the base case. Cells are shaded following stage 2 categories in Table 11

	Stochastic	NARClIM
Metric	Average (Min-Max)	Average (Min-Max)
Number of years with greater or equal to one zero flow spell in 130 years	0.3 (-0.3 to 4.7)	-0.7 (-10.4 to 2.3)
Very low flow rate (ML/d) measured as the 95th percentile discharge of daily flows	-2 (-12 to 0)	3198 (0 to 44305)
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	-3 (-18 to 0)	15 (0 to 140)
Median annual discharge (ML/y)	-1 (-8 to 1)	-1 (-7 to 1)
Median days below low flow	-1 (-10 to 5)	12 (0 to 50)
Low flow standard deviation	-2 (-9 to 1)	13 (0 to 47)
Low flow days below the 75 percentile	-1 (-11.1 to 0)	9 (-1 to 45)
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	-2 (-12 to 0)	45 (0 to 538)
Mean annual discharge (ML/y)	-0.3 (-2.8 to 0.2)	-0.4 (-4.3 to 0.5)
Fresh flow rate (ML/d), measured as discharge of daily flows	0 (0 to 0)	0 (0 to 0)
Average number of freshes per year	-0.7 (-3.7 to 0.4)	-0.8 (-4.2 to 0.8)
Average duration of freshes (number of days)	-0.2 (-3.2 to 0.5)	-0.4 (-3.6 to 2.8)
High flows - 2.5-year Annual Return Interval	0.1 (-0.1 to 0.7)	0 (-0.9 to 2.4)
High flows - 5-year ARI flow rate (ML/d)	0.5 (0 to 4.5)	-0.1 (-1 to 0.2)
Very high flows - 10 year ARI flow rate (ML/d)	0.7 (0 to 6.3)	-0.7 (-9.9 to 0.5)
Monthly flow coefficient of variation	-0.5 (-1.9 to 0.7)	11 (0 to 42)
Daily flow coefficient of variation	-0.5 (-2.4 to 0.3)	8 (-1 to 25)
Weekly flow coefficient of variation	-0.6 (-2.5 to 0.6)	9 (0 to 33)

Investigation of license conversion

Purpose	Increase water security and support the water needs of industries requiring high reliability water in the region by creating high security water entitlements to support high value crops and industries. A small amount of general security entitlement is converted to assess the benefit and impact on reliability of the remaining water access licence holders. This was Option 38 in the Draft Namoi Regional Water Strategy.
Description	This involves conversion of 5% (12.2 GL) of Lower Namoi General Security Shares to 5.5 GL High Security Shares.
Results	Viable due to a high net present value relative to capital outlay and a high benefit–cost ratio. The broader benefit to the region is the result of the shift from general security water access licences (-12 GL) to high security licence (5.5 GL), creating a conversion factor of 2-3 units of general security entitlement to 1 unit of high security entitlement. The modelling assumes: • Dam reserves are increased by 1.33 times the volume of high security licences created • New high security licences are used at Gunnedah and Narrabri of 5.5 GL • High security demand spread uniformly across October to March. At this conversion rate, the remaining general security has a small improvement in reliability. End of system flows are slightly reduced through the creation of the high security shares. The results are preliminary, but sufficient to demonstrate viability to proceed. More refined modelling is required to more precisely determine the appropriate conversion ratio and assess whether location constraints or other rules are required.
Limitations	The model assumes full utilisation of the high security shares, however, in practice it is likely that utilisation would be less.

Changes in water availability for towns and licence holders

Change in long-term average water take under licences (GL/year) under historical model (past 130 years)			Change in % of time system storage < 20% full supply level	Change in average end of system flows (GL/year)
General security	Supplementary	High security		
Upper Namoi No change	No change	5.15	1.31% Keepit Dam	-1.24 (-0.26%)
Lower Namoi -1.96 (-1.7%)			-3.31% Split Rock Dam	

Changes in economic outcomes

Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Net present value (\$ million, over 40 years)	Benefit to cost ratio
Towns	Annual Agriculture	Permanent Agriculture			
0.6	-10.8	33.7	8.4	15.0	2.8



Image courtesy of Gerhard Koertner, Department of Planning and Environment. Eastern Water Skink on rock.

Options for the Peel Valley

Pipeline from Manning to Peel Catchment

Purpose	To improve town water security for Tamworth Regional Council as water demand grows with population and industry growth .
Description	Construction of a new Inter-Basin Transfer from the upper Barnard River (Manning System) to the Peel Valley. The scheme transfers on average 16 GL/y from the Barnard to Chaffey Dam. The model assumes: • a proposed new 1 GL dam on the Barnard River (downstream of Back River) to divert flows to the Peel River (assumed to be immediately upstream of Chaffey Dam) to supplement inflows into Chaffey Dam. The option allowed pumped transfers through a new proposed pipeline of up to 70 ML/d when Chaffey Dam available storage was below 90%. • New high security licence of 5 GL between Tamworth and Appleby crossing • no annual transfer limit/entitlement modelled • water transferred from the Manning catchment is not subject to Basin Plan limits. The analysis assumes the proposed new Dungowan Dam is in place (i.e. it is included in the base case).
Results	Effective at meeting the main objective of reducing Tamworth’s water security risk and has been progressed to the short list, but requires further consultation, modelling, understanding of impacts on Manning catchment and improved understanding of costs. This inter-regional transfer has the potential to remove the risk of Tamworth running out of surface water under the stochastic climate data set and substantially reduces the risk under the NARcliM climate data. The time that Tamworth may experience restrictions is marginally reduced under the stochastic climate data at a 2.4% decrease of time experiencing any restrictions. Under NARcliM data it could be a decrease of 14.4% of time experiencing any restrictions. This option also has the potential to be used to create additional high security entitlements which could be used to support new industries entering the Namoi Regional Jobs Precinct. Economic gains from avoiding restrictions and failures for Tamworth are estimated at \$5 million under stochastic climate data and \$32 million under NARcliM climate data on average over a 40-year period. Annual agriculture and permanent agriculture would also experience benefits due to the transfer.
Limitations	This modelling has not considered the potential impacts of extracting water from the Manning catchment, and the reduced water security that may create for towns and industries in the Hunter catchment. The analysis also does not include an assessment of requirements for environmental water releases that would apply. If included these impacts would likely result in worse outcomes for the economic assessment.

Summary of modelled results are shown below

Climate data	Tamworth town water security metrics					General security mean allocation %	Change in long term average water take under general security licences (GL/year)
	Tamworth water demand (ML/year)	% time in level 1+ restrictions	% time in level 5 restrictions	# of complete failures over 10,000 years	Frequency of shortfalls		

Long term historical climate projections (10,000 years)

Base case	11,000	11.1%	2.5%	14	1 in 700 years	62.6%	5,933
Stochastic	11,000	8.70 (-2.4)	1.90 (-0.6)	1 (-13)	1 in 9,800 years	60.4 (-2.2)	6,042

Dry climate change scenario (NARcliM 10,000 years)

Base case	11,000	46.2%	22%	393	1 in 25 years	28.2%	5,601
NARcliM	11,000	31.80 (-14.4)	12.90 (-9.1)	47 (-346)	1 in 31 years	31.7 (+3.5)	5,867

Summary of economic results

Climate data	Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Average net present value (\$ million, over 40 years)	Average benefit to cost ratio
	Towns	Annual agriculture	Permanent agriculture			
Stochastic	5.0 (15.1%)	1.1 (1.2%)	0.0 (2.6%)	591	-585	<0.1
NARcliM	100.9 (40.5%)	1.8 (2.3%)	0.6 (148.3%)	591	-488	<1.0

The variability in the hydrologic record can result in a wide range of benefit cost ratios. Understanding what portion of the hydrologic dataset results in a positive result, or a poor outcome, is important to appreciating how likely the option will add economic value to the region. The range of the benefit to cost ratio is set out in the table below.

Benefit cost ratio (BCR)	Less than 0	Between 0 and 1	Greater than 1
Stochastic	35.3%	64.7%	0%
NARcliM	6.3%	93.4%	0.3%

Environmental effects of the Manning River transfer on the Peel River

The intervalley transfer from the Manning catchment into the Peel River above Chaffey dam was associated with extreme improvements in very low and low flows and the number of days below low flow, with the largest effects occurring at Paradise Weir in Tamworth or below Chaffey Dam. There were also improvements in mean annual discharge, base flow, average number of freshes and flood (Average Recurrence Interval (ARI) 2.5) flows, all of which were greatest downstream of Chaffey dam.

There were a range of impacts including major impacts on the duration of freshes which had its biggest impact at Dungowan Creek and median frequency of low flows (days/year) where the greatest effect was at Paradise weir near Tamworth.

Improvements in low and very low flows would be expected to be associated with additional habitat and improved water quality for the fish community. Increases in annual discharge and the number of freshes would be expected to provide benefits for the native fish community, through increases in productivity and opportunities to move. Freshes will also provide benefits to riparian vegetation, creating habitat for non-woody vegetation and replenishing soil moisture for trees such as red gum.

Moderate improvement in ARI 2.5 flows would provide a wide range of positive effects, including the fish community, riparian and floodplain vegetation and waterbirds. For short to moderate-lived floodplain specialist native fish species (e.g., purple-spotted gudgeon) these flows would maintain habitat and may provide opportunities to disperse, thereby increasing their distribution. The overbank flows would provide habitat for non-woody vegetation such as sedges to complete their life cycle. For waterbirds such as the eastern great egret, overbank flows would create foraging habitat.

The impacts on the duration of freshes were greatest downstream of Chaffey dam where there was a 50-day reduction. This change may have some effect on productivity within the Peel, however, the reduction was down to 20 days at Piallamore and half a day at Paradise Weir which is unlikely to have a significant effect on the system compared to the increase in the number of freshes.

The largest reduction in median annual flows was in Dungowan Creek, which is a smaller stream

The low flow, and possibly also fresh and ARI 2.5 effects will be largely affected by the model's configuration on environmental delivery, as it is modified to ensure minimum flows are met with the dam releases. Both Dungowan Creek below Dungowan Dam, and the Peel River below Chaffey Dam will be strongly affected by these model assumptions.

Flow variability was generally reduced across several measures under both scenarios, which are recorded as impacts. Note that, as a rule, flow regulation tends to reduce flow variability as operations seek high efficiency delivery for consumptive use, and so these analyses assume a reduction in variation is usually an impact. There can be exceptions to this rule, as noted below for water quality events in the Keepit Dam to Tamworth pipeline scenario. Also, the losses in low flow standard deviation (a measure of variation) in this scenario could be beneficial, as it might indicate a reduced frequency of low flow events that impact aquatic fauna and flora. This possibility requires further exploration but given that the low flow and very low flow rates have increased it is not currently considered a higher risk.

Table 14. Predicted environment effects of the Manning scenario using Stochastic and NARcliM modelling (Planning assumption). The environmental effect is calculated as the percentage change against the base case. Cells are shaded following stage 2 categories in Table 11

	Stochastic	NARcliM
Metric	Average (Min-Max)	Average (Min-Max)
Number of years with greater or equal to one zero flow spell in 130 years	1 (0 to 8)	8 (0 to 29)
Very low flow rate (ML/d) measured as the 95th percentile discharge of daily flows	38 (-4 to 70)	50 (5 to 89)
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	29 (-3 to 53)	53 (4 to 82)
Median annual discharge (ML/y)	4 (-4 to 19)	24 (1 to 66)
Median days below low flow	-137 (-700 to 17)	-58 (-300 to 20)
Low flow standard deviation	-58 (-236 to 1)	-29 (-72 to 0)
Low flow days below the 75 percentile	-167 (-500 to 0)	0 (0 to 0)
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	18 (-4 to 35)	39 (4 to 67)
Mean annual discharge (ML/y)	3 (0 to 12)	11 (0 to 29)
Fresh flow rate (ML/d), measured as dis-charge of daily flows	0 (0 to 0)	0 (0 to 0)
Average number of freshes per year	4 (-1 to 23)	12 (1 to 48)
Average duration of freshes (number of days)	-5 (-32 to 0)	-25 (-142 to -2)
High flows - 2.5-year Annual Return Interval	0.7 (0 to 2.8)	13 (0 to 39)
High flows - 5-year ARI flow rate (ML/d)	1 (0 to 4)	1 (0 to 5)
Very high flows - 10 year ARI flow rate (ML/d)	0.4 (0 to 1.8)	5 (0 to 36)
Monthly flow coefficient of variation	-9 (-24 to 0)	-20 (-52 to -1)
Daily flow coefficient of variation	-11 (-28 to 1)	-21 (-46 to 0)
Weekly flow coefficient of variation	-9 (-24 to 0)	-19 (-42 to 0)

Pipeline between Namoi Valley Dams (Keepit Dam) and Tamworth with a 41 GL increase in reserve set aside in Namoi Valley Dam

Purpose	Reduce Tamworth's water security risk.
Description	This option involves a pipeline from Keepit Dam to Tamworth to allow pumped transfers (capped at 6,800 ML/a) to directly satisfy Tamworth town water supply demands. The adopted option included a trigger of 10%, meaning when Chaffey Dam available storage falls below 10%, Keepit Dam transfer supplies Tamworth town water demands, up to 25 ML/d and 6,800 ML/a. The infrastructure assessed included: • construction of a pipeline from Keepit Dam to Tamworth Regional Council's Calala Lane WTP with a capacity of 25 ML/d and length 73 km (trenched) • construction of a pump station at Keepit Dam (125 m head) and a booster pump station (100 m head). The analysis of this option assumed that the proposed new Dungowan Dam was in place (i.e. it was in the base case).
Results	Viable – progressed to short list, but requires further analysis on the optimum reserve, further consultation and understanding of costs. This option significantly reduces the time spent in any level of restriction by 6.5% under the stochastic climate dataset and 17.2% under the NARcliM climate dataset and has the potential to remove risks of Tamworth running out of surface water. This improves economic outcomes for the town over an average 40 year period under stochastic climate data by \$31.2 million (95.4% improvement) and under NARcliM climate data by \$232.5 million (93.4% improvement). High security agricultural users also experience benefits due to the option as it has the benefit of improving reliability for high security licences, however these are secondary to the primary benefits required by Tamworth. However, this option does have an impact on general security licences in the Namoi Valley, and as a result, the average Net Present Value of the pipeline from Keepit Dam under both climate datasets is negative, with a benefit to cost ratio less than 1 in both cases.
Limitations	The modelling is sufficient to demonstrate the effect of this option on Tamworth's water security. However, amendments to the model set up are needed to accurately understand the impacts of this option on Namoi licence holders. Further fine tuning of the modelling could be done to identify the optimum reserve needed to be set aside in Keepit Dam which could reduce the impacts on general security licence holders, and in which dam the water can or should be stored in.

Peel Results

Changes in water availability for towns and licence holders

Climate data	Tamworth town water security					General security mean allocation %
	Tamworth water demand (ML/year)	% time in level 1+ restrictions	% time in level 5 restrictions	# of complete failures over 10,000 years	Frequency of shortfalls	

Long term historical climate projections (10,000 years)

Base Case	11,000	11.1%	2.5%	14	1 in 700 years	62.6%
Keepit pipeline and 41 GL reserve	11,000	4.60 (-6.5)	0.03 (-2.5)	0 (-14)	1 in 9,800 years	62.6 (+0.0)

Dry climate change scenario (NARClIM 10,000 years)

Base Case	11,000	46.2%	22%	393	1 in 25 years	28.2%
Keepit pipeline and 41 GL reserve	11,000	29.00 (-17.2)	0.09 (-21.1)	2 (-391)	1 in 4,900 years	28.6 (+0.4)

Changes in economic outcomes

Climate data	Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Average net present value (\$ million, over 40 years)
	Towns	Annual agriculture	Permanent agriculture		
Stochastic	44.2 (91.5%)	0.0 (0%)	0.1 (+4.0%)	327	-295
NARClIM	252.2 (83.4%)	0.1 (0.1%)	0.5 (+127.1%)	327	-93

Namoi Results

Changes in water availability to licence holders

Climate data	Change in long-term average water take under licences (GL/year)			Change in % of time system storage < 20% full supply level
	General security	Supplementary	High security	
Historical	-4.5 (-3.87%)	0.1 (0.3%)	0.0 (0.2%)	-10% Keepit Dam -0.5% Split Rock Dam
Stochastic	1 (-0.9%)	0.3 (0.6%)	0.0 (-0.6%)	-5.6% Keepit Dam 6.7% Split Rock Dam
NARClIM	0.5 (0.6%)	0.3 (1%)	0.0 (-3.7%)	-7.1% Keepit Dam 10.2% Split Rock Dam

Changes in town water security for towns in the Namoi valley

Towns	Percent of time with a town water supply shortfall			
	Stochastic (long-term climate record)		NARClIM (dry climate change scenario)	
	Base case	Keepit pipeline and 41 GL additional reserve	Base case	Keepit pipeline and 41 GL additional reserve
Manilla and Barraba*	0.21% (1 in 500 years)	0.0%	2.01% (1 in 50 years)	0.8% (1 in 125 years)
Walgett**	1.97% (1 in 50 years)	0.5% (1 in 200 years)	9.95% (1 in 10 years)	4.4% (1 in 22 years)

Changes in economic outcomes

Climate data	Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Average net present value (\$ million, over 40 years)
	Towns	Annual agriculture	Permanent agriculture		
Stochastic	0.7 (+68.2%)	-19.4 (-1.8%)	0.1 (4.0%)	327	-\$27
NARClIM	4.8 (+65.2%)	-11.2 (-1.5%)	0.1 (8.6%)	327	-\$24

Combined economic results (Namoi + Peel)

Climate data	Average net present value (\$ million, over 40 years)	Option cost (\$ million, over 40 years)	Average benefit to cost ratio (BCR)	BCR less than 0	BCR between 0 and 1	BCR greater than 1
Stochastic	-314.0	327	0.04	65%	35%	1%
NARClIM	-100.1	327	0.69	5%	72%	23%

Environmental effects of the Keepit Dam to Tamworth pipeline. Part 1 of 2: Effects on the Peel.

Maintaining a reserve in Keepit for use in Tamworth during droughts had little effect on the flow regime in the Peel River under stochastic modelling. In contrast, the climate change (NARcliM) modelling revealed moderate improvement in very low flows and minor improvement in low flows, which were concentrated in the river section between Chaffey Dam and Tamworth.

The NARcliM modelling also revealed some minor impacts on low flows and on several measures of flow variation including low flow standard deviation and daily, weekly and monthly variation. The largest impacts on variation were immediately below Chaffey Dam and decreased further downstream.

Low flows are critical for maintaining habitat and water quality during dry periods and so the improvement will be associated with improvements in habitat availability for the fish community. Changes to patterns of variation are a little more difficult to interpret as the Long-Term Water Plan identifies risks around flow increases that may cause water quality issues. The largest change in the number of low flow days was only six days a year, suggesting limited additional opportunities for pools to stratify or blooms to develop. The area has a history of pool stratification so while this increase may seem minor it is worth noting this increase in risk for bloom formation. Under current conditions stratification has been observed to occur (e.g., low dissolved oxygen and stratification in Pool 13 just downstream of Tamworth during October 2019 and the 2020-21 summer).⁴⁸



Image courtesy of John Spencer, Department of Planning and Environment. River and wilderness area, Werrikimbe National Park.

48. DPIE (2020). Consolidated Agency Response on Management Plans for the Peel River Pipeline Works. Department of Planning, Industry & Environment, August 2020.

Table 15. Predicted environment effects of the Keepit scenario using Stochastic and NARClIM modelling (Planning assumption). The environmental effect is calculated as the percentage change against the base case. Cells are shaded following Table 11

	Stochastic	NARClIM
Metric	Average (Min-Max)	Average (Min-Max)
Number of years with greater or equal to one zero flow spell in 130 years	0.1 (0 to 0.5)	1 (0 to 5)
Very low flow rate (ML/d) measured as the 95th percentile discharge of daily flows	0 (-1.1 to 0.7)	17 (6 to 27)
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	0.4 (-0.4 to 2)	8 (3 to 12)
Median annual discharge (ML/y)	0 (-0.1 to 0.1)	5 (0 to 20)
Median days below low flow	-1 (-6.7 to 0)	0 (0 to 0)
Low flow standard deviation	-0.4 (-2.7 to 0.3)	-7 (-24 to 0)
Low flow days below the 75 percentile	0 (0 to 0)	0 (0 to 0)
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	0.2 (0 to 1.5)	4 (1 to 8)
Mean annual discharge (ML/y)	0 (0 to 0.2)	1 (0.1 to 2.7)
Fresh flow rate (ML/d), measured as dis-charge of daily flows	0 (0 to 0)	0 (0 to 0)
Average number of freshes per year	0 (0 to 0.1)	0.8 (0.1 to 2)
Average duration of freshes (number of days)	0 (-0.3 to 0)	-1 (-4 to 0)
High flows - 2.5-year Annual Return Interval	0 (-0.1 to 0.1)	2 (0 to 5)
High flows - 5-year ARI flow rate (ML/d)	0 (0 to 0.1)	0.1 (0 to 0.2)
Very high flows - 10 year ARI flow rate (ML/d)	0 (-0.1 to 0.1)	0.8 (0 to 6.5)
Monthly flow coefficient of variation	-0.3 (-0.9 to 0)	-5 (-26 to 0)
Daily flow coefficient of variation	-0.2 (-0.5 to 0)	-3 (-12 to 0)
Weekly flow coefficient of variation	-0.3 (-0.8 to 0)	-5 (-19 to 0)

Environmental effects of the Keepit Dam to Tamworth pipeline. Part 2 of 2: Effects on the Namoi.

This option showed the most impacts on any river system, especially under the climate change (NARCLiM) scenario. The stochastic modelling identified seven minor impacts on the flow regime in the Namoi. There was a 6% decline in very low and low flows which was greatest downstream at Bugilbone and Goangra respectively. The other impacts were increases in the frequency of events below low flows and base flows, and for three measures of flow variation, low flow standard deviation, monthly and weekly coefficients of variation. While average impacts were minor, there were extreme impacts in certain locations. The largest impact on low and base flows was again in the downstream reach at Goangra.

The climate change modelling revealed eight severe, two moderate and six minor impacts on the flow regime. The largest impacts were on annual discharge and base flows. Bugilbone and Goangra were among the most impacted along with Baradine Creek and Pian Creek. Very low (95th percentile) and low flows (90th percentile) were also affected with 86% and 77% reductions at Halls Ck and Bugilbone respectively.

The severe effects forecast under the climate change modelling, particularly the annual discharge and impacts on high flows are likely to impact a range of environmental values. The reaches between Wee Waa and Walgett support extensive floodplains and wetlands that depend on high flows to sustain vegetation communities, which then provide important foraging, nesting, and roosting habitat for waterbirds. The high flows will also maintain a diversity of habitats, which will be important in sustaining populations of native fish. This includes species such as purple spotted gudgeon that depend on off-channel habitats.

Table 16. Predicted environment effects of the Keepit scenario using Stochastic and NARClIM modelling. The environmental effect is calculated as the percentage change against the base case. Cells are shaded following Table 11

	Stochastic	NARClIM
Metric	Average (Min-Max)	Average (Min-Max)
Number of years with greater or equal to one zero flow spell in 130 years	-0.1 (-1.5 to 0.5)	-8 (-12 to 0)
Very low flow rate (ML/d) measured as the 95th percentile discharge of daily flows	-6 (-50 to 0)	-18 (0 to -77)
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	-6 (-54 to 3)	-18 (0 to -87)
Median annual discharge (ML/y)	0.3 (-0.1 to 2.9)	-52 (-69 to -42)
Median days below low flow	-3 (-14 to 0)	-6 (-139 to 85)
Low flow standard deviation	-6 (-56 to 0)	-4 (-36 to 28)
Low flow days below the 75 percentile	-3 (-25 to 4)	-57 (-500 to 70)
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	-4 (-26 to 3)	-30 (-92 to 0)
Mean annual discharge (ML/y)	0.2 (-0.1 to 1.5)	-42 (-58 to -30)
Fresh flow rate (ML/d), measured as dis-charge of daily flows	0 (0 to 0)	0 (0 to 0)
Average number of freshes per year	0.3 (0 to 2)	-40 (-49 to -27)
Average duration of freshes (number of days)	0 (-2.2 to 0.6)	-20 (-30 to -15)
High flows - 2.5-year Annual Return Interval	0.2 (0 to 1.5)	-43 (-67 to -8)
High flows - 5-year ARI flow rate (ML/d)	0.2 (-1.4 to 4.1)	-38 (-79 to -17)
Very high flows - 10 year ARI flow rate (ML/d)	-0.1 (-2.3 to 1.2)	-33 (-84 to 0)
Monthly flow coefficient of variation	-5 (-20 to 0)	-18 (-39 to 6)
Daily flow coefficient of variation	-3 (-11 to 0)	-19 (-46 to 10)
Weekly flow coefficient of variation	-4 (-16 to 0)	-19 (-42 to 6)

Additional water treatment facilities for Tamworth

Purpose	Increase Tamworth's town water security by substituting dam water supply for purified recycled water. This was Option 6 in the Draft Namoi Regional Water Strategy.
Description	This option assumed that recycled effluent from Westdale Wastewater Treatment Plant would be used to supply town water supply via direct potable reuse to substitute the take of water from the Peel River under existing local water utility licences. The option assumed that 6 ML/d of reclaimed effluent was supplied to the water treatment plant and blended with raw water supplies from Dungowan and Chaffey Dams. This option was modelled by reducing Tamworth's water demand by 6 ML/d after restrictions had been applied to account for the recycled effluent. The infrastructure assumed included using existing Westdale Waste Water Treatment Plant treatment process and effluent storage dam (1,500 ML) this would involve: • construction of two effluent transfer pump stations adjacent to existing effluent storage (25 ML/d) • construction of 42 km of DN500 recycled effluent network (northern & southern irrigation schemes) to supply existing irrigators on the Peel River between Piallamore and Attunga. This option assumes that the proposed new Dungowan Dam is in place (i.e. it is in the base case).
Results	Viable – progressed to short list, but requires further community engagement and understanding of costs. This option improves water supply security for Tamworth without negatively impacting on agricultural supply within the Peel catchment. The time in any level of restriction is reduced by 4.9% under the stochastic climate dataset and by 11.5% under the NARcliM climate dataset. Avoiding these restrictions and shortfalls improves the average economic outcomes for Tamworth over a 40 year period by \$6 million under the stochastic climate dataset and by \$32 million under the NARcliM climate dataset. Minor improvements are also experienced by agricultural producers within the Peel catchment however are typically no greater than \$1 million over 40 years around both climate datasets.
Limitations	Hydrologic modelling assumes a constant reuse rate. This may not always be possible under dry climate conditions. No modification was applied to the town water supply restriction triggers. This could be further investigated to improve the time in restrictions while noting any security of supply impacts.

Changes in water availability for towns and licence holders

Climate data	Tamworth town water security					General security mean allocation %
	Tamworth water demand (ML/year)	% time in level 1+ restrictions	% time in level 5 restrictions	# of complete failures over 10,000 years	Frequency of shortfalls	

Long term historical climate projections (10,000 years)

Base Case	11,000	11.1%	2.5%	14	1 in 700 years	62.6%
Stochastic	11,000	6.20 (-4.9)	0.90 (-1.6)	1 (-13)	1 in 9,800 years	62.6 (0.0)

Dry climate change scenario (NARcliM 10,000 years)

Base Case	11,000	46.2%	22%	393	1 in 25 years	28.2%
NARcliM	11,000	31.80 (-11.5)	12.90 (-9.0)	104 (-289)	1 in 94 years	29.2 (+1.0)

Changes in economic outcomes

Climate data	Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Average net present value (\$ million, over 40 years)	Average benefit to cost ratio
	Towns	Annual agriculture	Permanent agriculture			
Stochastic	18.4 (56.3%)	1.0 (1.2%)	0.1 (5.0%)	278	-259	<0.1
NARcliM	106.7 (42.9%)	0.9 (1.2%)	0.5 (129.7%)	278	-170	<1.0

Table 17. Predicted environment effects of the Reuse scenario using Stochastic and NARClIM modelling (Planning assumption). The environmental effect is calculated as the percentage change against the base case. Cells are shaded following stage 2 categories in Table 11

	Stochastic	NARClIM
Metric	Average (Min-Max)	Average (Min-Max)
Number of years with greater or equal to one zero flow spell in 130 years	0.4 (-0.2 to 1.8)	2 (0 to 6)
Very low flow rate (ML/d) measured as the 95th percentile discharge of daily flows	1 (-12 to 6)	21 (5 to 34)
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	-1 (-16 to 4)	17 (3 to 40)
Median annual discharge (ML/y)	-0.7 (-5.2 to 1.7)	7 (-8 to 38)
Median days below low flow	10 (0 to 53)	-10 (-33 to 0)
Low flow standard deviation	-3 (-10 to 8)	-9 (-29 to 0)
Low flow days below the 75 percentile	33 (0 to 100)	0 (0 to 0)
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	-2 (-13 to 1)	6 (-2 to 19)
Mean annual discharge (ML/y)	1 (0 to 2.9)	2 (1 to 4)
Fresh flow rate (ML/d), measured as dis-charge of daily flows	0 (0 to 0)	0 (0 to 0)
Average number of freshes per year	0.9 (-5.7 to 3.7)	2 (-7 to 6)
Average duration of freshes (number of days)	-0.4 (-1.9 to 2.1)	-1 (-6 to 2)
High flows - 2.5-year Annual Return Interval	0.7 (0 to 3.2)	4 (0 to 13)
High flows - 5-year ARI flow rate (ML/d)	1 (0 to 4)	-0.2 (-3.1 to 2.6)
Very high flows - 10 year ARI flow rate (ML/d)	0.7 (0 to 2.1)	4 (0 to 26)
Monthly flow coefficient of variation	0.1 (-1 to 3.4)	-6 (-24 to 0)
Daily flow coefficient of variation	0.3 (-0.9 to 4.3)	-4 (-15 to 0)
Weekly flow coefficient of variation	0 (-1 to 3.3)	-6 (-20 to 0)

Increase the reserve in Chaffey Dam for Tamworth town water supply

Purpose	Increase security and reliability of supply for Tamworth to support long term growth in Tamworth's water demand.
Description	Increase the Tamworth town water reserve in Chaffey Dam by 14 GL to 42 GL.
Results	Viable – progressed to short list, but requires further analysis of optimum reserve change in combination with other long-term options to support Tamworth's water security. Increasing the reserve in Chaffey Dam by 14 GL results in improvements to Tamworth water security at the cost of reduced general security allocations. It will reduce the time spent in any level of restriction by 4.7% under the stochastic climate data set and by 8.3% under the NARClIM climate data set. By holding more water in storage there will be reductions in average general security allocations by 15% under the stochastic climate data and by 8.9% under the NARClIM climate data set. However, the modelling suggests that most of this reduction can be recovered by licence holders through increased off-allocation diversions with overall water diversions unlikely to change. This is reflected in the economic modelling which indicates that the average economic impact to agriculture over a 40-year period will be modest. Improvements in Tamworth water security from this option could help avoid estimated economic costs of \$9.3 million and \$34.55.7 million on average over a 40-year period under stochastic and NARClIM climate datasets respectively. This option assumes the proposed new Dungowan Dam is in place (i.e. it is in the base case).
Limitations	This option has been costed as a policy option. Compared to an infrastructure solution the costs are very low resulting in high benefit cost ratio. There are uncertainties of the actual costing of this option. There is a possibility some of the lost allocations could be offset through increased access to tributary inflows below the dam but further modelling would need to be undertaken to understand if this is possible and if so the size of the offset, and the impacts of this on the environment and planned environmental water.

Changes in water availability for towns and licence holders

Climate data	Tamworth town water security					General security mean allocation %	Change in long term average water take under general security licences (GL/year)
	Tamworth water demand (ML/year)	% time in level 1+ restrictions	% time in level 5 restrictions	# of complete failures over 10,000 years	Frequency of shortfalls		

Long term historical climate projections (10,000 years)

Base case	11,000	11.1%	2.5%	14	1 in 700 years	62.6%	5,933
Stochastic	11,000	6.40 (-4.7)	1.40 (-1.1)	7 (-7)	1 in 1400 years	47.6 (-15.0)	5,959

Dry climate change scenario (NARClIM 10,000 years)

Base case	11,000	46.2%	22%	393	1 in 25 years	28.2%	5,601
NARClIM	11,000	37.90 (-8.3)	18.00 (-4.0)	319 (-74)	1 in 31 years	19.3 (-8.9)	5,411

Summary of economic outcomes

Climate data	Average change in economic outcomes (\$ million, over 40 years)			Option cost (\$ million, over 40 years)	Average net present value (\$ million, over 40 years)	Average benefit to cost ratio
	Towns	Annual Agriculture	Permanent Agriculture			
Stochastic	9.1 (27.7%)	0.4 (0.5%)	0.0 (1.9%)	4.2	9.3	>1.0
NARClIM	35.7 (14.4%)	-1.4 (-1.8%)	0.2 (40.4%)	4.2	37.3	>1.0

Environment effects of an increased reserve held in Chaffey Dam for Tamworth

Increasing the water reserve for Tamworth held in Chaffey dam had a range of moderate and extreme impacts on flow regimes under stochastic modelling including increases in the frequency of base, low and very low flows, and reductions in the volume of these flows. There were some minor improvements in the frequency of low flows, duration of freshes and monthly variation. The climate change modelling revealed similar but smaller impacts on low flows, but also minor to moderate impacts on high flows (2.5 and 5 year ARI).

The increased frequency of and reduction in size of low and base flows will affect the fish community through both the amount of available habitat and opportunities to move. Increase in the duration of low flows would place additional stress on the fish community that

would likely be associated with declines in condition of long-lived species and declines in numbers of some smaller native species. The minor decreases in high flows under climate change would likely exacerbate changes to low flows as both changes would be associated with declines in in-stream ecological productivity (including nutrients and aquatic plants) and food (including aquatic invertebrates and smaller fish). The minor declines in high flows would also affect non-woody vegetation and water dependent bird species through their effects on wetland and foraging habitat.

The environmental consequences of this option would in large part depend on how the reserve is used when released from the dam under the models. Presumably, if the reserve releases were also targeted to minimising cease to flow and low flow periods that impact aquatic flora and fauna then the net effect of this option would be more positive for environmental outcomes.



Warrumbungle Range from Pilliga Forest lookout tower.

Table 18. Predicted environment effects of the Increased Tamworth reserve scenario using Stochastic and NARcliM modelling (Planning assumption). The environmental effect is calculated as the percentage change against the base case. Cells are shaded following stage 2 categories in Table 11

	Stochastic	NARcliM
Metric	Average (Min-Max)	Average (Min-Max)
Number of years with greater or equal to one zero flow spell in 130 years	-1 (-3 to 0)	-4 (-15 to 1)
Very low flow rate (ML/d) measured as the 95th percentile discharge of daily flows	-18 (-32 to -2)	5 (-1 to 13)
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	-18 (-33 to -6)	3 (-5 to 18)
Median annual discharge (ML/y)	-3 (-19 to 0)	-2 (-6 to 0)
Median days below low flow	40 (0 to 100)	14 (-33 to 75)
Low flow standard deviation	11 (1 to 47)	2 (-8 to 39)
Low flow days below the 75 percentile	28 (-2 to 100)	4 (-2 to 17)
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	-12 (-21 to -1)	-4 (-12 to 8)
Mean annual discharge (ML/y)	-0.3 (-1.3 to 0)	-0.5 (-5 to 1.5)
Fresh flow rate (ML/d), measured as dis-charge of daily flows	0 (0 to 0)	0 (0 to 0)
Average number of freshes per year	1 (-18 to 29)	-2 (-36 to 27)
Average duration of freshes (number of days)	3 (-1 to 18)	6 (-2 to 22)
High flows - 2.5-year Annual Return Interval	-3 (-25 to 4)	-13 (-81 to 32)
High flows - 5-year ARI flow rate (ML/d)	1 (-2 to 6)	-8 (-38 to 2)
Very high flows - 10 year ARI flow rate (ML/d)	0.7 (0 to 3)	3 (-4 to 24)
Monthly flow coefficient of variation	3 (0 to 6)	0.7 (-6.3 to 6.7)
Daily flow coefficient of variation	0.9 (-18.8 to 6.2)	-2 (-17 to 3)
Weekly flow coefficient of variation	2 (-8 to 6)	-0.6 (-6 to 3.8)

