Draft Regional Water Strategy

Far North Coast: Shortlisted Actions – Consultation Paper

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Cover image Image courtesy of Destination NSW. Tweed Valley, Murwillumbah.

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Acknowledging First Nations People

The NSW Government acknowledges First Nations people as its first Australian people and the traditional owners and custodians of the country's land and water. We recognise 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 Bundjalung and Githabul people as having an intrinsic connection with the lands and waters of the Far North Coast regional water strategy area. The landscape and its waters provide First Nations people with essential links to their history and help them to maintain and practice their traditional culture and lifestyle.

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

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 supporting the health and wellbeing of waterways and Country by valuing, respecting and being guided by Traditional Owners/First Nations people, who know that if we care for Country, it will care for us.

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

Artwork courtesy of Nikita Ridgeway.

Minister's foreword

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

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

When it comes to managing water in NSW my view is healthy rivers, healthy farms and healthy communities – not one over another.

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 Far North Coast is home to 240,000 people and the major regional centres of Tweed Heads, Lismore and Ballina, which drive the region's $13 billion average annual economy.

Water drives local businesses, supports towns and ensures a healthy local environment, which on the Far North Coast includes the Richmond, Tweed and Brunswick rivers.

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

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

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

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

Our state is no stranger to extremes; we have always had to manage our water resources through floods and prolonged droughts. Two years ago the Far North Coast experienced its most severe 2-year drought on record. Earlier this year the rainfall that deluged communities throughout the Far North Coast led to catastrophic, record-breaking flooding. The damage caused by the floods has crippled local businesses and destroyed thousands of homes. This has left affected communities economically weakened, distanced from critical services and socially vulnerable. In the face of an increasingly variable climate future, we must prepare for even longer and more severe wet and dry periods.

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

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

We know the Far North Coast faces significant challenges going forward. Future flood management and the risk to towns; declining river health; more demand for water when rivers are running low; saltwater intruding into freshwater sources; barriers to Aboriginal people's rights and access to water; and the need to improve future water security for regional industries, towns and communities.

The Far North Coast Regional Water Strategy will put forward the best mix of solutions to address these challenges and support environmental, social and economic outcomes. We also engaged Australia's national science agency, the CSIRO, to review the options in the strategy with a focus on flood risk management, river health and water security. After considering their review and after widespread community consultation, we have shortlisted options that support key priorities. These include taking a holistic approach to land and water management, ensuring water resources are used sustainably and fairly, and preparing for a more variable climate.

To complement the regional water strategies, the NSW Government is delivering the Future Ready Regions Strategy, which aims to improve 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 on the Far North Coast to get involved and have their say to help improve the draft strategy. Water is for everyone, and we are ensuring our water management policies support the future of the Far North Coast and all of NSW.

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

Contents

Image courtesy of Destination NSW. Koonyum Retreat, Mullumbimby.

Snapshot

The Far North Coast region

Aboriginal people (the Bundjalung and Githabul nations) have lost access to land and water. Water is deeply entwined with Aboriginal cultural and Aboriginal people's connection to country

240,000
population

Key towns:
Tweed Heads, Lismore, Ballina, Casino and Byron Bay

Councils include:
Ballina Shire, Byron Shire, Kyogle, Lismore City, Richmond Valley, Rous County and Tweed Shire

Main rivers:
Richmond River, Tweed River and Brunswick River

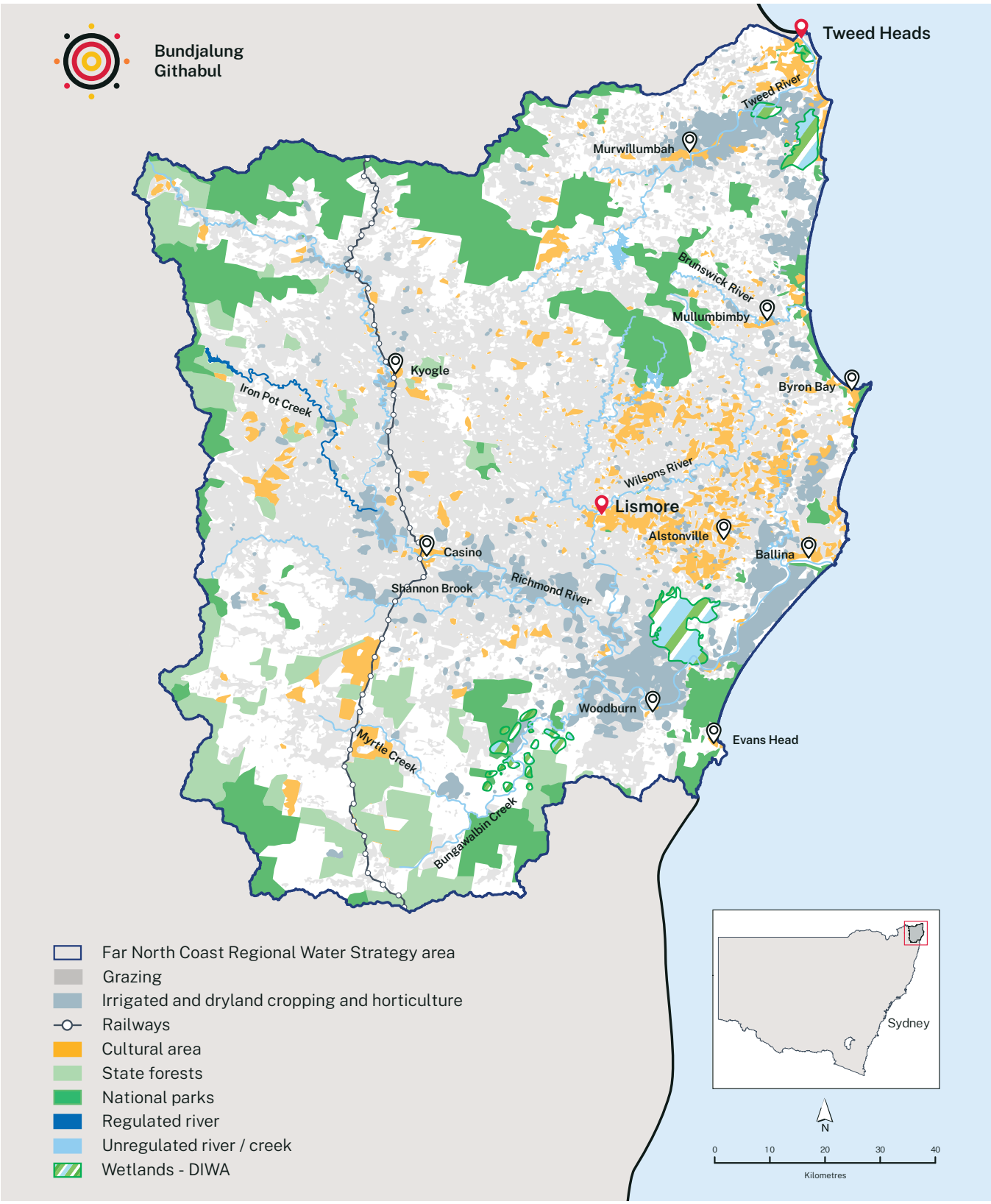
Major water storages:
Rocky Creek Dam (14 GL); Clarrie Hall Dam (16 GL); and Toonumbar Dam (11 GL), which regulates a small system on Iron Pot Creek

The region supports a **vast range of native flora and fauna**, state and nationally significant estuarine wetlands and swamps, national parks and nature reserves

Key industries:
Tourism, agriculture, aquaculture, food manufacturing, health care, education and retail. Agriculture is a key part of the regional economy and represents the second-highest use of water in the region. Water entitlements for agriculture represent about 60% of available licensed water in the region

Groundwater:
Groundwater is an important source of water for towns and industries. Main groundwater sources include: Richmond Coastal Sands and Tweed–Brunswick Coastal Sands, the North Coast Volcanics, the Alstonville Basalt Plateau, Clarence Moreton Basin and New England Fold Belt Coast

Figure 1. Map of the Far North Coast region



What is the purpose of this consultation paper?

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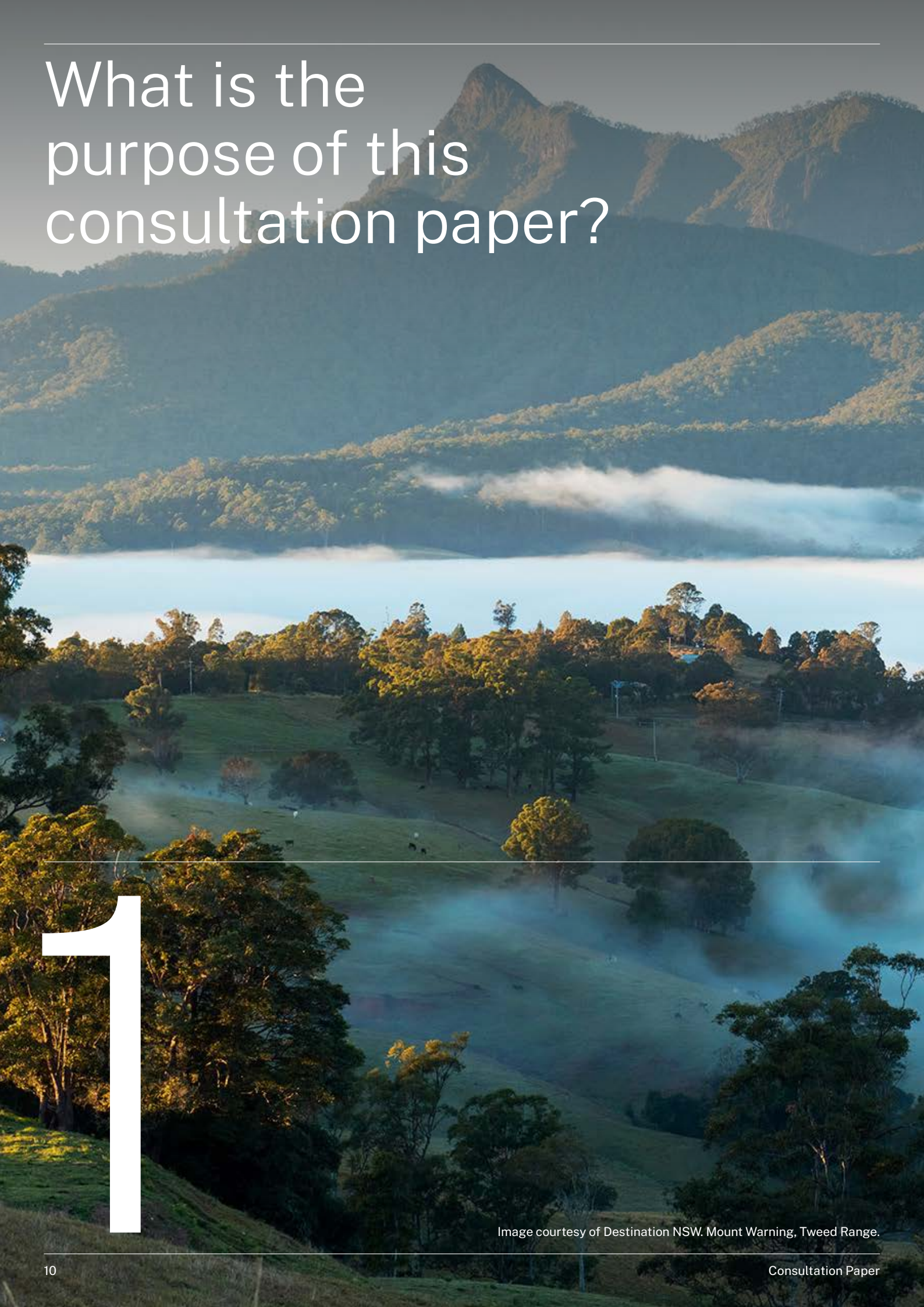

Image courtesy of Destination NSW. Mount Warning, Tweed Range.

The NSW Government is developing a suite of 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 Far North Coast Regional Water Strategy,*[1] including a long list of options, was released in October 2020.

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

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

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

Other regional water challenges previously described in the *Draft Far North Coast 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.

The regional water strategies cannot provide a comprehensive response to flooding

The role of regional water strategies is to support the delivery of healthy, reliable and resilient water resources that sustain a liveable and prosperous region.

Improvements to flood risk mitigation are being considered through the 2022 NSW Flood Inquiry. The inquiry report and the NSW Government response can be found at: www.nsw.gov.au/nsw-government/projects-and-initiatives/floodinquiry

A comprehensive response to flooding is outside the scope of the regional water strategies. However, the strategies can support local councils to make targeted flood management improvements.

The strategies can provide state and local decision-makers with technical advice that supports holistic flood management taking place through other channels. Actions such as improving catchment-scale flood modelling (Action 1.11) will give Far North Coast councils the best evidence base to meet the challenges associated with flooding.

1. Department of Planning, Industry and Environment 2020, *Draft Regional Water Strategy — Far North Coast: Strategy (PUB20/307),* water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/far-north-coast-regional-water-strategy
2. Department of Planning and Environment 2022, *Options Assessment Process: Overview,* Department of Planning and Environment, www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/identifying-and-assessing
3. Department of Planning, Industry and Environment 2021, *Far North Coast Region Draft Regional Water Strategy — What We Heard,* Department of Planning, Industry and Environment, water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/far-north-coast-regional-water-strategy

Figure 2. Proposed water security challenges and priorities for the Far North Coast region

Vision

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

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Objectives

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

Regional challenges to meeting our vision and objectives

- Declining catchment and river health
- Competition for low flows
- Saltwater intrusion into freshwater sources
- Aboriginal people's rights and access to water
- Water security for industries in the Far North Coast
- Water security for towns and communities in the Far North Coast
- Urban flooding risks to individuals, businesses and communities

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Priority 1

Take a holistic approach to land and water management

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Actions 1.1–1.12

Priority 2

Ensure water resource development and use is sustainable and equitable

Page 70

Actions 2.1–2.7

Priority 3

Prepare for future climatic extremes

Page 84

Actions 3.1–3.8

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 may face difficult decisions and choices about how to balance the different demands for this vital resource and manage water efficiently and sustainably into the future. The regional water strategy process identifies these risks and seeks to understand how we can manage and be best prepared for these future uncertainties and challenges.

In addition to understanding and managing future pressures, there are opportunities to consider the role water resources will play in growing our 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 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.

Image courtesy of Destination NSW. Cape Byron Lighthouse, Byron Bay.

How do regional water strategies fit with other water strategies?

The NSW Water Strategy, together with the suite of regional water strategies, and 2 metropolitan water strategies, 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.

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

- the Aboriginal Water Strategy – co-designed with Aboriginal people to identify a program of measures to deliver on First Nation's water rights and interests in water management
- 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 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 Far North Coast Regional Water Strategy also complement other whole-of-government strategies, including the:

- *20-Year Economic Vision for Regional NSW*
- updated State Infrastructure Strategy
- *Draft North Coast Regional Plan 2041.*

Additionally, the Far North Coast Regional Water Strategy will consider the strategies and recommendations of other initiatives that the NSW Government is developing, such as:

- the review of the Regional Economic Development Strategies
- the Housing 2041 – NSW Housing Strategy
- the NSW Electricity Strategy.

The NSW Floods Inquiry has also provided important learnings and recommendations that may affect catchment management, and infrastructure priorities and objectives. We will build resilience in regional communities by providing a coordinated approach to implementing the range of transformational NSW Government policies that have recently been introduced. We aspire to adopt a flexible place-based framework that is adaptive to changing circumstances. We hope this can enable government and regional communities to work together to ensure the Far North Coast is a great place to live, work, and visit.

Image courtesy of iStock. Mullumbimby, NSW.

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

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

Regional water strategies are backed by new climate data

To improve our strategic water planning, new ground-breaking climate datasets have been developed for the regional water strategies program. These datasets provide us with a more comprehensive understanding of the climate variability in the Far North Coast region beyond the recorded historical data.

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

- Historical data: data from rainfall and evaporation records collected by Australian Government meteorological records over the past 130 years.
- Long-term historical past climate: 10,000 years of stochastically-generated climate data developed using paleoclimatic information from the University of Adelaide, Australia.
- Dry future climate: climate data modified with 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 scenario[4] is the Intergovernmental Panel on Climate Change's *SRES A2* scenario. This represents a high carbon emissions scenario which leads to 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.

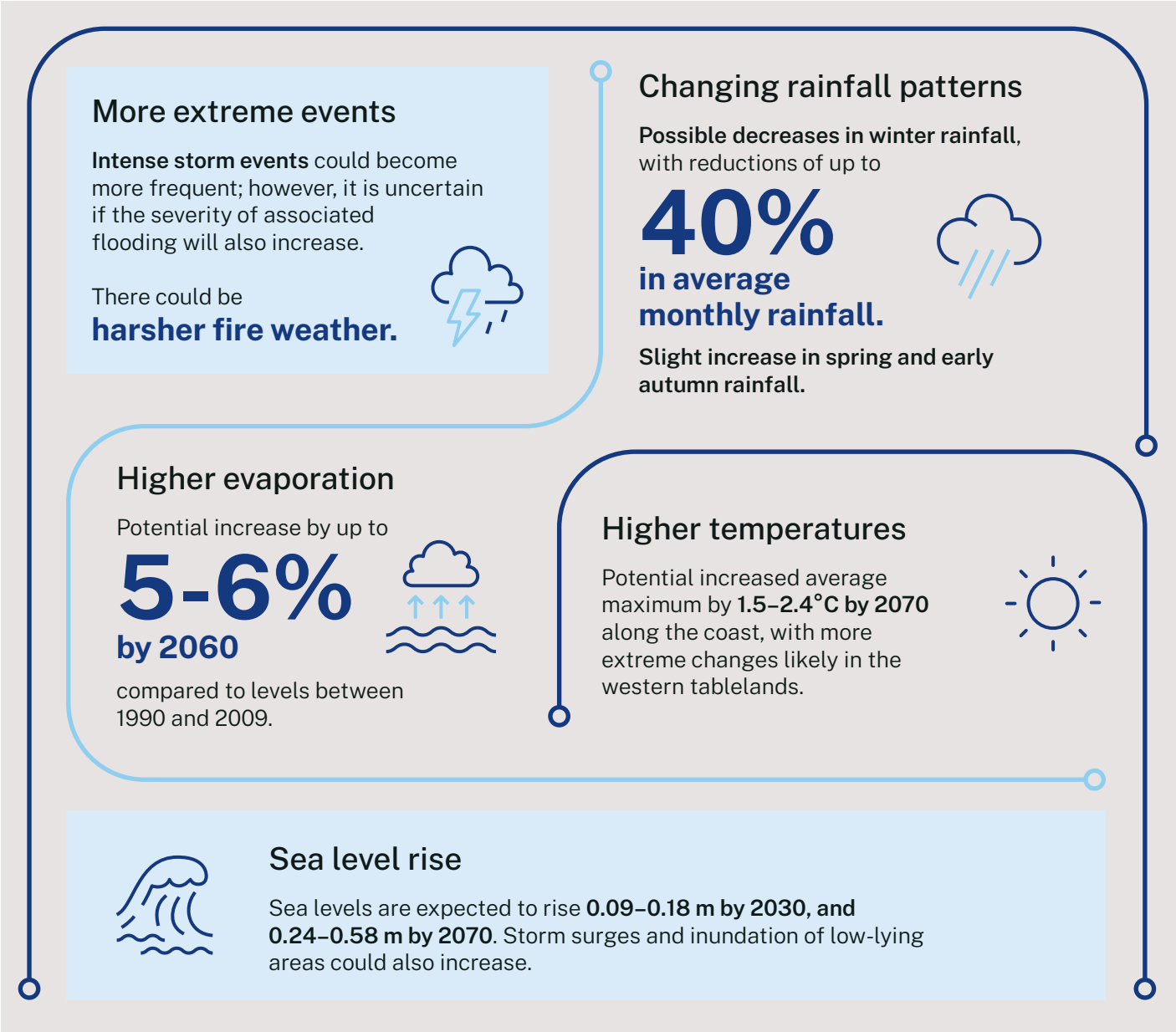
Our climate science is continuously improving. The regional water strategies are an important first step to better understand the region's climate and the potential vulnerability of our towns, communities, industries and the environment to a more variable and changing climate. We know that the future 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.

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's, AdaptNSW website: www.climatechange.environment.nsw.gov.au/climate-projections-used-adaptnsw
5. The SRES A2 scenario assumes a 2°C warming over the regional water strategy planning horizon.

What the future climate could look like in the Far North Coast region

We don't know for certain what the future climate will be like. Our analysis of different climate projections tells us there could be more extreme wet and dry periods than what we have observed in our lifetimes. Droughts could become hotter and longer, evaporation could increase, and there could be more unpredictable and variable rainfall and river flows. We need to plan for these uncertainties and continue to refine our understanding of the water-related risks in the region.

Figure 4. What the future climate could like in the Far North Coast



We want to hear from you

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

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

The feedback we receive from you will help us finalise the Far North Coast Regional Water Strategy and Implementation Plan.

The final strategy will identify a range of solutions that could reduce negative effects on water across the region and will support thriving regional communities. These could include policies, plans and regulation, as well as new technology and infrastructure. The strategy will bring together these solutions in an integrated package that is:

- based on the best evidence
- designed to respond to the Far North Coast 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.

Assessing benefits and impacts of actions that affect Aboriginal people and communities

Aboriginal communities in Far North Coast region have told us that they need specific information on how the proposed 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 proposed actions. Some of this information will not be available until we begin to do more detailed analyses of specific actions that remain in the final regional water strategy shortlist. Some of this additional analysis may be identified for early action in the strategy's implementation plan, while other work will progress as part of the strategic business cases for specific actions.

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 needed to progress preferred actions, we will share that information with Aboriginal communities and seek their feedback on how those actions may affect them. That evidence may help to refine a proposed action or identify risks in progressing an action.

Image courtesy of Destination NSW. Murwillumbah district, Northern Rivers.

What we have heard so far

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Image courtesy of John Spencer, Department of Planning and Environment.
Brunswick River picnic area, Brunswick Heads Nature Reserve.

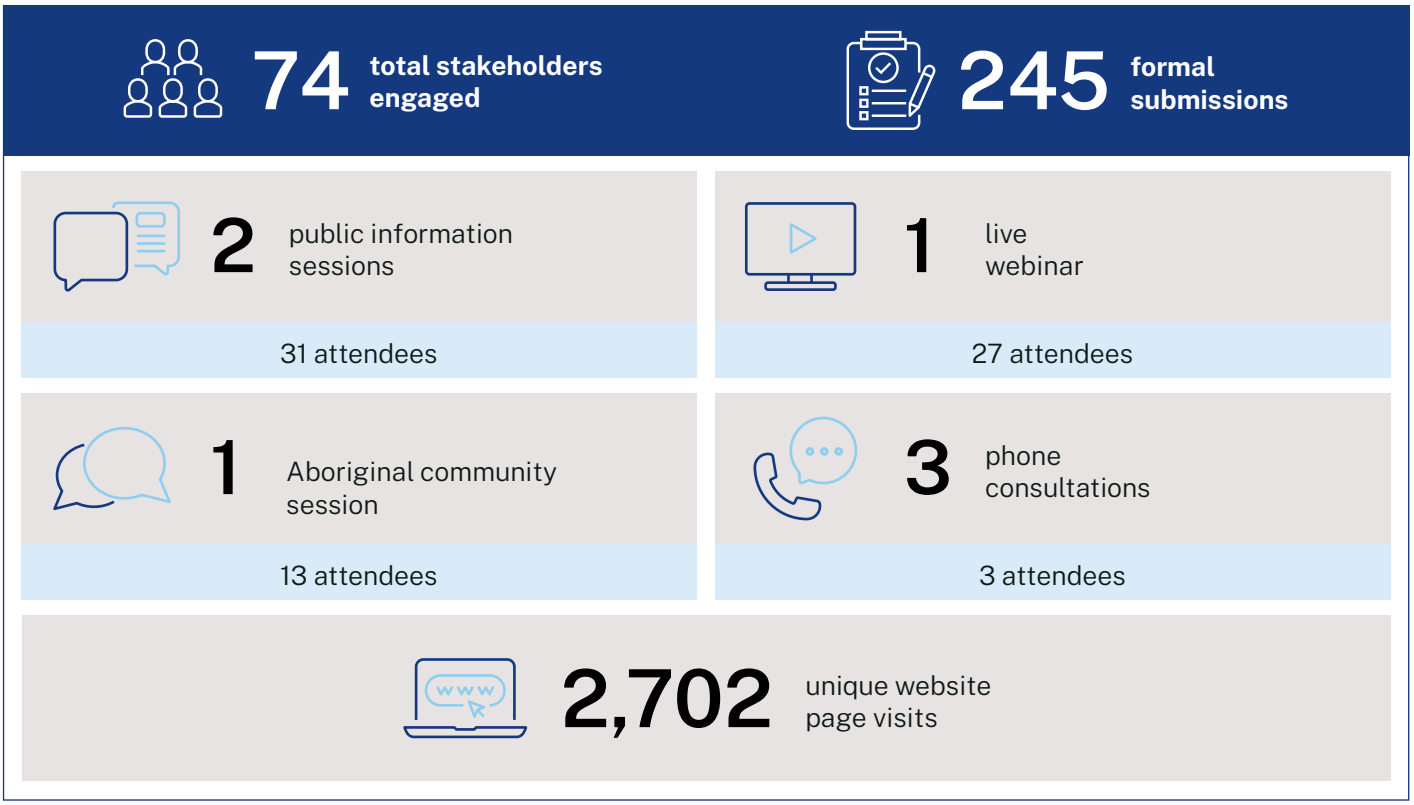
In 2020 we engaged with Aboriginal people, landholders, community members, local councils, and industry and environmental groups on the *Draft Far North Coast Regional Water Strategy* and the long list of options (Figure 5). The *Far North Coast region: Draft Regional Water Strategy: What we heard*[6] summarises the key issues we heard during the first round of public exhibition and highlights how all feedback received during this period has informed the next steps in the development of the Far North Coast Regional Water Strategy.

There was general support for the regional water strategies program and the development of the Far North Coast Regional Water Strategy.

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

Stakeholders encouraged the department to continue developing the NSW Water Strategy and regional water strategies. Since then, the NSW Water Strategy has been finalised.

Figure 5. Summary of stakeholder engagement



6. Department of Planning, Industry and Environment 2021, *Far North Coast Region Draft Regional Water Strategy — What We Heard*, Department of Planning, Industry and Environment, water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/far-north-coast-regional-water-strategy

We heard important feedback during our consultation with Aboriginal people, landholders, community members, local councils, and industry and environmental groups. The key insights are provided in Figure 6 below.

Figure 6. Key insights from consultation on the Draft Far North Coast Regional Water Strategy

Aboriginal knowledge and cultural heritage

- There was strong support for options that support the integration of Aboriginal water management knowledge, increased opportunities to access and trade, protection of cultural sites and creation of employment opportunities for local Aboriginal people.
- Consultation approaches with Aboriginal people need to be more culturally appropriate and have longer timeframes.
- There was support for more transparent governance frameworks and coordination of Aboriginal representative groups.

Water security

- There was strong support to diversify the region's water supply to be more climate-independent and for the inclusion of climate resilience plans for water supplies.
- There was concern about providing water for an increasing population in the region, with calls for limiting population growth to the water supply capacity or ensuring water reliability efforts keep pace with population growth.
- There was support for a greater focus on measures aimed at reducing demand and improving water efficiency.
- Reliability of water supply is important for the tourism economy.

Water infrastructure

- There was strong opposition to new on-stream storages such as the proposed Dunoon Dam during the public exhibition period and concerns that additional infrastructure options would not necessarily provide additional water reliability, especially if they are climate-dependent.
- Public support for the Dunoon Dam project has increased among some parts of the Far North Coast region's communities since public exhibition of the *Draft Far North Coast Regional Water Strategy* and the release of Rous County Council's *Future Water Strategy 2060*.
- There was strong support for options that include water reuse, recycling and purification projects, as well as support for options that aim to better integrate water efficiency measures and recycling infrastructure into development approvals processes.
- There was mixed support for desalination infrastructure in the region.

Flooding and flood mitigation

- Flooding is a significant issue of concern, with support for stronger regulation of development in flood-prone areas, particularly in high-risk areas.
- There was support for more extensive flood modelling and mitigation measures to be incorporated into the strategy, rather than the current focus on extreme drought events.

Groundwater

- There was community concern about commercial harvesting of groundwater for the production of bottled water.
- There was support for the need to better understand the health and sustainable use of groundwater sources, as well as the impacts of climate variability and climate change on groundwater demand, recharge and groundwater levels.

Image courtesy of iStock. Killen Falls, Tintenbar.

Where should we focus first?

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Image courtesy of iStock. Tweed River, NSW.

Our vision for the Far North Coast region, is to support the delivery of healthy, reliable and resilient water resources that will sustain a liveable and prosperous region.

The Far North Coast region stretches from the flat alluvial floodplains of the northern NSW coastline to the mountainous country towards the west. It includes 3 major catchments and lies within the traditional lands of the Bundjalung and Githabul Nations.

Like all regions across Australia, the Far North Coast 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 7 key challenges that are the immediate priority for the region. Addressing these will help us meet the vision and objectives we have set for the regional water strategies.

We have identified 7 key challenges that are the immediate priorities for the region:

- **Declining catchment and river health**
- **Competition for low flows**
- **Saltwater intrusion into freshwater sources**
- **Aboriginal people's rights and access to water**
- **Water security for industries in the Far North Coast**
- **Water security for towns and communities in the Far North Coast**
- **Urban flooding risks to individuals, businesses and communities**

Image courtesy of Murray Vanderveer, Department of Planning and Environment. Pinnacle Lookout, NSW.

Challenge: Declining catchment and river health

Poor catchment and riparian management and changes in catchment and river hydrology, are affecting river health, hydrologic connectivity and water quality.

The decline in catchment and river health threatens aquatic and riparian ecosystems, as well as downstream estuarine health. This decline impacts Aboriginal people's connection to Country and cultural sites associated with waterways. Communities and towns have an increased need to treat poor quality water for consumption, and there are reduced opportunities for recreation. Industries are directly impacted by poor water quality, particularly those operating in estuaries such as aquaculture. Other sectors such as tourism are indirectly impacted through loss of amenity.

Land management practices are impacting riverine health

Land use change, poor riparian management and uncontrolled stock access have led to riverbank and riverbed erosion, and the mobilisation of sediment, nutrients, pathogens and debris during rainfall events.

Many of the region's rivers, creeks and estuaries are suffering from poor water quality, particularly due to increased sediment and nutrient loads. In the Richmond River catchment, poor geomorphic condition has been directly linked to poor water quality, and poor condition of macroinvertebrates and riparian vegetation.[7] Only 18% of waterways in the Far North Coast region are in good condition. The remainder are either in moderate (53%) or poor condition (29%) (Figure 7). Catchment health monitoring programs conducted across the region note exceptionally high turbidity and nutrient concentrations for many rivers and creeks in the region but particularly in the Richmond River catchment.
The recent floods in the Far North Coast region have significantly affected the geomorphology of the region's rivers. These changes will take time to stabilise and will worsen water quality in the meantime. Low dissolved oxygen and acidic conditions are also known to have caused many fish deaths in the Richmond River.

The condition of riparian (streambank) vegetation is generally low across the region, except in protected or forested areas. This is due to weed infestations, vegetation clearing and access by livestock, which lead to large areas devoid of native vegetation or with poor vegetation diversity.[8] These factors also lead to reduced structure – such as leaf area and canopy height – and small, isolated and poorly connected patches of native vegetation. Most estuarine reaches are in poor condition and are dominated by riverbanks with little or no vegetation. The erosion caused by the recent flood events in the region will provide ideal conditions for new weed infestations in the short term.

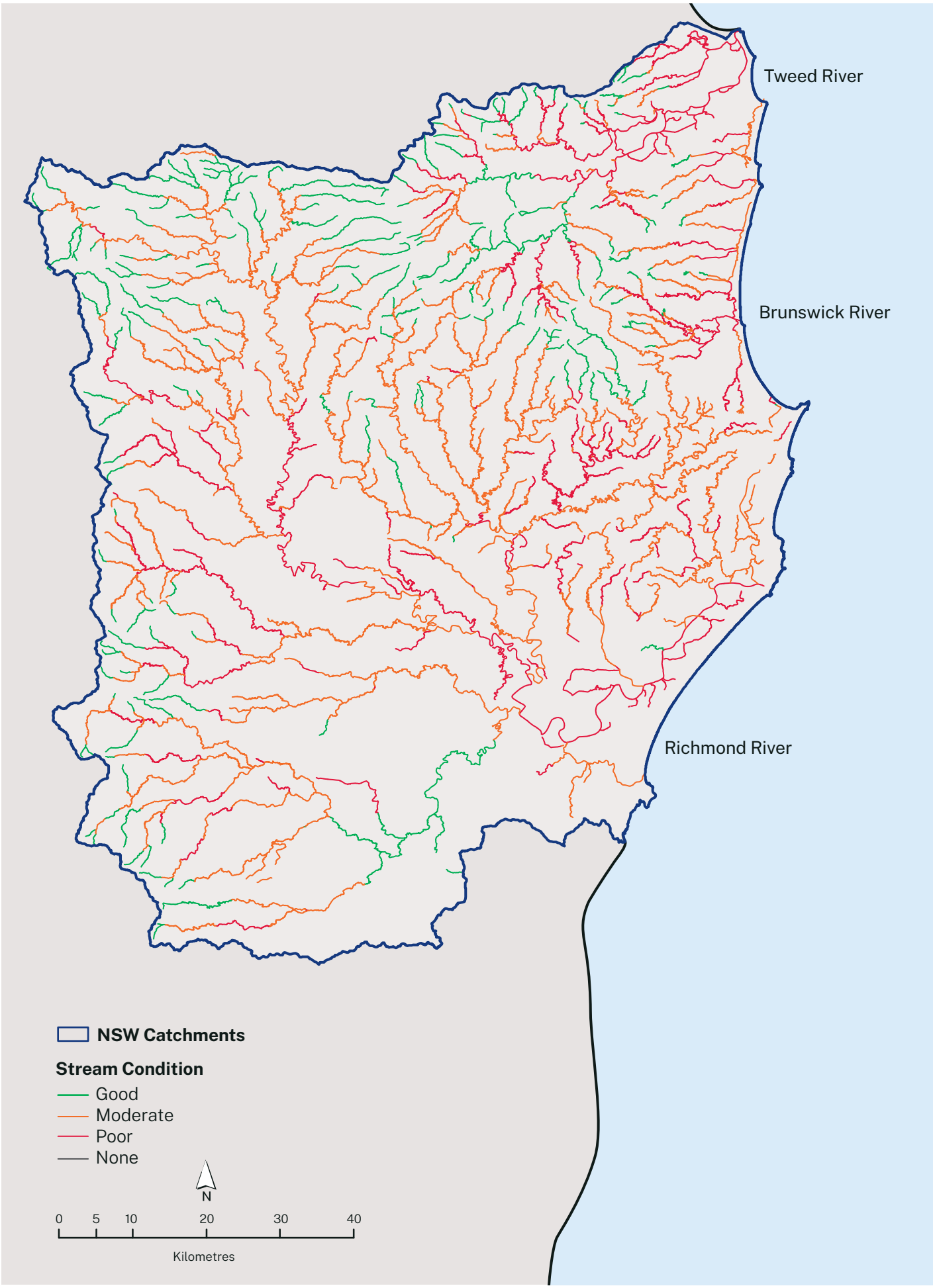
As a result of land use changes, water now moves more quickly and with more energy through the region's catchments than in its natural state. This fast-moving water further erodes land and waterways, reduces water quality and leads to less water stored in the landscape. Stock access to the region's rivers and creeks also contributes to bank erosion, water pollution and increased sediment inputs.

The impacts of land use change are heightened during the extreme rainfall events that are characteristic of the Far North Coast region. Runoff generated during these events is typically high in nutrients and sediment, causing elevated nutrient loads and smothering vegetation, and subsequent deoxygenation and further release of nutrients. These impacts can lead to increased river toxicity and subsequent fish deaths.

Some local councils find it difficult to treat water when turbidity is high. Feedback from the public consultation and engagement with Aboriginal communities on the *Draft Far North Coast Regional Water Strategy* also noted significant concern about the continued impact of catchment land use on the quality of the region's highly valued waterways.

7. Ryder, D., et al. 2015, *Richmond Ecohealth Project 2014: Assessment of River and Estuarine Condition – Final Technical Report*, www.ipart.nsw.gov.au/
8. Ryder, D., et al. 2015, *Richmond Ecohealth Project 2014: Assessment of River and Estuarine Condition – Final Technical Report*, www.ipart.nsw.gov.au/

Figure 7. Distribution of poor and moderate river reaches across the Far North Coast region



Poor management of fertiliser could be increasing nutrient loads in the region's waterways

Some crops that traditionally have not been fertilised are now being fertilised to increase yields. One example is macadamia plantations in the region, which are increasingly being fertigated.[9] Use of best practice fertiliser management helps prevent increased fertiliser use. This can prevent increased nutrient levels in downstream waterways and declines in water quality.

Current governance arrangements are inhibiting catchment-scale decision-making, planning and project delivery

Responsibility for managing water quality impacts is shared across several state and local government agencies. We lack an overarching framework for managing water quality and waterway impacts. This impedes planning, multi-actor collaboration, coordination and reconciliation of state and local priorities. It also:

- impacts the development and delivery of environmental catchment programs at different scales
- makes it difficult to ensure that both drainage management and environmental water quality and quantity needs are met throughout the catchment.

We have heard that a lack of social willingness of users and landholders, together with complicated natural resources regulation, is also reducing uptake of best practice.

Image courtesy of iStock. Byron Hinterland, Byron.

9. Fertigation is the practice of injecting fertilisers into an irrigation system

Declining quality and quantity of freshwater inflows to coastal systems is affecting estuarine health

Our new climate data and hydrologic modelling show that the annual volume of flows in the Far North Coast region catchments may decrease by about 4–16%, and that all parts of the flow regime may be impacted (Figure 8). Reductions in flows would affect sediment and nutrient transport, system flushing, and limit the number of events that trigger fish movement and spawning. These reductions may also impact salinity gradients and circulation patterns, detrimentally impacting estuarine ecology, particularly in the tidal pools at the upper limits of the estuaries. Freshwater inflows are needed to support the health and function of estuaries.

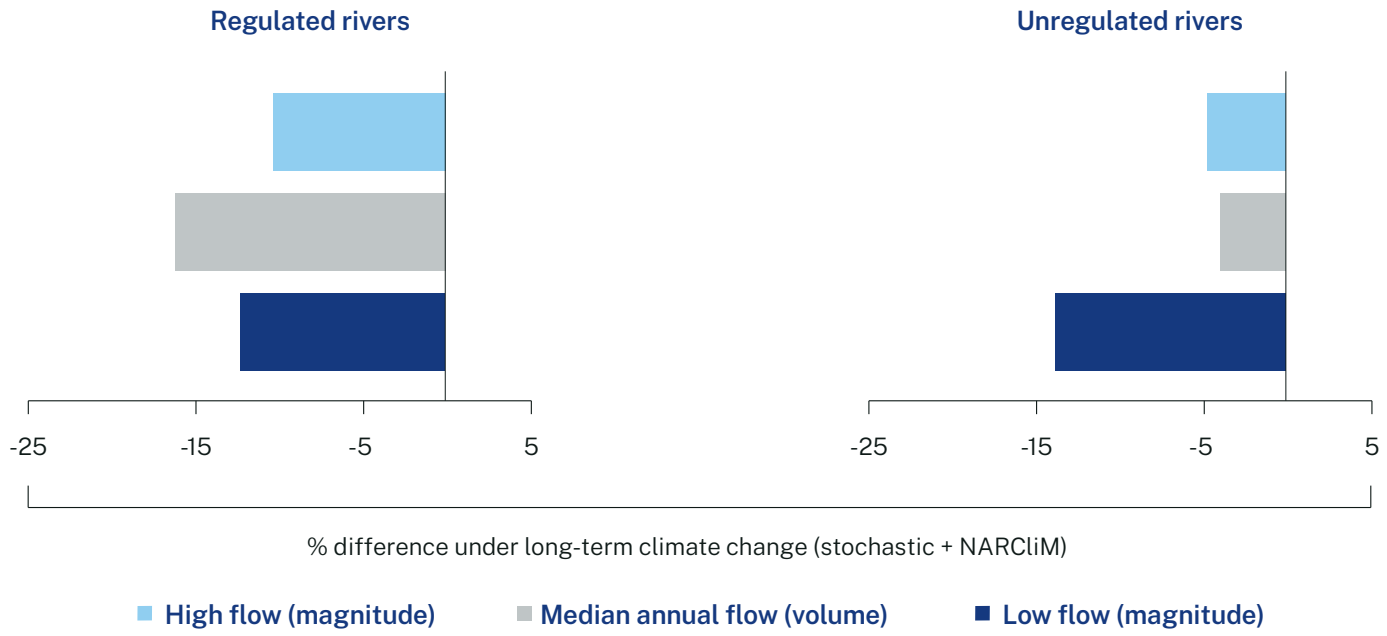
These inflows help maintain low salinity levels and mobilise the nutrients, sediment and pathogens needed to support habitat diversity and productivity.

Intermittently closed and open lakes and lagoons are particularly sensitive to modified freshwater flows, which can significantly impact water quality, geomorphology and entrance opening regimes. They can also impact the health and extent of mangroves, saltmarsh and seagrass, which are important fish habitats.

To help address these issues, the Marine Estate Management Strategy has flagged the regulation and extraction of freshwater flows as a priority threat.

The quality of freshwater inflows is also important to estuarine health and the communities and industries they support. For example, poor water quality and smothering by fine sediments have led to low numbers and diversity of fish, shellfish and crustaceans in the Richmond River system.[10]

Figure 8. Impacts of climate change on the flow regime – regulated and unregulated rivers[11]



10. Ryder, D., et al. 2015, *Richmond Ecohealth Project 2014: Assessment of River and Estuarine Condition – Final Technical Report*, www.ipart.nsw.gov.au/
11. Similar trends are also likely to be seen in estuary inflows. See Department of Planning, Industry and Environment 2020, *Draft Regional Water Strategy — Far North Coast: Strategy (PUB20/307)*, water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/far-north-coast-regional-water-strategy

Instream structures are impacting natural flow regimes, aquatic health and fish movement

Although most rivers in the Far North Coast region are unregulated, there are still many instream structures that control and modify flows and drainage. These structures alter the natural flow of rivers and streams, and their associated floodplains and wetlands, and contribute to the loss of biodiversity and ecological function of waterways. Instream structures – such as dams, weirs, culverts, navigation locks and floodgates – can be significant barriers to native fish migration.

Instream structures can also adversely affect water quality in the Far North Coast region. Floodgates and other drainage infrastructure can cause blackwater (deoxygenated water) events that lead to large numbers of fish deaths. Cold water pollution from dams and weirs can negatively affect aquatic organisms and ecological processes. Cold water pollution has been flagged as a possible issue in the region, primarily at Toonumbar Dam.

Species known to be directly affected by instream structures and their operation include the endangered eastern freshwater cod (*Maccullochella ikea*) and southern purple spotted gudgeon (*Mogurnda adspersa*). Other coastal fish species potentially impacted by barriers to fish passage include freshwater catfish (*Tandanus tandanus*), diadromous species such as freshwater herring (*Potamalosa richmondia*) and short-finned eel (*Anguilla australis*), and high recreational value species such as Australian bass (*Macquaria novemaculeata*) and estuary perch (*Percalates colonorum*). Government programs have been addressing this through fish restocking programs and actions to progress fish passages on weirs.

Many other protected or unlisted species of invertebrates and mammals can also be negatively affected by instream structures.

Image courtesy of iStock. Tweed River, NSW.

Image courtesy of iStock. Brunswick River, NSW.

Challenge: Competition for low flows

Competition for water during low flow periods is restricting access for landholders and industries and placing many of the region's waterways under stress.

There is generally enough water across the Far North Coast region to meet urban and rural water demands each year, on average. However, competition for low flows during the drier spring months places many of the region's rivers and creeks under increased hydrologic stress. Competition for low flows is likely to increase in the future with projected climate change. Our new modelling suggests that extended droughts could be more frequent and more severe in the future. Rainfall-reliant agriculture will become more dependent on surface water and groundwater sources.

Low flows are needed to maintain connectivity between river pools, to provide riffle flow and aeration, and to provide freshwater inputs to sensitive estuaries and intermittently closed and open lakes and lagoons. These river functions are critical in supporting river and ecosystem health, and water-dependent industries.

Competition for low flows also impacts groundwater systems. Many of the region's alluvial and coastal sand groundwater systems are highly connected to surface water flows and reductions in surface flows can affect recharge rates. This impacts both the health of groundwater dependent ecosystems and consumptive users of groundwater.

Competition for water also negatively affects the reliability of water accessed for irrigated agriculture. Unreliable water supplies can seriously threaten the long-term viability of existing industry and discourages future investment in emerging industries.

Catchment conditions and limited data are constraining our ability to set effective rules to manage competing demands for low flows

Protecting low flows reduces the stress on the region's rivers and protects water for downstream users. Currently, we protect these low flows with cease-to-pump rules. These rules require licenced water users to stop taking water under low flow conditions and are based either on gauged flow rates or visible flow conditions and daily extraction limits.

A lack of stream gauging has made it difficult to effectively implement cease-to-pump rules. Sand-dominated coastal streams are not suited to conventional stream gauges and identifying reliable long-term gauging sites is difficult. Gauging stations are also expensive to install and maintain. To get adequate coverage across all streams where extraction occurs would require many new gauges. Consequently, augmenting the coastal gauging network would come at a considerable cost to water users. This may be difficult to justify given the low level of extraction that takes place, particularly compared to inland regions.

Visible flow rules were adopted in many of the small unregulated coastal catchments in the region to manage these challenges. However, visible flows have been criticised for being subjective. Often they are so low that they do not provide sufficient protection for environmental assets.

Daily extraction limits are another tool for addressing competition for water. They permit water users to take a proportion of the daily flow at a particular site, leaving enough water for the environment and downstream users. However, implementing daily extraction limits takes considerable resources, including stream flow gauges, water meters and coordinated rostering among users.

Growth in harvestable rights dams and water extraction under basic landholder rights places additional pressure on low flows

The protection of low flows can be compromised by water take that does not require licensing and approvals. This is particularly true where there is significant take-up of both harvestable rights and basic landholder rights within a catchment.

Harvestable rights allow landholders to intercept a percentage of average regional rainfall-runoff from their property and store it in one or more farm dams without a water access licence, water supply work approval or water use approval. Many landholders in coastal areas have sought the right to take and store more water during wet periods to improve their preparedness for dry periods. However, a range of stakeholders are also concerned about the impact this may have on freshes and low flows in downstream rivers and creeks.

Harvestable rights dams do not require a licence, so we have a limited understanding of their current level of water take, and their impacts on the environment and licensed water users. Additionally, many harvestable rights dams in the region have been found to be significantly larger than the permissible size. This could be negatively affecting baseflows to downstream waterways. Changes to harvestable rights in coastal-draining catchments announced in October 2021 will allow an increase in the proportion of average regional rainfall-runoff that may be harvested from 10% to 30%, subject to limitations and mitigation measures intended to minimise effects on low flows. Further detailed catchment analysis in 2022 will confirm the suitability of these changes to harvestable rights.

We have heard that growth in water extraction for domestic and stock purposes under basic landholder rights is also increasing competition for water at low flows. This is particularly so for rural residential sub-divisions with waterway frontage. Water extraction for basic landholder rights is not regulated. There is no limit on the volume of water that may be taken nor guidelines about how the right can be used, although basic landholder rights cannot be traded. Consequently, increases in these rights could compromise the effectiveness of any cease-to-pump conditions aimed at protecting the environment and downstream users. Under the NSW Water Strategy, we will review how domestic and stock basic landholder rights are regulated. This will include estimating the quantity of water extracted under these rights.

The low number of metered pumps makes it difficult to understand the extent of low flow competition and to manage water sharing among users

Protecting low flows requires water users to comply with the rules. However, very few pumps for surface water or groundwater are metered. This makes it difficult to ensure water is extracted legally and shared equitably during low-flow periods. In some parts of the region, water sharing arrangements and compliance with cease-to-pump rules is managed through community-operated water user associations. However, management is difficult without meters or adequate stream gauging.

Challenge: Saltwater intrusion into freshwater sources

Sea level rise, groundwater extraction and changes in catchment hydrology are projected to negatively affect coastal waterways and aquifers. We need to better understand the magnitude of this threat and how best to manage it.

Global sea levels are rising, mostly from increasing greenhouse gas concentrations in the atmosphere and associated glacial and ice sheet melt.[12] Between 1966 and 2009, sea levels around the coastline of Australia have risen at an average rate of 1.6 mm/year,[13] which equates to approximately 7 cm over the past 50 years. Rising sea levels will result in saline water migrating upstream and saltwater intrusion in many of the region's groundwater and low-lying water sources. Increased water salinity may negatively affect:

- coastal wetlands, and freshwater and estuarine habitats such as mangroves that are critical for fauna breeding and recruitment
- town water security and water users who currently access and rely on freshwater close to, or within, current tidal limits
- Aboriginal communities' abilities to practice culture and protect important cultural sites and assets.

The magnitude of sea level rise and its effects will vary by location due to geological factors, ocean currents and localised thermal expansion or contraction of oceans. The extent to which sea levels rise will also depend on how much greenhouse gas emissions are reduced in the coming years.

The average projection for sea level rise along coastal NSW is between 0.30 m and 0.45 m.[14] For the Far North Coast region, the average projection is between 0.24 m and 0.58 m by 2070 (Table 1).

Larger sea level rises are possible beyond these scenarios. The Intergovernmental Panel on Climate Change states that sea level rise will continue for centuries to millennia due to continuing deep ocean warming and ice sheet melt, and the likely global mean sea level rise by 2100 could be up to nearly 2 m (for a very high greenhouse gas emission scenario). Storm surges may also contribute to higher sea levels during the more frequent and intense low-pressure systems caused by climate change.

The frequency and severity of effects from sea level rise, saltwater intrusion and altered catchment hydrology are likely to worsen as growing populations and industries increase the demand for freshwater in coastal areas.

12. Oppenheimer et al. 2019, *Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities*. In Pörtner et al. (Eds.), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*, Intergovernmental Panel on Climate Change.
13. Siebentritt, M. 2016, *Understanding sea-level rise and climate change, and associated impacts on the coastal zone*, CoastAdapt Information Manual 2, N*ational Climate Change Adaptation Research Facility*, Gold Coast. Available at: coastadapt.com.au/sites/default/files/information-manual/IM02_Understanding_sea_level_rise.pdf
14. CoastAdapt 2017, *Sea-level rise and future climate information for coastal councils*, accessed 14 July 2020 from coastadapt.com.au/sea-level-rise-information-all-australian-coastal-councils

Table 1. Sea level rise projections for the Far North Coast region[15]

Year	Low emissions scenario (RCP4.5) [m]	Very high emissions scenario (RCP8.5) [m]
2030	0.14 (0.09–0.18)	0.14 (0.09–0.18)
2050	0.24 (0.17–0.32)	0.27 (0.19–0.35)
2070	0.36 (0.24–0.48)	0.44 (0.31–0.58)

Notes: Values are averaged, with the likely range provided in brackets.
Projections are relative to an average calculated between 1986 and 2005.
RCP = representative concentration pathway

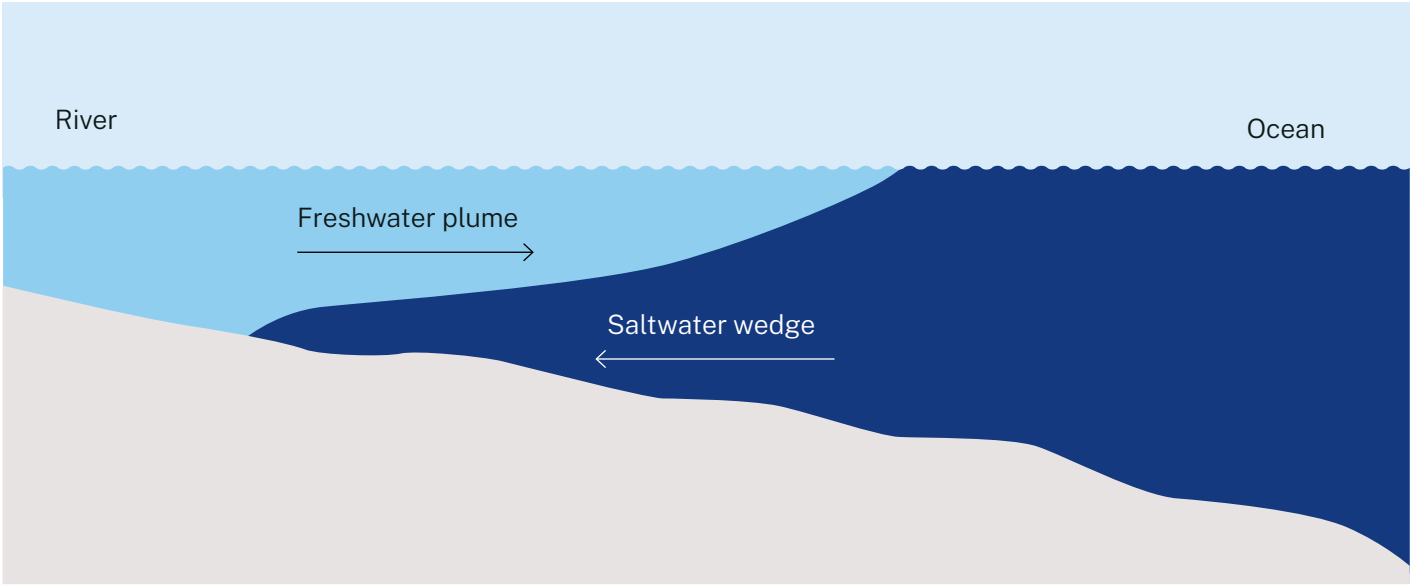
Possible reductions in river flows are likely to increase the effects of sea level rise

Many of the Far North Coast region's rivers have a maximum high-tide footprint that extends far upstream, including a 90 km tidal influence for the Richmond River. Sea level rise is likely to cause estuarine zones to migrate further upstream. Other climate change impacts on coastal estuaries are expected, mainly due to the reduction in the magnitude of freshwater inflows and increased frequency of cease-to-flow events. We expect this will have other negative effects.

During low-flow and cease-to-flow events, salinity gradients in tidal pools change as freshwater entering estuaries is either reduced or stops (Figure 9). This change allows the saltwater wedge that usually sits below the freshwater in tidal pools to move further upstream.

Our modelling shows that median annual flows in the region's rivers could decrease by up to 16% under a worst-case climate change scenario, with the potential for flows into the region's estuaries decreasing by 33%. The most significant reductions in flow are likely to occur in the Richmond River catchment. Cease-to-flow events are likely to occur more often, with the largest increases occurring at the Tweed River estuary (up to 13%).

Figure 9. Concept of a tidal saltwater wedge in a permanently open estuary[16]



15. CoastAdapt 2017, *Sea-level rise and future climate information for coastal councils*, accessed 14 July 2020 from coastadapt.com.au/sea-level-rise-information-all-australian-coastal-councils
16. Adapted from Hurdle, J. 2020, *As Sea Levels Rise, Will Drinking Water Supplies Be at Risk?*, Yale School of the Environment, e360.yale.edu/features/as-sea-levels-rise-will-drinking-water-supplies-be-at-risk

Saltwater intrusion in freshwater and estuarine systems – and the associated increase in salinity levels – is a significant risk to water users in low-lying areas across the region. Freshwater extraction from below the tidal limit accounts for a large portion of entitlement volume in the region. As such, even a small rise in sea level will reduce the suitability of water sources for local town water supplies, irrigation, dairy washdown, and stock and domestic supplies. It may also compromise water and wastewater treatment plant infrastructure.

Sea level rise is likely to negatively affect coastal environments such as low-lying coastal wetlands. These environments – an example of which is Tuckean Swamp – would become inundated for longer or, at the most extreme, inundated permanently. The Marine Estate Management Strategy recognises this as a key threat to the NSW coastal, estuarine and marine environment and has identified several actions that prepare the region to manage this risk. These actions include on-ground activities that provide habitat protection and rehabilitation to help mitigate the impacts of climate change. They also include tools that will help industry and the community better understand future impacts.

Plans and strategies for water resources in the region need more up-to-date information on climate change to better manage the future impacts of sea level rise. For example, the hydraulic models developed for the Richmond River catchment for the Marine Estate Management Strategy considered sea level rise and saltwater intrusion but did not consider the impacts from changes in freshwater inflows due to climate change.

It is critical that we form a clearer regional picture of the combined effects of changes to catchment hydrology and sea level rise. This will help us develop appropriate local management responses.

Sea level rise is likely to increase the risk of saltwater intrusion into groundwater, particularly for low-lying areas with high volumes of extraction

Saltwater intrusion into groundwater is caused by sea level rise and over-extraction of groundwater and freshwater. Areas where groundwater and surface water systems are highly connected are particularly vulnerable. The intrusion of saltwater into groundwater affects ecosystems and town water security by significantly degrading water quality and reducing freshwater availability.

Groundwater sources that are vulnerable to saltwater intrusion across the Far North Coast include coastal sands and floodplain alluvials. These groundwater sources are important to industries and for stock and domestic use across the region. Around 4,300 ML of water entitlement is issued in alluvial water sources across the region and about 2,750 ML is issued in coastal sands aquifers.

Climate-related salinity problems have already been experienced in the Richmond River catchment. During the Millennium Drought, flows into the tidal pool were very low and the saltwater/freshwater interface migrated a significant distance upstream. This caused large increases in salinity in the tidal pool and prevented water extractors from pumping at certain times.

We currently manage the impacts of saltwater intrusion by ensuring coastal aquifers are not over-extracted. This is done mainly by controlling licensed extraction and managing water levels in areas of high extraction.

Challenge: Aboriginal people's rights and access to water

Historical dispossession of land, effects of colonisation and government water management processes continue to impact Aboriginal people's access to water and their ability to care for Country.

The people of the Bundjalung and Githabul nations have been the custodians of the lands and waterways in the Far North Coast region for tens of thousands of years. Water is deeply entwined with Aboriginal culture. Healthy waterways are essential to the culture and wellbeing of Aboriginal communities across the Far North Coast region, providing food, kinship, connection, recreation, stories, songlines and healing.

> *'Water is not a resource – it's a source of life... Clean water is caring for country.'*
>
> *(Arakwal people, Draft Far North Coast Regional Water Strategy consultation, 2020).*

Aboriginal people have lost access to waterways

The historical dispossession of land and the effect of colonial-era settler laws continue to affect the ability of Aboriginal people in the Far North Coast to access water and to care for Country. Fences and locked gates on public land such as Crown land and State Conservation Areas prevent Aboriginal people from accessing Country, carrying out cultural practices and using traditional knowledge to care for and manage land and waterways.

Water infrastructure, modifications made to waterways, and poor land management and land use practices negatively affect important cultural sites and traditional water and food sources. Access to Country and waterways and the important sites they hold is critical to providing a purpose and pathway for young people to connect to culture. These sites provide spaces for healing, as well as for food, medicine, and teaching.

Governments are already taking steps to address this. For example, the National Parks and Wildlife Services is developing a new model for Aboriginal joint management of the NSW national parks estate. It is anticipated the new model will provide for the potential handback of title to all NSW national parks – covering nearly 10% of the State – over a 15 to 20-year period, subject to the land being leased back (long-term and for nominal rent) to the NSW Government for its continued use and management as national park.

Aboriginal communities in the Far North Coast region want a 'seat at the table' when it comes to decision making

Current water legislation and water management processes do not adequately bring the Aboriginal people in the Far North Coast region into decision making, nor do they fully reflect Aboriginal perspectives, approaches and values. These processes also do not draw on the knowledge that the Aboriginal people in the region have of their traditional lands, water bodies and the flora and fauna that inhabit them. This is made worse by the limited involvement of the Aboriginal people in water consultation processes. Most often this lack of involvement has been because:

- There is a lack of trust in governments. Historically, governments have not engaged thoroughly in water and natural resource management in the region, nor have they followed through on previous commitments.
- Consultation timeframes and processes around water policy changes do not allow the time needed for Aboriginal cultural governance processes.
- The state and federal laws and systems around water and natural resource management are complex. They do not match well with Aboriginal perspectives and are often not clearly explained.
- Aboriginal groups lack resources and support to drive their engagement in water management. Often, Aboriginal people, as well as individual members of the broader community, need to give up personal time and resources to have a say in water consultation processes.

The Aboriginal people in the Far North Coast region want a 'seat at the table' when it comes to decision making, both at the state and local levels. Government needs to develop a collaborative, culturally-sensitive approach that is appropriate for Aboriginal communities. This means working with Aboriginal communities to develop governance structures that are familiar to them, and setting aside adequate time to engage, consult and genuinely listen to Aboriginal people. These investments in time and resources will help build respect and trust between all parties. They will also help identify the different needs, challenges and interests of each Aboriginal community.

This model can benefit both Aboriginal communities and government by:

- offering the Aboriginal people in the Far North Coast region the opportunity to improve outcomes for Country and for their communities
- improving natural resources management with the rich and holistic approach to water and land management that Aboriginal people have been practicing for thousands of years.

Image courtesy of Destination NSW. Tweed Eco Cruises, Tweed Heads.

Challenge: Water security for industries in the Far North Coast

The viability and growth of regional industries is constrained by the uncertainty of future access to secure water supplies.

Water-dependent industries are facing an uncertain future in the region due to climate variability and climate change. New modelling shows that the reliability of existing water access licences is likely to be less than we originally thought and may reduce in the future. Saltwater intrusion also threatens existing supplies of high-quality surface water in low-lying areas close to the coast and coastal groundwater systems.

We have also heard that existing and prospective Far North Coast region businesses find it hard to gain access to additional water to mitigate these risks or support new or expanding industries.

There is limited stored water or alternative sources of water to meet irrigation demands, particularly during drought

Historically, there has not been a need to store large volumes of water for irrigation across the Far North Coast region. Traditional crops were rain-fed and only required irrigation during the drier spring months. For most landholders, the costs of constructing, maintaining and operating farm dams and the additional pumping infrastructure was not economically viable.

The 2018–2020 drought highlighted a need to shift from a reactive to a proactive management approach to weather extremes. It showed that the crops currently grown in the Far North Coast region, particularly the more recent horticultural crops, are vulnerable to extended dry periods.

Our modelling shows that dry periods are likely to increase in frequency and intensity and traditional surface water sources may be less reliable than we thought. For example, 2018–20 was the driest 2-year period on record. Over this time only 13.9 GL water flowed into Toonumbar Dam. Our modelling suggests that the probability of these low inflows occurring again over a 24-month period is about 2.5%. This equates to roughly a one in 40-year event based on the long-term climate projection. This probability increases to about 8.5% – or a one in 11-year event – if the worst-case climate change scenario from our modelling eventuates.

Currently, there are few alternative water sources available in the region that are readily accessible and able to mitigate the water security risks of drought.

Groundwater is often considered an emergency supply of water during drought. For the Far North Coast region, the interconnectivity between surface water and many of the region's groundwater sources means that reductions in surface water flows – from changes to rainfall during periods of drought as well as from over-extraction – can deplete groundwater yields.

Water extraction limits are restricting development opportunities in unregulated catchments

Water sharing plans set limits on how much water can be extracted annually from the region's water sources through long-term average annual extraction limits (LTAAELs). LTAAELs aim to balance long-term reliable access to water with protecting the environment.

Surface water and alluvial groundwater LTAAELs in the Far North Coast region reflect the sum of licensed volumes and estimated basic landholder rights at the time the water sharing plan was originally made. As such, no new water access licences can be issued to surface water sources, even if they would not cause water extractions to exceed long-term sustainable limits.

The region's groundwater LTAAELs vary by aquifer and are based on the calculation of several key components, including groundwater recharge, risk assessments, planned environmental water, and current and future water requirements. Unassigned water exists in these sources because the LTAAELs still exceed the total volume of water access licences and basic landholder rights. Acknowledging this, the NSW Government has made shares available in these groundwater sources through a controlled allocation process each year since 2017. Future controlled allocations will be made in accordance with the *Strategy for the controlled allocation of groundwater*.[17]

We have also heard that agricultural production in the Far North Coast region is constrained by existing harvestable rights limits. Harvestable rights apply to coastal-draining catchments and allow landholders to collect a proportion of the average regional rainfall-runoff from their property in one or more dams on non-permanent, mapped minor streams, or unmapped streams. This is allowed without a water access licence, water supply work approval or water use approval.

Some water users have advocated for increases in harvestable rights to support commercial enterprises and believe that this could be done while still maintaining a sustainable level of access for downstream users. The recently announced increase in the harvestable rights limit in coastal-draining catchments recognises the strong interest received from some water users for the need to improve water security for stock and domestic and basic farming use during extended dry periods, and to ensure water for firefighting. It excludes the use of this water for intensive agricultural uses such as horticulture and aquaculture.

Water users are not taking up opportunities in water sharing plans to access water

For water sources where no additional licences can be allocated, access to additional water can occur through permanent or temporary trade of existing water access licences, in line with water sharing rules. The rules aim to maximise flexibility for water users without negatively affecting the environment or the reliability of other water access licences.

Although trade is allowed and annual water usage in most areas is generally well below LTAAELs, very little trade occurs in the region's catchments. There are no examples of temporary trades and only one example of a permanent trade. Water users have noted many barriers to trade, including lack of meters, restrictive trade rules and limited market information.

Water sharing plan rules allow for low-flow to high-flow conversions in many Far North Coast region water sources. Although the main intent of these conversions is to protect low flows, they also allow landholders to access a greater volume of water during high-flow periods to store for later use. In theory, this approach could also provide landholders with more water to support expanded operations. However, licence holders in the region have not taken up conversions to high-flow access.

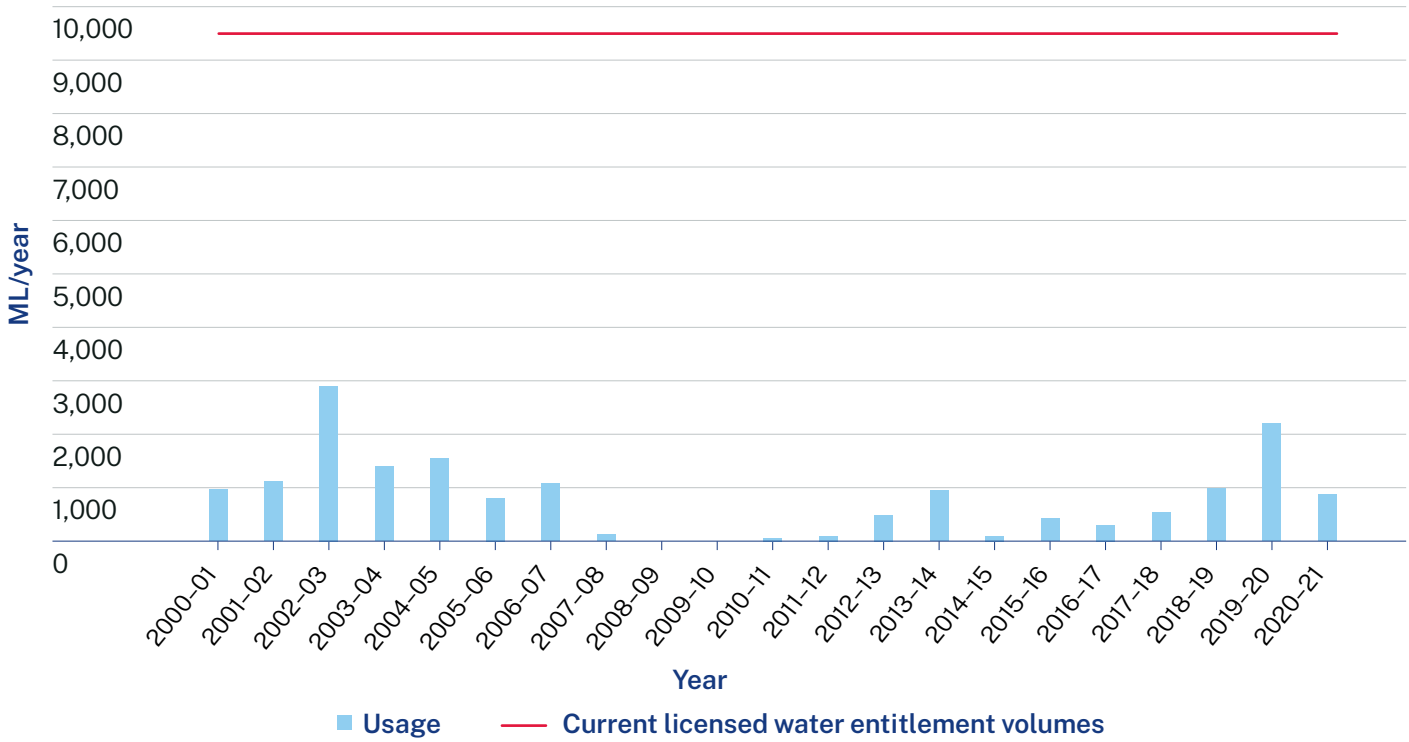
17. Department of Primary Industries – Water 2017, *Strategy for the controlled allocation of groundwater*, NSW Government, www.dpie.nsw.gov.au/__data/assets/pdf_file/0005/159170/Strategy-for-the-controlled-allocation-of-groundwater.pdf

Water entitlements in the Richmond River regulated system are underutilised

Toonumbar Dam stores around 11 GL water and supplies a small number of agricultural producers. It has historically filled to capacity in most years. The dam is very underused, mostly because the region has high rainfall and supports cropping with relatively low irrigation demand (see Figure 10). This means Toonumbar Dam is used primarily to manage droughts.

Water prices across the region for both regulated and unregulated sources are some of the highest in NSW. This can make it difficult for producers to afford water when they need it. The cost of water increases with decreasing water use because it becomes more difficult for WaterNSW to recover the costs of operating Toonumbar Dam. Consequently, WaterNSW operates the dam at a loss, despite water charges being high compared to other large regulated systems in NSW.

Figure 10. Water usage from Toonumbar Dam between 2000–2021



Challenge: Water security for towns and communities in the Far North Coast

The reliability of existing town water supply sources could decrease with population growth and projected climate change.

Population growth is putting pressure on town water supply systems in the Far North Coast region. Extended dry periods as a result of climate variability and projected climate change could increase the risks to these systems.

There are risks to town water supplies during extended dry periods

The new long-term climate data shows risks of extended droughts are greater than previously thought. Climate change is also likely to lead to future reductions in winter rainfall and higher temperatures. This may result in a reduction in overall water availability and an increase in evaporation from storages.

Over the next 40 years, population growth in the Far North Coast is likely to have a greater impact on water supply security than climate change. The population of towns across the Far North Coast coastal fringe is projected to increase significantly. This increase in demand will put more pressure on reticulated town water supplies during dry periods. Rural users (unconnected residents) can put extra pressure on town water supplies during intense dry periods as they often need to cart in water to replenish their own domestic supplies. This can increase overall demand on town water supplies even though water restrictions may be reducing use in urban areas.

Our modelling suggests that the risks to town water supplies in the Far North Coast region occur mostly during extreme dry periods. This is of particular concern for the Rous County Council and Tweed Shire Council water supply systems because they service large populations and the consequences of shortages could be severe.

Levels of risk to town water supplies are uncertain

In the Far North Coast region, climate and population are the variables that most profoundly affect town water supply systems. Future changes to both of these are very uncertain. The future state of the climate will depend on global emissions and the policies of governments and other actors around the globe. Uncertainty in the future population of the Far North Coast region has led the NSW Government and local government authorities to estimate different rates of population growth. There is currently no way to calculate the likelihood of any of these different states occurring – they are all plausible futures, the trajectories of which will become clearer only with time.

The modelling completed for the Far North Coast Regional Water Strategy has tested many different climatic conditions, as well as both state and local government population projections. This modelling has given us a much better understanding of multiple plausible futures. For most communities, the modelling suggests that the current water supply systems across the Far North Coast region perform well across a broad range of climatic conditions and population estimates. However, shortfalls are possible, particularly in the worst-case scenarios.

Importantly, the models that we use for this analysis consider unrestricted supply. That is, they do not account for water restrictions during drought. However, water restrictions are known to play a vital role in reducing the risk of shortfalls. This means that the current framework of water restrictions, water efficiency and conservation measures can go a long way to reducing these risks. While risks to future water supply still remain, local councils are managing these risks as part of their core business.

Local councils need more support to diversify town water sources

Coastal aquifers are important in helping to provide a source of reliable water during droughts and can produce good-quality, high-yielding groundwater for the Far North Coast region. However, these coastal aquifers are vulnerable to contamination and are coming under increasing pressure from growing coastal populations, such as the growing regions of Alstonville, Ballina and the Tweed coast. Concurrent growth in local industries has also placed pressure on groundwater sources such as the Alstonville Basalt Plateau, Richmond Coastal Sands and North Coast Volcanics groundwater sources. As a result, these coastal aquifers require careful management to ensure reliable groundwater sources are available for the Far North Coast region when they are needed most.

We have a limited understanding of coastal groundwater systems. In particular, we have knowledge gaps on aquifer capacities and on how much groundwater users can rely on these resources during dry periods. Rous County Council is looking to expand its groundwater supplies as part of its new integrated water cycle management strategy. However, our limited understanding of groundwater systems in the region may be limiting our capacity to secure essential supplies.

Other water sources such as purified recycled water for drinking can also be challenging to implement. Studies from across the globe have shown that one of the major hurdles to implementing potable reuse schemes is community acceptance. In some parts of the Far North Coast region's communities, public perception of purified recycled water makes acceptance of potable reuse schemes challenging. Additionally, the frameworks that currently govern the treatment and use of purified recycled water for potable use can make it difficult for local councils to pursue reuse as an augmentation option.

Any future decision to include purified recycled water would be subject to community consultation and require stringent government approvals.

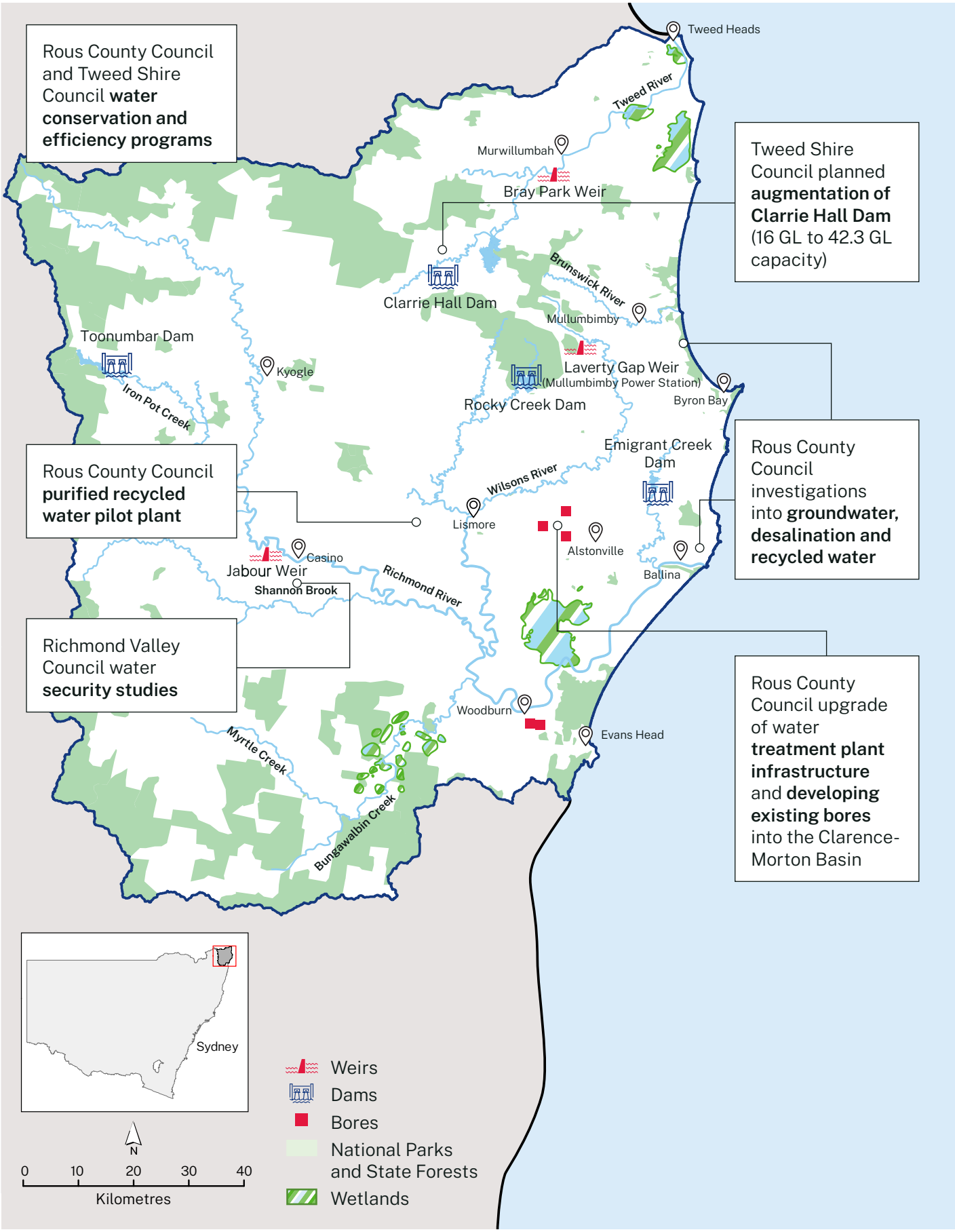
Most local councils have already taken steps to protect town water supplies against dry periods

The 2018–2020 drought highlighted that some of the region's town water supply systems can be put under pressure during drought. Local councils in the Far North Coast region are already taking steps to protect town water supplies from dry periods (Figure 11). Most of the local councils have developed – or are developing – integrated water cycle management strategies for their supplies.

Key initiatives for the region include:

- Tweed Shire Council is planning augmentation of Clarrie Hall Dam (from 16 GL to 42.3 GL capacity).
- Rous County Council is planning an upgrade to the Alstonville groundwater scheme, increasing access to groundwater, and further investigating long-term augmentations, including recycled water and desalination. By 2030, Rous County Council aims to have plans in place for new groundwater sources and to pilot a purified recycled water plant.
- Water security studies are being carried out by Richmond Valley council.
- Water conservation and efficiency programs are being rolled out by Tweed Shire and Rous County councils.

Figure 11. Current town water security initiatives in the Far North Coast



The assessment undertaken for the Far North Coast Regional Water Strategy uses new climate data that differs from the data councils have used to develop their integrated water cycle management strategies. The Department of Planning and Environment is currently working with councils to determine how this new data should be used.

In further developing and implementing the Far North Coast Regional Water Strategy, we need to work with councils to better understand population pressures, including from rural landholders. It is also important to recognise that the integrated water cycle management process will continue to be the key tool for quantifying and addressing town water needs.

Regional solutions for improving access to water for towns are limited

There are several regional solutions that are beyond the capacities of individual councils to implement but that could be considered in integrated water cycle management planning. This can lead to inefficient investment decisions, higher capital and operational costs, and less resilient systems.

Examples of regional-scale augmentations that can benefit multiple local councils include regional desalination, network interconnections and infrastructure sharing.

Image courtesy of Destination NSW. Townships, Casino.

Challenge: Urban flooding risks to individuals, businesses and communities

The complex nature of governance arrangements for flood mitigation may be limiting the capacities of local councils to manage future flood risks.

Floods are an important part of the ecosystem, but they can negatively affect communities

Flooding is a vital, natural process that supports the region's diverse ecosystems. Floods provide significant groundwater recharge events and connections between rivers and their wetlands and floodplains, such as the Tuckean Swamp, Ballina Nature Reserve and Big Scrub in the lower Richmond River. Floodplains and their ecosystems are integral to Aboriginal culture and traditions. Floods are also responsible for the productive soils valued by landholders on the Far North Coast region's floodplains. Flooding is also a key driver of estuarine productivity – it transports carbon and nutrients into the estuary, and provides breeding cues for species such as prawns. This can bring significant economic benefit to local communities.

However, development on the floodplain has meant that floods can have significant impacts on people and businesses – damaging infrastructure, creating safety risks and causing financial and economic loss.

Flooding is a major concern in the Far North Coast region, particularly in the urban areas of the Richmond River catchment. Earlier in 2022 the region experienced the largest and most devastating floods on record. During community consultation in 2020, we heard that the community in the region considers flooding a critical and persistent risk. Climate change is expected to worsen this risk.

Image courtesy of Lori Cameron, Department of Planning and Environment. Brunswick River picnic area, Brunswick Heads Nature Reserve.

2022 NSW Flood Inquiry

In response to the widespread floods in 2021 and 2022, the NSW Government commissioned an independent expert inquiry into the preparation for, causes of, response to and recovery from the 2022 flood events in NSW.[18] The final inquiry report was published in August 2022 and included 28 recommendations. The NSW Government supported all 28 recommendations, either in full or in principle.

Several of the report's recommendations and the NSW Government's response are relevant to the Far North Coast Regional Water Strategy. These include but are not limited to NSW Government in-principle support for:

- building more accurate and complete data for flood threat identification, warning and modelling systems (recommendation 1)
- building on existing initiatives around climate and weather research to identify opportunities to build and align disaster research and technology development (recommendation 2)
- strengthening the delivery of evidence-based, targeted education campaigns aimed at building disaster resilience (recommendation 14)
- developing further essential service infrastructure above the flood planning level, where appropriate (recommendation 28).

The NSW Government responded to the Flood Inquiry on 17 August 2022. The response is available at: www.nsw.gov.au/sites/default/files/noindex/2022-08/NSW_Government_Reponse.pdf

Image courtesy of iStock. Flooding near Lismore, NSW.

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

Limitations of the Richmond River catchment flood model are not well defined

Roles and responsibilities for flood mitigation in the Richmond River catchment are complex. Local councils are generally responsible for managing floods within their boundaries. However, the Richmond River catchment contains 5 local government areas, so implementing an integrated and consistent approach can be challenging. Land use development or geomorphic changes in one local government area can influence flood behaviour in downstream local government areas.

Generally, local councils develop and maintain their own flood models. These models can be useful for localised flood assessments and management actions. However, when several local government areas are located within the same catchment, catchment-scale models become important for assessing mitigation works or large infrastructure proposals.

Rous County Council is the flood-mitigation authority for the Richmond River catchment. One of its core functions is to assist its constituent councils to manage and mitigate flood impacts. It is well placed to manage flood impacts that are catchment-wide and that cross local government area borders.

In 2010, Rous County Council collaborated with the NSW Government on a catchment-wide flood model. However, there are some issues with the model, including its inability to evaluate development and mitigation proposals in the Wilsons River. The limitations of the flood model need to be addressed to ensure we have the best flood management outcomes for the catchment and its communities.

Managing flood risks

Local councils are primarily responsible for managing flood risks in their local government areas. The Department of Planning and Environment is the lead NSW flood risk management agency. It provides technical advice and financial support to assist councils' flood risk management activities. Local councils develop floodplain risk management plans and include measures in their planning instruments to ensure that development is appropriately sited and that controls such as minimum floor levels are complied with. These measures can go a long way towards minimising localised flood threats. The NSW Government provides support through:

- Floodplain Management Program: This program provides financial assistance and technical advice to councils to assist them manage flood risks. Between 2012 and 2020, the NSW Government granted approximately $8 million under this program to councils in the region to help them better understand and manage flood risk in their communities.
- Flood Prone Land Package 2021: Updated guidelines for the consideration of flooding in strategic and statutory land use planning instruments.
- Interagency collaboration: Councils work closely with the Department of Planning and Environment and the State Emergency Service to ensure that land use planning and emergency management processes are in place to protect the community from the impacts of flooding. This includes considering the potential impacts of climate change on flood risk.
- Climate Change Fund: This fund supports projects to improve NSW's resilience to natural hazards and climate risks. As part of the current program, $3 million was granted to Tweed Shire Council for its *Industrial Land Flood Mitigation Strategy*.

Councils are taking steps to address flood risks around Lismore

Rous County Council completed a flood risk management study for Lismore in January 2021. The hydrologic model covered the catchments upstream of Lismore and the hydraulic model extended downstream to Wyrallah in the Wilsons River. Lismore City Council has commenced preparing its flood risk management plan which it expects to complete mid-2023. Lismore City Council is considering nature-based solutions for the upper catchments as one of many flood mitigation measures. In the long-term, nature-based solutions can reduce flood flows into Lismore and can offer other benefits such as improving water quality, and riparian and geomorphic condition.

Risks of sea level rise and climate change impacts on flood behaviour are not fully defined

To understand and manage coastal flooding, we need to consider the additional impacts of climate change and sea level rise on flooding.

Hydraulic modelling for the Richmond and Tweed estuaries is being conducted through the Marine Estate Management Strategy. This modelling considers future sea level rise and saline intrusion to help us better understand the impacts of these issues on flooding. By better integrating hydraulic and hydrologic models with localised flood models, we can improve our understanding of floods under conditions of future sea level rise and climate change.

The regional water strategies cannot provide a comprehensive response to flooding

The role of regional water strategies is to support the delivery of healthy, reliable and resilient water resources that sustain a liveable and prosperous region.

Improvements to flood risk mitigation are being considered through the 2022 NSW Flood Inquiry. The inquiry report and the NSW Government response is available: www.nsw.gov.au/nsw-government/projects-and-initiatives/floodinquiry

A comprehensive response to flooding is outside the scope of the regional water strategies. However, the strategies can support local councils to make targeted flood management improvements.

The strategies can provide state and local decision-makers with technical advice that supports holistic flood management taking place through other channels. Actions such as improving catchment-scale flood modelling (Action 1.11) will give Far North Coast councils the best evidence base to meet the challenges associated with flooding.

Image courtesy of iStock. Boulder Beach, Lennox Head.

Addressing the challenges

4

Image courtesy of iStock. Killen Falls, Tintenbar.

To address the challenges in the Far North Coast region, we have set 3 priorities and have proposed actions under each.

The regional priorities are:

1. Take a holistic approach to land and water management.
2. Ensure water resource development and use is sustainable and equitable.
3. Prepare for future climatic extremes.

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

Image courtesy of iStock. Sugar cane fields, Murwillumbah.

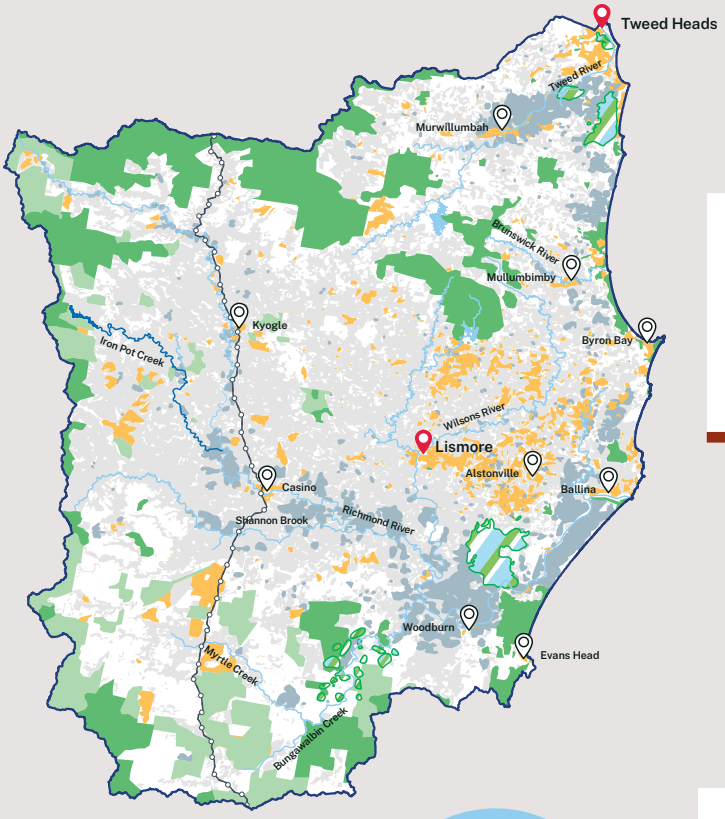
Figure 12. Summary of Far North Coast proposed actions

All water users benefit

- Provide better information about water access, availability and climate risks
- Improve monitoring of water extraction

Aboriginal people

- Greater participation in water management
- Local initiatives to deliver cultural outcomes
- Increased business opportunities



Groundwater

- Impacts of climate change, sea level rise and land use on coastal groundwater sources

Healthy catchments

- Whole-of-catchment governance
- River rehabilitation program
- Improve fish passage
- Implement fish-friendly screens on pumps

Water for the environment

- Sustainable extraction limits for surface water and groundwater sources
- Reduce the take of low flows
- Address impacts of increased harvestable rights limits
- Identify environmental water needs
- Protect ecosystems that depend on groundwater

Industry sustainability

- Increase on-farm water storage
- Adoption of best practice land management
- Enhance coastal water markets
- Investigate a recycled water plan for the Far North Coast region

Water security for towns

- Support local councils to provide secure and affordable water supply systems
- Support adaptive development of the regional water supply system

Sea level rise

- Impact of sea level rise on surface water supplies

Image courtesy of iStock. Tweed River, Murwillumbah.

Priority 1

Take a holistic approach to land and water management

To continue to protect and enhance the region's waterways, groundwater systems and the ecosystems they support, we need to ensure our management systems and decision-making processes use a holistic, whole-of-catchment approach. This approach includes coordinating efforts across stakeholder groups and supporting landholders to build awareness and capacity for best practice natural resource management and sustainable agriculture. Adopting best practice land and water management that considers Aboriginal knowledge and culture, together with science, will be critical to ensuring efforts that protect waterway health are targeted and benefit users at a local, whole-of-catchment and regional scale.

What we have heard so far

- Protecting and enhancing the health of the region's groundwater and waterways is a priority. This can be done by restoring natural flows, reducing the environmental impacts of water infrastructure, and increasing vegetation cover.
- We need to better manage what we do on the land and how we use water to protect rivers, creeks, and groundwater systems. Land and water (both saltwater and freshwater) should not be managed in silos. Governments should incorporate and consider Aboriginal knowledge and culture in management decisions.
- Current knowledge gaps need to be filled and our understanding of flood behaviour, groundwater resources and water use should improve to better manage water in the long-term.
- Landholders, industry and government need to improve their understanding of Aboriginal cultural needs and their importance, and water and land management should better reflect important Aboriginal cultural connections.
- Aboriginal communities need more autonomy and opportunities to care for Country, and want to build more effective relationships with water managers to improve trust and the sharing of knowledge.

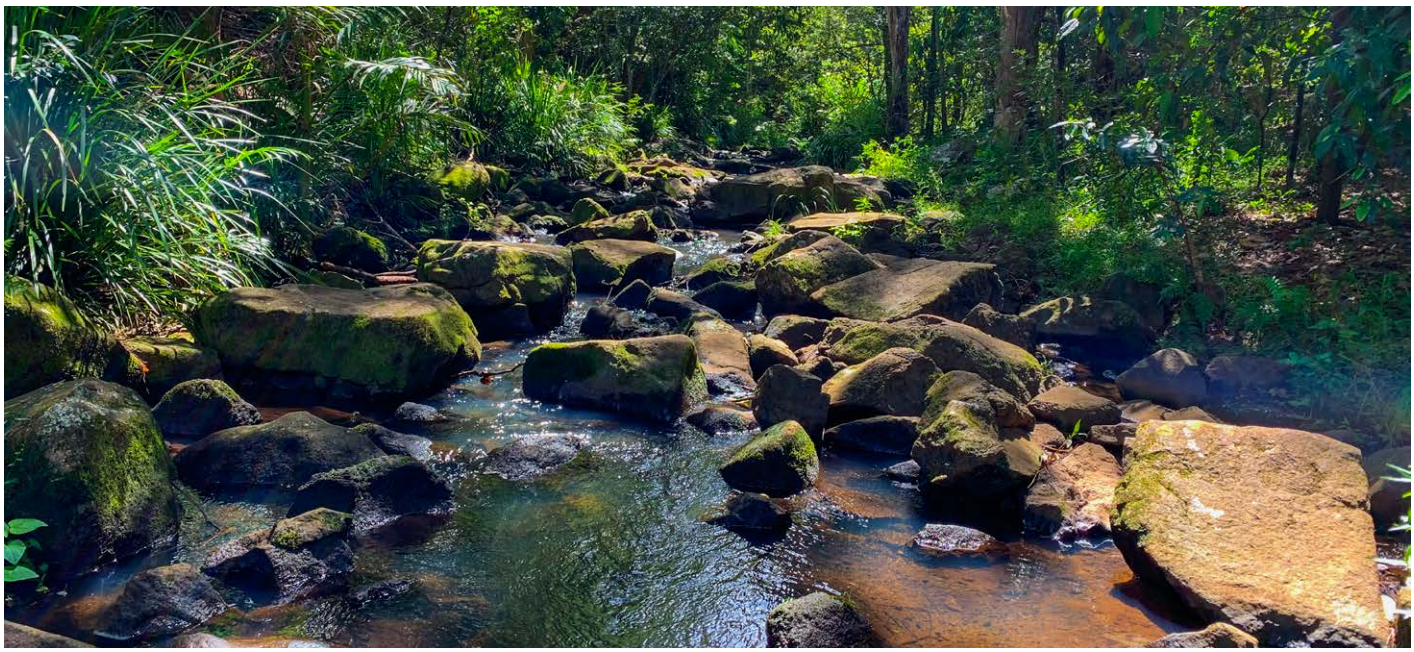


Image courtesy of iStock. Lismore, NSW.

What we are already doing

The **NSW Water Strategy** commits to actions to improve river, floodplain and aquifer ecosystem health and system connectivity (Priority 3). One example of this is by taking landscape scale action to improve river and catchment health and adopting a more intense, state-wide focus on improving water quality.

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

The **Marine Estate Management Strategy** is progressing actions that address the cumulative impact of agricultural runoff, urban stormwater, sediment contamination and other threats to the water quality of NSW estuaries (Initiative 1). Actions such as on-ground activities that provide habitat protection and rehabilitation are being designed to help mitigate the impacts of climate change on estuarine and coastal habitats, particularly from sea level rise.

The NSW Government is investigating options for better managing the issues caused by coastal drains through a review of coastal drainage management in NSW. This is being delivered through the Marine Estate Management Strategy.

North Coast Local Land Services delivers a large number of natural resource management and sustainable agriculture projects across the region. These support private landholders to adopt best practice land and water management practices. These projects contribute to improvements in soil, vegetation and riparian condition, and ultimately water quality and landscape health. Funding for these projects has been provided through a variety of sources including the Marine Estate Management Strategy and Catchment Action NSW.

Coastal Management Programs, developed by local councils with the support of the Department of Planning and Environment, provide strategic direction and funding support for local councils to address key coastal management issues, including impacts that originate from higher up in the catchment.

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

The NSW Government is implementing the new **non-urban metering framework** through the 2017 Water Reform Action Plan. Under the framework, all surface water and groundwater works covered by the rules in the South Coast region will need to be fitted with compliant metering equipment by 1 December 2023.

The **Protecting Our Places Grants Program** is a contestable grants program for Aboriginal community organisations and groups, seeking to achieve long-term beneficial outcomes for the environment.

The NSW Government has announced a **Sustainable Farming Program** which will accredit farmers who take action to improve biodiversity and reduce carbon emissions while enhancing their productivity.

Legend						
Declining catchment and river health	Competition for low flows	Saltwater intrusion into freshwater sources	Aboriginal people's rights and access to water	Water security for industries in the Far North Coast	Water security for towns and communities in the Far North Coast	Urban flooding risks to individuals, businesses and communities

Table 2. Priority 1: Take a holistic approach to land and water management

Proposed action	Summary	Challenges addressed
Incorporate Aboriginal knowledge and culture into land and water management		
Action 1.1 Foster ongoing arrangements for participation of local Aboriginal people in water management	Fund existing or new Aboriginal groups to participate in water management processes. These groups will help facilitate culturally appropriate: • water knowledge programs • engagement and consultation.	
Action 1.2 Support place-based initiatives to deliver cultural outcomes for Aboriginal people	Fund and support Aboriginal organisations and communities to develop tailored projects for their communities. This action aims to move away from central decision-making and to develop a flexible program that can be adapted and is driven by the principles of self-determination and collaboration.	
Undertake whole-of-catchment planning, decision-making and project delivery		
Action 1.3 Support whole-of-catchment governance	Develop a new governance approach that recognises stakeholder roles and responsibilities, and supports whole-of-catchment planning, coordination, decision-making, and project delivery.	
Action 1.4 Deliver a river rehabilitation program	Deliver a whole-of-catchment program that prioritises and guides works to improve the health of the region's rivers and the ecosystems they support (including native and threatened aquatic species).	
Support local landholders to adopt best practice land use and water management		
Action 1.5 Support landholder adoption of best practice land management	Build on existing programs to support private landholders to adopt best practice farm management. This will help improve the health of priority waterways by reducing the discharge of sediment and nutrients from agricultural land.	

Proposed action	Summary	Challenges addressed
Improve our understanding and management of the region's water resources		
Action 1.6 Assess the vulnerability of surface water supplies to sea level rise and saltwater intrusion	Improve our understanding of the risks of saltwater intrusion from sea level rise and changes in catchment hydrology and extraction, to local council water supplies and industries, by developing an integrated catchment model for high priority sites.	
Action 1.7 Identify environmental water needs to support healthy coastal waterways	Define objectives and the amount and quality of water necessary to sustain priority surface and groundwater aquatic ecosystems across the region.	
Action 1.8 Characterise and plan for climate change and land use impacts on coastal groundwater sources	Increase investment in accurately determining the availability and vulnerability of groundwater sources from climate change. Ensure the NSW Government and the community have the necessary information to inform management frameworks and consider the protection of water resources in land use planning decisions.	
Action 1.9 Protect ecosystems that depend on coastal groundwater	Better understand groundwater dependent ecosystems and incorporate knowledge and monitoring programs into current and future water quality and water sharing plans.	
Action 1.10 Improve monitoring of water extraction	Expand on recent NSW Government metering reforms by investigating opportunities to further improve how we monitor water extraction – particularly in managing competition during low flow periods and assessing the impact of extraction limits on water sharing plan objectives.	
Action 1.11 Support councils to improve catchment-scale flood modelling in the Richmond River catchment	Audit the existing Richmond River catchment flood model to understand its limitations and make required improvements.	
Action 1.12 Plan for land use pressures on coastal groundwater resources	Integrate land use planning considerations into the assessment of impacts on aquifer recharge and storage.	

Incorporate Aboriginal knowledge and culture into land and water management

As custodians of Australia's land and water for thousands of years, Aboriginal people have developed a rich spiritual connection to Country and have a large body of culture and knowledge. Healthy waterways are critical for their health, wellbeing and culture.

Aboriginal people do not consider land and water as separate. A more holistic approach to land and water management involves working collaboratively with Aboriginal people, drawing on their knowledge and experience, and integrating their perspectives, approaches and values into water legislation and management frameworks. We need to develop whole-of-system governance structures that are supported and understood by Aboriginal people and to give Aboriginal people direct input to water management decision-making. We also need to provide Aboriginal people with opportunities to manage water using their culture and knowledge and to create improved economic opportunities and environmental outcomes. Restoring degraded spiritual and cultural sites are also important acts of reconciliation.

Proposed action 1.1: Foster ongoing arrangements for participation of local Aboriginal people in water management

Aboriginal people have told us that consultation with their communities on water issues has been infrequent and poorly executed. Community sentiment is that government agencies often come out to 'tick a box' and after they have got what they want, they are never seen again. During consultation in the Far North Coast 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 issue 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 incorporated into decision-making.

An effective governance, engagement and knowledge-sharing arrangement is the first step in improving Aboriginal people's involvement in water management. The makeup and function of groups need to be led by local communities to be successful. Experience has shown that governance models for Aboriginal communities do not work when they are set by government.

This action would include supporting new or existing Aboriginal groups to develop a model 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 the groups.

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

Local Aboriginal groups in the Far North Coast region could be involved in:

- developing culturally appropriate water knowledge programs
- identifying culturally appropriate methods for how and when communities should be consulted and how their feedback should be considered in decision-making processes
- outlining a process that the NSW Government can follow to ensure water decisions have been appropriately considered by the community.

Have your say

What level of government support do you think is needed to successfully implement this?

Proposed action 1.2: Support place-based initiatives to deliver cultural outcomes for Aboriginal people

The Australian Government's *Closing the Gap* report and Local and Indigenous Voice program have highlighted that Aboriginal people want strong and inclusive partnerships in which local communities set their own priorities and tailor services and projects to their unique situations. Successful programs are often those that are tailored to local circumstances, place-based, well resourced, and locally driven.

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

There are already some examples of local Aboriginal groups leading the way in delivering on-ground river restoration and education programs. For example, the Githabul Rangers, a group of Githabul people, have been operating since 2009. They combine their traditional knowledge with western practices to restore and look after the land, as well as to inform and empower local Aboriginal people (especially the young) to take a more active interest in the environment and language of their Country.

In the Far North Coast region, this action would build on the work already started by local Aboriginal groups by:

- identifying **cultural water needs** for specific sites or locations where water may support cultural practices. This could involve working with the Department of Planning and Environment – Water, Department of Planning and Environment – Environment, Energy and Science and WaterNSW to understand if cultural water access licences or water for the environment could help deliver water to these locations
- improving access to Country, including locations of significance, by **opening up local parcels of land** that have access to waterways but are otherwise gated or locked. These include travelling stock reserves or Crown roads that provide access to waterways
- developing a **demonstration reach** within the proposed river rehabilitation program (proposed action 1.4), where cultural knowledge and science is used to rehabilitate riparian land, plant native species and care for Country
- supporting other local Aboriginal communities to develop 'Caring for Country' programs that **engage young Aboriginal people** in water and landscape management, with the objectives of building cultural awareness and giving a sense of ownership and cultural connectivity.

To receive government funding or support, these initiatives would need to have local champions, effective local governance arrangements and a strong capacity-building component, such as activities that focus on water legislation, licensing structures, landscape management or knowledge activities for schools and youth programs.

Undertake whole-of-catchment planning, decision-making and project delivery

Many strategies, programs and on-ground projects have been implemented to improve the health of the region's aquatic environment. These have mainly focused on managing the impact of diffuse pollutants from urban and rural land on the coastal, estuarine and marine environments. These initiatives include the NSW Government's Marine Estate Management Strategy, the NSW Coastal Management Framework, and supporting coastal management programs and on-ground works administered by the Department of Planning and Environment, Local Land Services, Department of Regional NSW, Department of Primary Industries – Fisheries and Agriculture, local councils, community groups, private landholders, and local Aboriginal organisations.

The following proposed actions aim to apply a whole-of-catchment approach to planning, decision-making and project delivery. They would build on existing programs that focus on managing the impact of diffuse pollutants from urban and rural land on the coastal, estuarine and marine environments. Catchment planning will help target and coordinate these programs under one framework. It will also help highlight and address gaps in the current range of programs being delivered, particularly those related to river and geomorphic health.

Proposed action 1.3: Support whole-of-catchment governance

Current governance arrangements have been criticised as fragmented, which affects decision-making, investment prioritisation, monitoring and reporting. Delivering effective governance is a key initiative of the Marine Estate Management Strategy to help address threats and improve health outcomes to the NSW coastal, estuarine, and marine environments. The Marine Estate Management Strategy recognises the need to improve collaboration and integration across government agencies and has proposed to try a new governance framework, starting with a pilot program for the Richmond River catchment in the Far North Coast region.

These issues are not unique to the Far North Coast region or the coastal environment. They affect the delivery of good environmental management outcomes across all coastal and riverine environments.

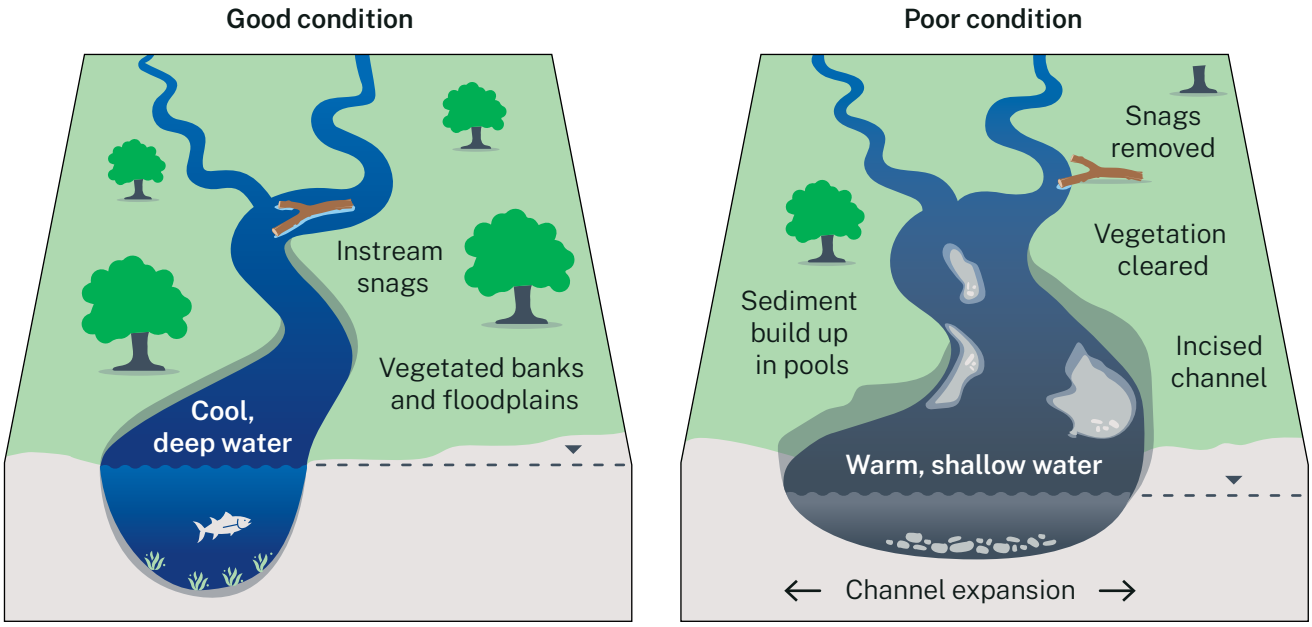
This action proposes to support the Richmond River pilot governance framework. The new framework will help to improve river and estuarine health by clarifying roles and responsibilities, synchronising projects, building collaborative networks, avoiding duplication, coordinating funding and highlighting gaps in knowledge. This action will underpin planning and delivery of the proposed river rehabilitation program (proposed action 1.4). The framework will also benefit the region's commercial, social and cultural values, which all place a high priority on the local natural environment.

Proposed action 1.4: Deliver a river rehabilitation program

The health and resilience of rivers and the ecosystems they support is directly linked to their geomorphic condition and that of the surrounding floodplains (see Figure 13). In the Richmond River catchment, the active restoration of riparian vegetation is critical as a long-term action for improving geomorphic condition. Improving geomorphic condition – particularly in the mid and lower reaches – will lead to improvements in all other river health indicators.[19]

19. Ryder, D., et al. 2015, *Richmond Ecohealth Project 2014: Assessment of River and Estuarine Condition – Final Technical Report*, www.ipart.nsw.gov.au/

Figure 13. Conceptual models underpinning river health and resilience



Strong connections between healthy floodplain, channel and groundwater.

Loss of groundwater and floodplain connections as channel incises into its bed.

This action will develop a whole-of-catchment program for improving the health and water quality of the region's rivers and the ecosystems they support, including native and threatened aquatic species. A key part of the program will be the development of a framework to prioritise the works required and where they should be implemented. The framework will use the condition and recovery potential classes from the River Styles classification system and will mainly focus on reaches classified as conservation, strategic or rapid recovery. It will also consider severity of land degradation, high ecological value aquatic ecosystems, and local Aboriginal knowledge and cultural water needs.

Other key steps for implementing this action are:

- addressing any overlaps with similar programs to ensure efforts are complementary and not duplicated
- establishing a program of potential recovery and management measures such as increased riparian vegetation, spawning boxes for the recovery of threatened species, and measures that address bed erosion and improve river system function (for example, rock chutes and log jams, and creating pool and riffle systems)
- identifying funding models, which may include landholder incentives
- developing a clear decision-making and program-delivery framework that brings together relevant government agencies with responsibilities in these areas. It would also consider how to involve local community and Aboriginal groups
- developing a monitoring and evaluation framework.

This action is important to ensure that future river recovery efforts are coordinated and effective at a catchment scale and that they support broader ecological, social, cultural and economic outcomes. When planned and implemented well, these works can achieve multiple benefits. For example, measures that slow and filter water – such as increasing channel roughness, re-introducing large woody debris in pool and riffle systems, and improving instream native vegetation – improve water quality by removing sediment and nutrients, and can provide flood mitigation benefits downstream. This benefits Aboriginal people's connection to Country, improves water security, asset protection and amenity for local towns and enhances local industries. Riparian revegetation improves bank stability and helps retain water in the landscape. This improves soil health and can make crops more resilient to extended dry periods.

The impact of this action is tightly linked to the effectiveness of the governance framework of proposed action 1.3 and to the capacity of landholders to implement best practice land and water management practices (proposed action 1.5).

Proposed actions that seek to reduce the impact of extraction on flows will complement this action. For example, establishing sustainable extraction limits (proposed action 2.4) and reducing take from low flows (proposed action 2.5). Future reviews of water sharing plans will also consider and manage future changes in flow.

Support local landholders to adopt best practice land use and water management

The Department of Planning and Environment, Local Land Services, and Regional NSW (Department of Primary Industries – Fisheries and Agriculture) already deliver programs that support the adoption of best practice land management by local landholders to improve productivity and reduce land and water degradation. These programs include:

- irrigation audits
- guidelines for fertiliser application
- improved management of farm runoff and water quality
- improved capacity to prepare and recover from droughts and bushfires.

Complementary extension services are also provided by the Natural Resource Access Regulator.

While many landholders have adopted best practice land and water management, we have heard that some landholders need support to recognise potential improvements to their land and water management. Feedback received through recent engagement with local landholders indicates that some are frustrated with the lack of extension services available to help them understand the rules, obligations and opportunities for accessing and managing farm water needs.

Proposed action 1.5: Support landholder adoption of best practice land management

This action will build on existing programs to support private landholders to adopt best practice land management to improve water quality of priority waterways by reducing the discharge of sediment and nutrients from agricultural land across the region.

Support will largely be provided through natural resource management and sustainable agriculture advisory services as well as through on-ground projects, with a focus on:

- stock grazing management
- carbon farming
- soil disturbance and erosion management
- soil condition and ground cover management
- native vegetation and biodiversity management
- streambank and riparian vegetation protection and restoration
- structural in-stream habitat restoration works
- drainage and fertiliser use management.

A suite of fit-for-purpose tools would be used to build landholder capacity in knowledge, skills, access to networks and resources. This could include one-on-one consultation, advice and referrals, webinars and podcasts, online videos, regular social media, field days, demonstration sites, farm planning training and incentives to deliver on-ground projects.

The delivery of this program will be supported by the framework developed in proposed action 1.3 and the environmental water requirements established under proposed action 1.7. This will ensure that improvements in private landholder land and water management practice are targeted to catchments where either river reaches have a high recovery potential or improvements are critical to achieving key environmental objectives.

Implementation of this action will be delivered in partnership with government agencies, as well as local Aboriginal and community groups.

Have your say

- What are the constraints to landholders adopting measures that reduce farm runoff and fertiliser use?
- What support is needed to encourage widespread improvements?

Improve our understanding and management of the region's water resources

The NSW Government has a key role to play in helping coastal regions prepare and adapt to future climate-related challenges.

Filling critical gaps in our understanding of these impacts is key to us fulfilling this role. Our investment in new climate datasets, the development of new hydrological models and the roll-out of the NSW Government's non-urban metering framework are all good first steps. However, further targeted investigations are required to properly understand the cumulative impacts of climate change, water extraction, and sea level rise on the region's water resources and to allow more flexibility in how we share and manage them.

The following actions have been shortlisted or adapted from the draft long list of options because they are important first steps to improving our understanding and future management of the region's water resources. These actions will build on the initiatives of other strategies, particularly the NSW Water Strategy, the Marine Estate Management Strategy and the NSW Groundwater Strategy.

Proposed action 1.6: Assess the vulnerability of surface water supplies to sea level rise and saltwater intrusion

This action would improve our understanding of the risks of saltwater intrusion into surface freshwater sources from sea level rise. It will consider the impacts of changes to future hydrology and water extraction on salinity dynamics in key tidal pools and estuaries of the Far North Coast region. High-priority sites in the Tweed River catchment include Cudgen Creek. In the Richmond River catchment, the Richmond River and Wilson River tidal pools are medium-to-high priority sites.

This action will require the development of integrated models that will identify possible changes to salinity by considering several important variables including: surface water flows, local-scale runoff, water extraction and estuary hydrodynamics.

These models will use the new hydrologic modelling completed for the Far North Coast Regional Water Strategy and the hydrodynamic models developed for the Marine Estate Management Strategy. Studies that assess the impacts of water extraction on salinity dynamics are already underway for the Richmond River and the Shoalhaven tidal pool on the South Coast. These studies will provide important insights for progressing this action.

As part of this action, we would develop a framework to assess the economic and social impacts of sea level rise and saltwater intrusion to water users, local council infrastructure, and Aboriginal cultural assets identified as being at risk. The outputs of the modelling may also inform our understanding of future environmental water requirements.

This action provides 3 key benefits:

- **Reduced cost to government and water users in the long-term:** Formulating policy for sea level rise challenges is complex due to the uncertainty involved. While this uncertainty cannot be removed entirely, taking early action can significantly reduce the possible future costs of damages.
- **Tidal pool water users supported in managing their business risks into the future:** Previous studies have considered the impacts of projected sea level increases on coastal properties, infrastructure and future development. However, little has been done in NSW to assess risks to water users and water resources, particularly regarding increasing tidal pool salinity.
- **Aboriginal communities supported in managing cultural assets that may be impacted by sea level rise:** This action will help to identify cultural assets that may be impacted by future sea level rise.

Proposed action 1.7: Identify environmental water needs to support healthy coastal waterways

This action will establish objectives and water requirements for priority environmental assets – species, communities, and aquatic ecosystem functions – across the region.

Coastal water sharing plans have ecological objectives, but they are difficult to evaluate because links between the objectives and the associated water management activities or levers a water sharing plan uses to deliver these objectives are unclear and the data needed to undertake effective evaluation is missing.

As well as measurable ecological objectives, we also need to know more about the environmental water requirements – both in terms of flow and quality – for species and aquatic ecosystems. Environmental water requirements define a suite of flow strategies to maintain and improve aquatic health. This includes information related to the volume, frequency, timing, and duration of flows for various flow classes, the impacts from changes in baseline water quality, as well as the risks, constraints, and complementary non-water measures. Environmental water requirements are a key tool for linking environmental objectives to management strategies and water sharing plan rules, yet many species and aquatic ecosystems in the Far North Coast region have not been studied sufficiently to reliably describe these requirements and target them through management actions.

The key steps for this action are:

- developing a method to prioritise key environmental assets (for example, based on high ecological value aquatic ecosystems) and the subsequent data and monitoring needs for defining their environmental water requirements
- establishing objectives for the recommended environmental flow and water quality requirements, including upper and lower threshold limits that are adaptive to predicted climate variability
- testing the proposed environmental water requirements (for example, through hydrological modelling) to ensure they are achievable
- agreeing to an initial set of environmental water requirements
- investing in the research required for developing and monitoring environmental water requirements.

This action will also provide a framework to identify and prioritise data and monitoring gaps, and will develop methods to address these gaps. These methods could include using data from information-rich areas to represent the water needs of a broader river reach or valley, as appropriate. The framework will also consider existing initiatives to address monitoring gaps, such as the review of the existing hydrometric gauging network. This information will be integrated with existing data platforms, where possible, in a readily accessible format.

The delivery of ecological objectives and environmental water requirements would be coordinated with the review of water sharing plans across the region. The proposed objectives will be tested against water sharing plan levers – such as long-term average annual extraction limits and cease-to-pump conditions – to ensure they are feasible and can be met within the required timeframe. The *Richmond River Area Unregulated, Regulated and Alluvial Water Sources* and the *Tweed River Area Unregulated and Alluvial Water Sources* are the next 2 water sharing plans being reviewed in the Far North Coast region. They have been extended for 2 years to 2023 to allow enough resources to make the required plan improvements. Public consultation on updates to both these water sharing plans commenced in October 2022.

Proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources

There is currently a lack of data and information about groundwater sources across the coastal regions. Data is essential to ensure future management decisions effectively mitigate potential impacts from climate change, particularly saltwater intrusion, and associated changes to catchment hydrology, sea level rise, and over-extraction.

This action proposes to characterise key groundwater resources across the region, beginning with the Alstonville Plateau and the North Coast Volcanics groundwater sources. These 2 groundwater resources have been chosen because there is a high level of dependency on licensed entitlements, mainly for industry. Saltwater intrusion has already been observed.

Data sources for this action would include initial satellite imagery, and field investigations[20] to help characterise the groundwater resource based on factors known to be affected by climate change and land use pressures. These investigations would be supported by a review and potential expansion of the bore monitoring and metering network.

The outcome of this work would be a conceptual model of key groundwater resources across the Far North Coast region that would provide decision-makers with a better idea of how much groundwater is available, how it recharges, where it discharges, and how the extraction impacts on the resource. Depending on what this conceptual model tells us about the risks of climate change and land use to these resources, more detailed modelling may be conducted.

This action will also consider how this information is made available to water users to inform individual decision-making, and to co-design potential projects with local stakeholders and universities to mitigate the key impacts of climate change and land use.

Proposed action 1.9: Protect ecosystems that depend on coastal groundwater

Groundwater-dependent ecosystems are classified broadly as terrestrial (vegetation communities), aquatic (wetlands and springs), or subterranean (aquifers). In the Far North Coast region, vegetation communities include red gum/swamp turpentine, turpentine/grey gum, river oak, swamp oak, paperbark/swamp mahogany. They also include coastal wetlands such as the Tyagarah Nature Reserve – which relies on groundwater contained within coastal sands – and lowland subtropical rainforest communities.

This action would improve our knowledge and management of groundwater-dependent ecosystems in the Far North Coast region. This knowledge would inform and guide sustainable water sharing arrangements that protect the inherent environmental values of these ecosystems.

Our knowledge of these communities is still developing. To support the protection of these communities, this action would develop a method for identifying groundwater-dependent ecosystems across the Far North Coast region that rely on surface water flows (i.e. baseflows) and monitoring the condition and extent of the associated vegetation community.

The ability to implement this action will depend on the adequacy of the monitoring bore network and metering coverage across the Far North Coast region, both of which are being considered as part of other proposed actions (see proposed action 1.10 and proposed action 2.4).

Outputs from this action will also be critical to informing environmental water requirements for the region's catchments (see proposed action 1.7) and reviewing the effectiveness of associated water sharing plan rules in protecting these groundwater-dependent communities.

20. Such as geological, geophysical, geochemical, ecological and hydrogeological studies

Proposed action 1.10: Improve monitoring of water extraction

A lack of monitoring and data is impacting our understanding of the effects of extraction, on-farm storage and growth in basic landholder rights on water sources across the Far North Coast. An irrigation profile completed in 2003 for the NSW North Coast[21] notes the scarcity of data as a key issue affecting natural resource planning, as well as irrigation management and planning. The scarcity of data has been noted in several reports and reviews, including the recent audit reports of the Richmond River and Tweed River surface water and alluvial water sharing plans by the Natural Resources Commission.[22]

Implementing the NSW Government's non-urban metering framework will ensure around 13% of surface water and 22% groundwater supply works will be metered in the Far North Coast region by 2023. This metering will provide a good starting point to better understand the impact of water extraction in the Far North Coast region.

While the current metering reforms target larger water users, smaller water users can also have a large impact on water resources during low-flow events. Additionally, increases in water extraction under basic landholder rights, particularly from the recently announced increase in the harvestable rights limits in coastal-draining catchments, may increase unmetered water take across the Far North Coast region.

This action aims to give us a better understanding of the impact of extraction limits on water sharing plan objectives and may allow us to better manage competition during low flows. It will expand on the current metering reforms by investigating opportunities to further improve how we monitor water extraction across the region. The investigations would consider innovative methods for collecting data (such as satellite imagery or GIS databases) to estimate water use, or calibrating electricity meters to track pump rates and use. This action may also include incentives for voluntary uptake of metering and telemetry, or a review of thresholds for pump sizes requiring metering.

These types of initiatives have already been flagged through the recent announcement of changes to the harvestable rights limit in coastal areas. The NSW Government has purchased high resolution satellite imagery to better understand the current levels of uptake of harvestable rights dams. Further, landholders who build new or enlarged dams – above their existing maximum harvestable right dam capacity – will also need to notify the change with the relevant water agency. These initiatives will provide important information to both planners and regulators.

As well as improving environmental outcomes, improved monitoring would also provide a useful tool for landholders to identify where water use can be reduced and to help build resilience against extended dry periods.

21. Hope, M. 2003, *NSW North Coast Region Irrigation Profile,* NSW Agriculture.
22. Natural Resources Commission 2021, *Final Report: Review of the water sharing plans for the Richmond and Tweed unregulated and alluvial water sources (D20/3832),* NSW Government.

Proposed action 1.11: Support councils to improve catchment-scale flood modelling in the Richmond River catchment

Local councils are primarily responsible for managing flood risks in their local government areas. However, the Richmond River catchment contains 5 local government areas. This adds complexity to the roles and responsibilities for flood mitigation in the Richmond River as there is sometimes no clear lead agent. It also makes it challenging to implement an integrated and consistent approach. Land use development or geomorphic changes in one council area can influence flood behaviour in downstream local government areas.

There is a need to improve catchment-scale flood modelling in the Richmond River catchment. The existing models have several limitations that impact our ability to ensure the best flood management and mitigation outcomes for the catchment and the communities that live there.

This action would provide several benefits, including:

- supporting local councils and the Department of Planning and Environment to better assess catchment-scale interventions such as riparian restoration and improved storage of water in the landscape
- supporting local councils to assess the impacts of developments on council areas located downstream
- improving the capacity of local councils to understand the impacts of flood mitigation works upstream of Lismore.

There may be future opportunities to build on this work for the Tweed and Brunswick catchments in the Far North Coast Region.

This proposed action can be implemented in 2 stages:

Stage 1 (2022–23)

Regional water strategies would support:

- auditing the existing catchment-scale flood model to identify its limitations and possible improvements. This would include assessing the opportunity to incorporate the models recently completed for Rous County Council's Lismore flood risk management study
- scoping the works required to address the limitations and improvements
- liaison with constituent councils regarding the requirements for updated modelling
- liaison with the CSIRO through their work in the Northern Rivers Resilience Initiative.

Stage 2 (2023–24)

Regional water strategies would:

- support Rous County Council to implement the model improvements
- work with the Department of Planning and Environment – Environment and Heritage to assess the use of the new stochastic climatic data for flood modelling
- provide new climatic data to improve model performance, where appropriate.

Proposed action 1.12: Plan for land use pressures on coastal groundwater resources

A number of aquifers may be important for the future water security of the Far North Coast if the population grows. These include the North Coast Volcanics, the Clarence-Morton Basin and the New England Fold Belt. The increased use of these groundwater sources is subject to water quality.

This action would integrate land use planning considerations into the assessments of impacts on aquifer recharge and storage. It will mainly focus on aquifers that are important for water security in the context of population growth in the Far North Coast region. The action would aim to protect groundwater resources from activities associated with development, such as changes to recharge patterns, storage, acid sulfate soils, saltwater intrusion, and groundwater pollution.

The action would involve:

- identifying the key challenges facing coastal groundwater resources in the region
- assessing the risk to coastal sands from diffuse pollution sources (pesticides and fertilisers)
- engaging with all levels of government to develop partnerships and ensure proposed actions are coordinated when making changes to land management practices or legislation.

The NSW Groundwater Strategy, currently under development, will conduct a state-level review of the policy and legislative instruments relevant to this action. The review will assess whether the current legislation is fit-for-purpose to address the key challenges, including groundwater quality; identify gaps in current policy and regulation; and make recommendations for regulatory reform. It will also propose roles and responsibilities for each government department in managing coastal groundwater sources and set out a strategic framework for the long-term management of coastal aquifers.

Have your say

What types of activities do you think may impact groundwater resources in the region?

Image courtesy of iStock. Tweed River, Tumbulgum.

Priority 2

Ensure water resource development and use is sustainable and equitable

Sustainable water management means that we meet the water needs of the present without compromising the ability of future generations to do the same. Ensuring this for the Far North Coast region will require us to improve management of water between users and to reduce the impact of infrastructure on waterway health.

What we have heard so far

- There was concern about the impact of development on the health of rivers and riparian vegetation, including the disturbance of acid sulphate soils and the deoxygenation of waters that have resulted in fish death events in the region.
- There was strong opposition to new on-stream storages, with concerns raised about their impacts on endangered flora and fauna, unique ecosystems and culturally significant sites.
- There was strong support for measures that would increase the frequency of environmental flows downstream of storages.
- The existing water licensing system for Aboriginal people needs to be more accessible, easier to understand, and more flexible in the potential uses of water. Aboriginal communities also want equal trading rights to other water users and are concerned that they should not have to pay for water that comes from cultural or spiritual sites.
- There was support for schemes to help transition non-urban water users out of low flow extraction. However, these schemes would need to allow users to store water during periods of high flows.
- Feedback was mixed about the need to establish sustainable extraction limits, although it was generally acknowledged there was a need to collect more data before any limit is established.

Image courtesy of iStock. Lake Ainsworth, Lennox Head.

What we are already doing

The **NSW Water Strategy** has committed to the sustainable management of surface water and groundwater systems. These initiatives include better integrating land use planning and water management, reviewing water allocation and water sharing in response to new climate information, and developing the NSW Groundwater Strategy.

The NSW Government is currently updating the **North Coast and New England North West regional plans**. The objectives of these plans recognise the need to think holistically about water management and to encourage innovation in water efficiency and whole-of-water-cycle management.

The Department of Planning and Environment is applying a **new risk-based assessment process** to help understand the relative impact of water sharing plan rules on key environmental functions. For example, the effects that reduced inflows can haven on low flows, freshes and water quality. This new approach is being considered as part of the review or remake of coastal water sharing plans.

The **NSW Fish Passage Strategy** provides a coordinated 20-year plan to proactively restore unimpeded fish passage and improve native fish access to main-stem rivers and key off-channel habitats across NSW. Under the Marine Estate Management Strategy, the action Reconnecting Fish Habitats aims to address high priority fish passage barriers along the NSW coast. Both strategies are led by the Department of Regional NSW, and provide a framework for prioritising restoration work across the state and North Coast region.

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

The NSW Government has also committed $3.9 million under **Future Ready Communities** to promote resilience and develop drought resilience plans which will assess drought impacts and responses.

Image courtesy of iStock. Woodburn, NSW.

Review of harvestable rights

From May 2022, landholders in the Far North Coast region are able to capture a maximum of 30% of the average regional rainfall-runoff from their property in harvestable rights dams. This applies to dams that are built on non-permanent flowing minor streams, hillsides and gullies. The remaining runoff will continue to flow into licensed dams and the local river systems, where it is shared among the environment and other downstream water users.

This increase from 10% up to a maximum 30% limit follows a review and community consultation of harvestable right limits in coastal-draining areas of NSW.[23] It provides landholders in these regions better access to water storage for domestic and stock, and extensive agriculture, such as stock grazing and pasture irrigation. However, the increase excludes intensive livestock and plant agriculture, such as horticulture and feedlots. Water taken under the existing 10% harvestable right can continue to be used for any purpose.

A number of critical steps have been completed to support these new arrangements. These include:

- further consultation with native title holders
- determining a method for setting a landholder's revised maximum harvestable right dam capacity
- working with other agencies, including the Natural Resources Access Regulator, on monitoring and enforcement issues
- replacing the harvestable rights Order applying to the Central and Eastern Division with 2 separate new Orders.

The Far North Coast Regional Water Strategy will provide a path for supporting the implementation of these changes while effectively managing future impacts from an increased uptake in the higher limit on downstream water needs, including those of the environment. Commencing 2022, the department will assess whether the increase to a 30% harvestable right limit is appropriate for each water source, noting the limitations and mitigation measures announced as part of these changes.

The department will include an amendment provision in upcoming water sharing plans to review the uptake of harvestable rights by either year 3 or year 5 of the plan. The provision will require a review of access, trade and water supply work approval rules if the uptake of harvestable rights has increased above the 10% limit in the original Harvestable Rights Order. Updated plans will include an estimate of the current uptake in harvestable rights within the long-term average annual extraction limit.

The Far North Coast Regional Water Strategy can help ensure these changes not only improve water security for rural landholders, but also consider the impacts on downstream environments and licenced users.

23. water.dpie.nsw.gov.au/licensing-and-trade/basic-landholder-rights/harvestable-rights/coastal-review

Legend						
Declining catchment and river health	Competition for low flows	Saltwater intrusion into freshwater sources	Aboriginal people's rights and access to water	Water security for industries in the Far North Coast	Water security for towns and communities in the Far North Coast	Urban flooding risks to individuals, businesses and communities

Table 3. Priority 2: Ensure water resource development and use is sustainable and equitable

Proposed action	Summary	Challenges addressed
Reduce the impact of water infrastructure on ecosystem health		
Action 2.1 Improve fish passage	Implement the *NSW Fish Passage Strategy* to replace or remediate high-priority fish barriers in the Far North Coast region.	
Action 2.2 Implement fish-friendly water extraction	Promote and implement the strategic installation of diversion screens on irrigation pumps and diversion offtakes across priority waterways and irrigation channels.	
Action 2.3 Address cold water pollution	Address cold water pollution from major storages in the Far North Coast region to restore near-natural river water temperature. This ensures native and threatened fish species have the necessary environmental cues to spawn, recruit, move and grow.	
Better manage competing demands for water		
Action 2.4 Establish sustainable extraction limits for surface water and groundwater sources	Use an evidence-based approach to establish the extraction capacity of the region's surface water and groundwater systems. Integrate this new knowledge into water sharing arrangements to improve outcomes for the environment and the community.	
Action 2.5 Reduce the take of low flows	Investigate and assess options for reducing water extraction during low flows, focusing on the effectiveness of high-flow conversions, suitability of low-flow bypasses for on-farm dams, and options for landholders to store water extracted from the region's streams under basic landholder rights.	

Proposed action	Summary	Challenges addressed
Action 2.6 Address catchment-based impacts of increased harvestable rights limits	Understand the local-scale effects of increased harvestable rights limits and account for these in future water sharing plan arrangements.	
Action 2.7 Support Aboriginal business opportunities	Support Aboriginal people to develop business opportunities in the Far North Coast region by: • identifying new business opportunities • better management of existing businesses • accessing support or grant funding.	

Image courtesy of iStock. Lismore, NSW.

Reduce the impact of water infrastructure on ecosystem health

Many native fish species in the Far North Coast region require free passage up and down the region's rivers: to access food, avoid predators and find shelter; and seasonally to spawn, migrate and reproduce. Removing high-risk barriers to fish movement will help the resilience of fish species, particularly those that are threatened or endangered.

Proposed action 2.1: Improve fish passage

Physical barriers to fish passage such as weirs, floodgates, causeways and bridges 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, find food and locate ideal habitat is critical to supporting native fish populations in the Far North Coast region.

The NSW Fish Passage Strategy aims to address the highest priority fish barriers remaining in NSW. This action would remediate fish passage at 6 priority barriers in the Far North Coast region: Bray Park Weir, Jabour Weir, Pioneer Crossing, Eureka Road, Eden Creek Weir and Goolmangar Creek Weir.

Improving fish passage can lead to changes in current flow patterns near instream structures. The effects that improving fish passage could have on flows near town water supply extraction points will be considered, to ensure that local councils' access to drinking water is not compromised.

Proposed action 2.2: Implement fish-friendly water extraction

Every year, large numbers of native fish are removed from rivers. Adult fish as well as juveniles, larvae and eggs are extracted by pumps, along with debris such as sticks and leaves. This impacts the sustainability of native fish populations and can also damage irrigation infrastructure.

Installation of screens at pump sites can reduce fish losses at these sites by over 90%, helping more fish survive to maturity and boosting fish numbers. This protection also extends to other aquatic species such as crayfish and turtles.

As well as benefiting fish, the screens will help prevent blockages caused by debris. This will avoid damage to irrigation infrastructure and improve pump operation, water delivery and extraction efficiency for asset owners.

This action proposes to support the installation of screens on pumps at key sites across the Far North Coast region. The action will confirm the location of diversion pumps and prioritise where the installation of screens will have the largest impact – for example in protecting threatened or susceptible species. The project will include high-level costings and an implementation plan to support landholders install screens in priority locations.

Have your say

What support do irrigators require to implement screens on pumps?

Proposed action 2.3: Address cold water pollution

Between spring and autumn, the water stored in large dams can form 2 layers, with a warm surface layer overlaying a cold bottom layer. Cold water pollution – an artificial decrease in the temperature of water in a natural river – is caused when this cold water is released into rivers from large dams during warmer months. This can have serious negative effects on ecological health.

This option aims to evaluate the extent of cold water pollution impacts from existing storages in the Far North Coast and to work with asset owners to implement appropriate capital and operational responses to mitigate those impacts. This option is structured as a 5-year partnership with a scoping-study in the first phase to assess the issue and identify suitable works and project partners.

The major storages in the Far North Coast region vary in their likelihood of releasing cold water to the environment.[24] While Toonumbar Dam has a destratification system, the dam was identified in the NSW Cold Water Pollution Strategy as having the potential to cause moderate cold water pollution effects. Clarrie Hall Dam does not have a destratification system and is likely to intermittently cause cold water pollution effects. Cold water pollution effects of Emigrant Creek Dam are likely to be minimal, while Rocky Creek Dam does not release water to the environment.

There is a lack of monitoring sites both upstream and downstream of storages in the region. This can make it difficult to determine the extent of cold water pollution in the region.

This action would include:

- aligning with NSW Cold Water Pollution Strategy
- assessing existing temperature metrics against best-practice frameworks for managing impacts on aquatic fauna
- examining the extent and magnitude of cold water pollution effects from Toonumbar Dam and Clarrie Hall Dam
- exploring the potential for, and feasibility of, technologies to mitigate cold-water pollution effects, such as augmentation of dam outlets, improvements to mixing regimes, and modifications to water delivery mechanisms.

Image courtesy of WaterNSW. Toonumbar Dam, NSW.

24. Department of Planning, Industry and Environment 2020, *Draft Regional Water Strategy — Far North Coast: Strategy (PUB20/307)*, water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/far-north-coast-regional-water-strategy

Better manage competing demands for water

Governments have a legal responsibility to ensure that water is allocated and used to achieve beneficial environmental, social and economic outcomes. We need to review how we regulate extraction across the region to ensure that we appropriately meet this responsibility, particularly in managing competing demands for water during dry and low-flow periods. We also need to provide greater opportunities for the Far North Coast region's Aboriginal people to gain access to water.

The following proposed actions would help provide confidence that the rules that determine water sharing arrangements are equitable and sustainable, while also providing opportunities to shift water demand and extraction out of critical low-flow periods.

Proposed action 2.4: Establish sustainable extraction limits for surface water and groundwater sources

The *Water Management Act 2000* (WMA) outlines the principles that guide water sharing. These principles oblige the government to ensure the ecological sustainability of the state's water sources and to maximise the economic and community benefits from water.

The water sharing plans prepared under the WMA regulate the diversion, extraction, and development of water resources in NSW. Putting limits on extracting water from rivers and aquifers is a key tool that can help meet the obligations of the WMA.

Water sharing plans can define different types of extraction limits. These include the total volume of water that can be extracted from a river or aquifer in a year. These annual limits are called the long-term average annual extraction limits (LTAAELs). Other types of limits aim to protect specific parts of river flows by governing when water users can take water from a river. An example of this type of limit is daily extraction limits.

Water sharing plans in the Far North Coast region do currently include LTAAELs. However, the current LTAAELs were set as the sum of existing water entitlements at the time the water sharing plans were first developed. We don't know if the current LTAAELs can meet the requirements of the environment and the community.

The NSW Natural Resources Commission has recommended that the department reviews coastal LTAAELs. It has also recommended that the department develops extraction limits that better meet water sharing principles.

This action would transition water sharing to a regime that is based on science and evidence. It would establish the extraction capacity of the region's surface water and groundwater systems. It would then use this new knowledge as the starting point for water sharing. This will allow us to manage water extraction as best as possible to improve outcomes for the environment and the community.

Implementing this action would require:

- understanding different methods for setting extraction limits
- testing one or more methods on a pilot water source
- establishing the appropriate extraction limits for water sources across the region
- investigating the feasibility of implementing and setting daily extraction limits.

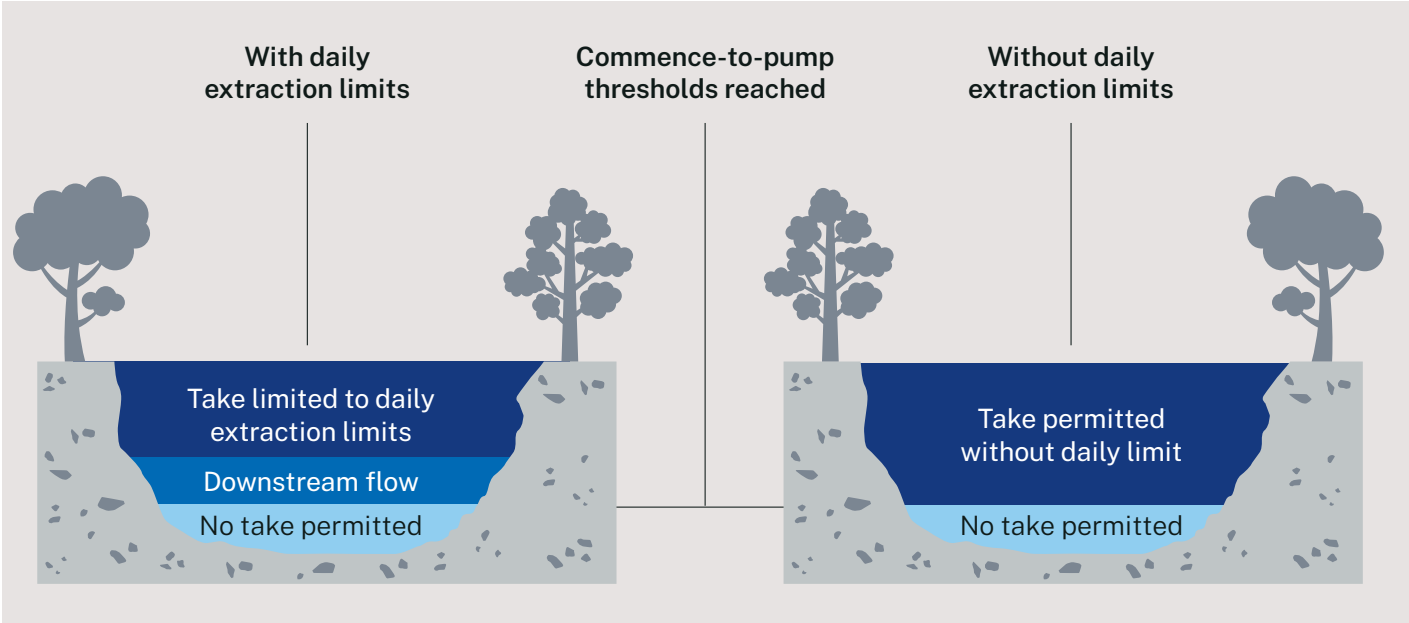
Defining sustainable LTAAELs in water sharing plans across the region would provide a number of benefits. It would:

- allow water users to maximise water resource development within ecological limits
- ensure that water is shared equitably among users
- provide water users with greater certainty in their share of the resource
- identify if and where additional water entitlements could be made available.

This action could also investigate and assess approaches for implementing daily extraction limits.

Daily extraction limits restrict the impact of rapid removal of water during peak irrigation periods (Figure 14). They have been written into water sharing plans to protect low and medium flows so that there is enough water in a system at any one time for the environment, non-extractive users (aquaculture, cultural, recreation) and downstream water users. Implementing daily extraction limits requires stream gauging and monitoring, daily measurements (or estimates) of water extraction, and personnel to co-ordinate extractions among water users.

Figure 14. Daily extraction limit concept



The NSW Government previously supported the implementation of daily extraction limits in some catchments by providing field officers to coordinate extractions among water users. However, the government ceased carrying out this role about a decade ago, with the expectation that water user groups would implement daily extraction limits in line with water sharing plan rules. In most cases, this has not eventuated because water user groups lack established infrastructure, systems and incentives. Consequently, daily extraction limits are not being implemented and the environment, downstream water users and non-extractive water users risk not receiving their designated share of low and medium flows.

Image courtesy of iStock. Sugar cane fields, Murwillumbah.

Proposed action 2.5: Reduce the take of low flows

Reducing water extraction from rivers during periods of low flow will improve both river connectivity and natural flow variability. It will also complement other proposed actions aimed at improving river health.

This action would investigate and assess options for reducing water extraction during low flows. The assessments will focus on:

- the effectiveness of high flow conversions
- adopting low flow bypasses across catchments
- options for landholders to store water extracted from the region's streams under basic landholder rights.

Improving river connectivity and natural flow variability in the region's rivers would complement other actions proposed in the Far North Coast Regional Water Strategy aimed at improving river health.

High-flow conversions

In some water sources in the Far North Coast region, water users can apply to have their existing water access licence converted to allow extraction of a greater volume of water under high-flow conditions. The high-flow conversion rule applies in catchments that are gauged and experiencing hydrologic stress. Widespread adoption across a catchment would increase the protection of low flows and improve river connectivity during dry times, while increasing the water available for extraction during wetter times.

No licence holders on the Far North Coast region have taken up licence conversions, mainly because the proposed conversion rates do not provide enough water security benefits to offset the additional costs of irrigating from on-farm storages. Any modification to the current conversion rate will consider the impact on all parts of the flow regime (particularly high flows) and subsequent changes to river health, the reliability of downstream licences, and social and cultural values.

Overcoming constraints in constructing and operating on-farm storages (proposed action 3.5) and an improved understanding of climate risks to surface water availability in the region, may make high-flow conversions more viable in the future.

Have your say

What barriers do we need to overcome for irrigators to convert to high-flow licences?

Low-flow bypasses

Farm dams offer increased water security for landholders but reduce the volume of runoff that makes its way into downstream waterways. The impacts are greater during extended dry periods when the volumes of water stored in farm dams are typically low if they are configured in a way that prevents all runoff from passing downstream. Farm dams fitted with devices that allow some runoff to bypass or flow through the dam reduce their impact on low flows, while still offering water security benefits for landholders (Figure 15).

A targeted, catchment-wide program investing in low-flow bypasses on existing dams has the potential to restore more natural stream flows in the region's stressed waterways. The Department of Planning and Environment will commission a desktop review of the use of low-flow bypasses in other jurisdictions to inform further potential measures for mitigating downstream impacts from an increase in the coastal harvestable rights dams. Subject to the findings of this review, field trials will be conducted to test their design efficacy under a range of NSW coastal conditions and their cost effectiveness. The outputs of these investigations will be a key input to understanding the benefits and constraints of low-flow bypasses more broadly.

Low-flow bypasses may also be necessary to mitigate the environmental impacts of infrastructure options being proposed through the Far North Coast Regional Water Strategy, such as increased on-farm storage (proposed action 3.5).

Figure 15. Low-flow bypass technology[25]

25. Adapted from *Flows For the Future – Factsheet #1*, South Australian Department of Environment and Water

Storage of water extracted under basic landholder rights

Landholders with river frontage are allowed to extract water under very low flow conditions under their basic landholder rights, regardless of water sharing plan cease-to-pump rules. Extracting water under these rights during higher-flow periods and storing in tanks or turkey-nest dams[26] can reduce the volume of water extracted from stressed rivers and delay the need to cart water from town water supply networks.

State and local government rebates on rainwater tanks have partially addressed this problem. We need to better understand the extent to which current and future growth of water extraction under basic landholder rights threaten environmental assets.

Image courtesy of iStock. Tweed Heads, NSW.

26. A dam with a completely enclosed earth embankment that is filled by pumping water from alternative water sources

Proposed action 2.6: Address catchment-based impacts of increased harvestable rights limits

The recent decision to increase the current harvestable rights limit from 10% to 30% in coastal-draining areas includes a range of mitigation measures to manage the impact of these changes on downstream users.

This action supports the implementation of these mitigation measures through the following 2 measures:

- **Further analysis to confirm the appropriateness of the 30% limit at a local level:** An assessment will be conducted at the water-source scale to determine whether a higher or lower limit – including reverting to the previous 10% limit – is more appropriate in the longer term. The action would prioritise catchments and water sources across the Far North Coast region based on the sensitivity of the downstream environment or the likely uptake of the new limit. Landholders will be required to adjust any works at their own cost to ensure they comply with the new limit.
- **Introduce levers to manage future impacts from an increase in the uptake of harvestable rights on existing water sharing plan arrangements:** An amendment provision will be included in upcoming water sharing plans to review the uptake of harvestable rights by either year 3 or year 5 of the plan. The provisions will require a review of access, trade and water supply work approval rules if the harvestable rights uptake has increased above the 10% limit in the original Harvestable Rights Order. The review will occur within the first 3 years for all areas where there is a high possibility of uptake of increased harvestable rights.

Revised coastal water sharing plans will also include an estimate of annual extractions under harvestable rights in establishing the long-term average annual extraction limits. This is an important first step in ensuring harvestable rights take is included when establishing sustainable long-term average annual extraction limits into the future (see proposed action 2.4).

Proposed action 2.7: Support Aboriginal business opportunities

During our consultation on the *Draft Far North Coast Regional Water Strategy* we heard of a need for, and support of, business opportunities in the region that are led by Aboriginal communities. We also heard of business plans already being pursued by local Aboriginal people.

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

This action would support Aboriginal business development opportunities in the Far North Coast region. The action will be led by the Department of Planning and Environment with support from the Department of Regional NSW. Through the Aboriginal Partnership Program, a dedicated partnership manager will work with Aboriginal organisations, businesses, and individuals to:

- identify and develop new business opportunities
- better manage existing business
- access support or grant funding.

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

Image courtesy of Destination NSW. Duranbah, NSW.

Priority 3

Prepare for future climatic extremes

We need to prepare for future climate variability, particularly extended dry periods, to help build a stronger and more resilient region. Providing more and better information on the impacts of climate change on water resources will allow the community to plan better for the future, particularly local councils and businesses that are highly dependent on water. The resilience of local industries will be strengthened by having the tools and infrastructure at hand to make the most of existing water supplies and manage risks of increased climate variability and change.

What we have heard so far

- It is important to address impacts of population growth, sea level rise and climate change, and to understand how these impact water availability and influence decisions about water management and use.
- Dunoon Dam has attracted both strong opposition and support among some parts of the Far North Coast region's communities. More information is provided on page 102.
- The need for greater water security, particularly in times of drought, was an important priority and there was strong support for climate-independent water sources.
- There was strong support for towns with independent water supplies to be connected to the network and that more residential and commercial buildings should incorporate stormwater reuse and rooftop rainwater harvesting.
- There was mixed support for desalination water supply solutions. The relative strength of support increases if commitments can be made to power desalination plants with renewable energy. Hesitation generally centred on abundance of rainfall in the region, relatively high costs for construction and ongoing operation, and potential ecological impacts on the fragile coastal ecosystems where a plant may be located.
- There was strong community support for consistent demand management practices across the region as well as measures to minimise water network leakage.
- There was support for a review of the water market in the Far North Coast region, although there were concerns about foreign ownership of water, that water should not be 'owned' by individuals and that this action might allow water to be traded out of the region.

What we are already doing

The NSW Water Strategy has committed to increasing the resilience of the region's water users to changes in water availability. This includes supporting more efficient water use by industry and improving drought planning, preparation and resilience.

The $1 billion **Safe and Secure Water Program** supports councils to implement infrastructure and non-infrastructure solutions to address key risks to regional water safety and security.

The **Town Water Risk Reduction Program** is currently underway. Its aim is to work with councils to develop a new framework to better support local councils manage safe, secure and sustainable water supply and sewerage services to regional communities across NSW.

The Government will support water utilities to diversify sources of water including groundwater, stormwater harvesting and recycling. This will include progressing relevant regulatory reform and community acceptance campaigns to help increase the uptake of diverse water sources with the potential to increase water security and resilience for towns and communities.

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

The NSW Government Climate Change Research Strategy is supporting projects that help primary industry sectors adapt to climate change. Under this strategy, the Department of Primary Industries is undertaking a detailed analysis of the risks and opportunities of a changing climate to support resilience and adaptation in the broadacre cropping sector.

The NSW Government has recently published the long-term climate variability risk data that supports the regional water strategies. This is the first step in providing water users with better access to information on future risk to water availability. The stochastic datasets for rainfall and potential evaporation on the Far North Coast and a number of other regions are available on the SEED portal.[27]

The NSW Government is working towards a policy of more open and easily accessible data. The open data framework outlines how we will manage and drive open data to improve transparency and data sharing.

Image courtesy of iStock. Rocky Creek Dam, Lismore.

27. Department of Planning and Environment 2022, *Water Modelling — Stochastic Climate Data,* datasets.seed.nsw.gov.au/dataset/water-modelling-stochastic-climate-data

Legend						
Declining catchment and river health	Competition for low flows	Saltwater intrusion into freshwater sources	Aboriginal people's rights and access to water	Water security for industries in the Far North Coast	Water security for towns and communities in the Far North Coast	Urban flooding risks to individuals, businesses and communities

Table 4. Priority 3: Prepare for future climatic extremes

Proposed action	Summary	Challenges addressed
Support local councils and water users to manage risks		
Action 3.1 Support local councils to provide a secure and affordable water supply for towns	Continue to support local councils across the region, both in integrated water cycle management planning and co-funding infrastructure options to address key risks. This support will include addressing the recommendations of the NSW Government's Town Water Risk Reduction Program.	
Action 3.2 Provide better information about water availability and climate risks	Improve existing platforms and products to provide information about water availability and climate change in forms that are suitable to stakeholders to allow better business planning.	
Action 3.3 Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast	Support Far North Coast councils to make adaptive, regional-scale water supply decision, and progress studies needed to support decision-making.	
Optimise use of existing water supplies		
Action 3.4 Enhance coastal water markets	Review water markets to improve water security, encourage trade efficiencies, and allow transparency of information.	
Action 3.5 Investigate increased on-farm water storage	Assess the hurdles to constructing on-farm-storages, and the value of on-farm storages to landholders, industry and local fire-fighting.	
Action 3.6 Investigate managed aquifer recharge in the Far North Coast region	Investigate suitable locations and feasibility of managed aquifer recharge projects in the Far North Coast region.	

Proposed action	Summary	Challenges addressed
Action 3.7 Protect coastal groundwater resources for town water supplies and rural water users	Investigate reserving water in key aquifers across the Far North Coast region for emergency supplies when surface water availability is low due to drought.	
Investigate alternative water supplies		
Action 3.8 Investigate a recycled water plan for the Far North Coast	Work collaboratively with local councils, industry and potential water users to identify the best uses of existing and potential recycled water streams around the Far North Coast region.	

Image courtesy of Ryan Fowler, Destination NSW. Cudgen Farmland, NSW.

Support local councils and water users to manage risks

The NSW Government already supports local councils to manage town water supply and security risks through the Safe and Secure Water Program. The Safe and Secure Water Program has funded around $38 million of investigations and works in the Far North Coast region over the past 3 years, including funding support for the preparation of integrated water cycle management strategies. Under this program, funding priorities have been for sewage discharges and sewer overflows that pose risks to water quality, water security and the environment.

However, as recognised in the NSW Auditor-General's report *Support for regional town water infrastructure*,[28] more needs to be done to properly support local councils. For example, in some instances, despite the funding available through the Safe and Secure Water Program, councils may still find affordability and, therefore, project delivery an issue.

Local industries also need our support. Sustainable and drought-resilient long-term growth for industries and towns is linked to good business planning, which includes understanding future water availability.

Proposed action 3.1: Support local councils to provide a secure and affordable water supply for towns

This action will continue to support local councils with water system planning, and to build skills and capacity for implementation. This support will focus on the department's new regulatory and assurance framework for local water utilities.

The new regulatory and assurance framework sets the expectations the department has on local water utilities. These include:

- establishing the outcomes required to meet customer needs and to manage key risks
- undertaking evidence-based strategic planning to meet these outcomes
- assessing the standard to which the outcomes are met.

The framework highlights understanding and addressing water security and water quality risks as key outcomes.

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 service level roughly correlates to town water supplies being able to withstand a drought that has the probability of occurring one in 1,000 years.[29] This level of risk may be too high for large towns in extreme droughts where there are no last resort options such as water carting.

The NSW Government aims to provide the right mix of tools to support local councils in the Far North Coast region to address their key town water security challenges. This includes assisting councils to explore options to reduce demands on surface and groundwater sources. For example, water use efficiency programs and accessing other water sources such desalinated water and purified recycled water. The department will provide guidance and support to local water utilities to help them undertake their strategic planning under the framework. The department will also monitor this work to ensure it sufficiently manages the key risks. This could also include delivery of pre-existing work undertaken by local water utilities through their integrated water cycle management plans. Updated guidance about water security is being prepared for Councils. While this is being developed, Councils should continue to use the department's draft assessment and adaptation guidelines.[30]

Other actions in the Far North Coast Regional Water Strategy aim to improve river health and land management. These will also benefit councils by improving access to high quality water for town water supplies.

28. New South Wales Auditor-General 2020, *Support for regional town water infrastructure,* Audit Office of New South Wales, www.audit.nsw.gov.au/our-work/reports/support-for-regional-town-water-infrastructure
29. This does not mean that a drought will only occur once in 1,000 years. Rather, it means there is a 0.1% probability that this severity of drought could occur in any given year.
30. NSW Office of Water 2013, *Assuring future urban water security: Assessment and adaption guidelines for NSW local water utilities (Draft – December 2013),* www.industry.nsw.gov.au/__data/assets/pdf_file/0005/489587/assuring-future-urban-water-security.pdf

Proposed action 3.2: Provide better information about water availability and climate risks

The NSW Government's Future Ready Regions Strategy recognises that providing clear and accessible information on surface water and groundwater availability allows industries to forward-plan with certainty. However, this data is often not accessible or available to water users in a format that is useful to their needs or preferences. Recent consultation on the coastal regional water strategies and the review of the coastal harvestable rights limit echoed this concern, with stakeholders stating they did not know who to contact for advice on their options for accessing water. This ultimately affects landholders' ability to make optimal business decisions, particularly when considering the impacts of extended dry periods.

The NSW Government is committed to supporting better planning and decision-making for normal and dry times by providing more information and data to enable businesses to make the right decisions for their circumstances. For example, 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.

The new climate data that has been published as part of the regional water strategies is a key step in providing more information to water users and managers on the risks of different climate scenarios on the reliability of water access licences over the long term.

The NSW Government can design and deliver suitable training and information products for:

- medium-term (12 month) climate outlooks that will look at how climate could influence water availability to help water users make informed decisions on managing their allocations or trading water on the market
- implications of the long-term climate data on surface water availability and the likelihood of periods of low or no water availability
- implications of the long-term climate data on groundwater availability from different aquifers
- understanding water access options in coastal areas, including the implications of the recent changes in the coastal harvestable rights limit.

The NSW Government will consult with stakeholders and review the ways water information is made available to users to improve usability and accessibility. Where appropriate, this work would build on existing information platforms and products to provide information in forms that are suitable to stakeholders.

Have your say

What water information would you like made available?

Proposed action 3.3: Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast

Regional-scale decision-making

Local councils in the Far North Coast are responsible for providing safe and secure drinking water to residents in the region. Councils plan their supplies based on the knowledge of their water systems and the service requirements set by the NSW Government. We also support them to plan and implement improvements to their water supplies through initiatives like the Safe and Secure Water Program and the Town Water Risk Reduction Program.

The Far North Coast presents opportunities for regional-scale water initiatives that cut across local council and state boundaries. Regional-scale initiatives can help build the resilience of town water supplies in the region. They do this by increasing the water sources available to different councils, and by sharing the benefits and costs of infrastructure across the region.

However, planning and implementing cross-border initiatives is complex and can be very challenging. The uncertainties about future water supply requirements in the region add to this complexity. Our analysis shows that there is still a lot of uncertainty in the Far North Coast around:

- future population
- future water demands, and
- the effects of climate change, like changes to rainfall and rates of sea-level rise.

Councils in the Far North Coast region have tried to coordinate regional water supply planning in the past. The *Northern Rivers Regional Bulk Water Supply Strategy*[31] was an important start for this work. The Far North Coast Regional Water Strategy provides an opportunity to support local councils and state-owned corporations to continue this regional-scale planning. This can help councils to properly consider and implement regional projects that are difficult to achieve without state-level support. It also provides the opportunity to take an agile, flexible approach to ongoing water system investment. This enables councils across the region to benefit from their own short- and medium-term investments while providing the time to better understand and plan adaptive pathways.

What are adaptive pathways?

An adaptive pathway approach to planning can be useful when dealing with uncertainty because it avoids making premature decisions. It acknowledges that while not all decisions can be made now, they can be prioritised, planned and prepared for.

Adaptive strategies typically do not rely on a single static solution. They set out a suite of potential options together with social and environmental triggers for decisions. The available options are 'tested' against plausible futures and acceptable risks when a trigger is reached. This allows us to choose the most appropriate option for the moment while remaining resilient and able to adapt to new conditions, information and technologies.

When designing adaptive pathways, it is important to prioritise no-regrets or low-regrets options until critical knowledge gaps are filled. This helps keep options open for the future as more information becomes available. These types of decisions – such as water efficiency improvements and upgrades to existing local council assets – increase reliability without constraining future options. Local councils are already progressing no-regrets decisions through their integrated water cycle management planning. The NSW Government will continue to support councils with these decisions through proposed action 3.1.

Key steps

This proposed action will support local councils in the Far North Coast to make and implement regional water supply decisions. The key steps for implementing this action are:

- support councils to identify and progress additional studies, research or designs required to adequately assess regional-scale supply options and bring them to an equal level of understanding
- continue the existing government initiatives that support councils to identify and progress the studies they need to understand their own supply risks and future options
- support councils to coordinate negotiations needed to progress regional-scale supply options
- collaboratively develop the modelling methods and decision-making processes that will inform the adaptive pathways and future decisions, including defining triggers and thresholds for decision-making.

31. Hydrosphere Consulting 2013, Northern Rivers Regional Bulk Water Supply Strategy.

Optimise use of existing water supplies

Water resources are finite, and by using water wisely today, we can support thriving and resilient communities in a drier future. Current rules and regulations allow for flexibility in how and when water is extracted, while protecting the environment and other water users. The following actions propose to review these rules to ensure they provide the flexibility needed for local businesses to prepare for and manage drought.

Proposed action 3.4: Enhance coastal water markets

Climate modelling indicates that the Far North Coast region is likely to experience more frequent droughts and drier conditions in the future. Active and effective water markets are important for maintaining a thriving regional economy by enabling industries, especially those reliant on unregulated water, to prepare for drier conditions. Trade could also be used as a key tool in shifting water demands from low flows to high flows in the region's unregulated rivers, consistent with the regional priority to better manage competing demands for water.

This action would:

- investigate why so little trade has occurred in the region's regulated, unregulated and groundwater sources
- identify improvements that can be made to the region's water markets.

The Australian Consumer and Competition Commission (ACCC) identified common elements of effective water markets in its *Murray–Darling Basin Water Markets Inquiry*.[32] This action would assess how well the Far North Coast region's water markets are set up to deliver these key elements in addition to identifying and exploring barriers for participation in the markets. This action would also consider the extent to which the issues and barriers identified in the *Murray–Darling Basin Water Markets Inquiry* would apply to a more developed water market in the Far North Coast region.

The investigation would be informed by forecast behaviour change. It may also require more detailed hydrologic and economic analysis of benefits and costs. It would also be informed by recommendations from the department's review of trade rules in unregulated catchments and a review of the existing long-term average annual extraction limits for surface water and groundwater (proposed action 2.4).

Have your say

What is constraining buying or selling water through the water market on the Far North Coast?

32. Australian Competition and Consumer Commission 2021, *Murray–Darling Basin water markets inquiry*, Australian Competition and Consumer Commission, www.accc.gov.au/publications/murray-darling-basin-water-markets-inquiry-final-report

Proposed action 3.5: Investigate increased on-farm water storage

Increasing the volume of water stored on farms will help landholders in unregulated catchments to manage the impacts of climate change on water security. Furthermore, capturing runoff high in the catchment and applying it for irrigation in drier times will assist in retaining water in the catchment for longer periods.

This action considers water harvested and stored in farm dams under a water access licence, and would investigate:

- current levels of on-farm storage and usage as well as barriers to constructing on-farm dams
- options to mitigate downstream environmental and water security impacts of on-farm storages, such as the provision of low-flow bypasses
- the value of on-farm storages to various Far North Coast region industries and as a local water supply to fight bushfires
- options for incentivising the uptake of on-farm storage.

As farm dams can increase how much licensed water is taken, this action may risk placing further pressure on rivers and streams already under hydrologic stress. This action will have the greatest benefits to extractive users and the least impact on river ecology if considered in conjunction with actions that shift water extraction away from low flows, which is where the greatest pressure from extraction occurs (proposed action 2.5) or through increased trade (proposed action 3.4).

Any proposal to increase on-farm storage will need to be considered and implemented alongside the increase in harvestable rights limits for coastal-draining catchments (proposed action 2.6) and implementation of sustainable extraction limits (proposed action 2.4).

Have your say

Do farm dams (including those with low flow by passes) offer a realistic option for improving water security for landholders and industry?

Image courtesy of iStock. Clarrie Hall Dam, NSW.

Proposed action 3.6: Investigate managed aquifer recharge in the Far North Coast 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, particularly during drought. A range of water sources can be used to recharge aquifers, 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 surface storage of water
- 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, including in the Alstonville Basalt Plateau and North Coast Volcanics groundwater sources. While a site maybe 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.

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 and community consultation will be essential.

Progressing this action would involve investigating the feasibility of local, place-based managed aquifer recharge projects in the Far North Coast region.

Proposed action 3.7: Protect coastal groundwater resources for town water supplies and rural water users

Rural water users can place additional pressure on town water supplies during drought as water carters typically source water from town supplies. Protecting groundwater resources to ensure a drought reserve can help dampen the effects of rural water carting on town supplies during drought by providing an additional source.

The coastal sands of the Far North Coast region are typically shallow, unconfined, highly porous, and highly permeable. These characteristics make coastal sands a ready and available groundwater source, particularly during droughts for both town water supply and rural water users. To ensure the use of coastal sands in drought periods, a proactive approach is essential. This proactive approach would require appropriate policy and infrastructure to ensure adequate groundwater access and sustainable use during times of low surface water availability. Protecting groundwater sources, such as the Tweed–Brunswick Coastal Sands and Alstonville Basalt groundwater sources to provide an emergency drought reserve would require:

- assessing and securing groundwater availability
- assessing and protecting groundwater quality.

This proposed action would require collecting information to assist the NSW Government to plan where to best invest its resources, while also allowing local councils to prepare for future droughts. It would ensure that towns and rural water users in the Far North Coast region will have more certainty during drought conditions.

Investigate alternative water supplies

Projected climate change impacts in the Far North Coast region will require us to ensure that water supply is resilient to changes, and that users have access to alternative water supplies.

Local councils, as part of their integrated water cycle management planning, are already considering local options and alternative water sources to meet future water security challenges. The NSW Government has also committed to progressing statewide initiatives to help overcome regulatory constraints and to work with communities to increase understanding and acceptance of recycled water use.

Proposed action 3.8: Investigate a recycled water plan for the Far North Coast region

Getting the most from our recycled water resources requires us to consider a wide range of recycled water technologies, processes and end uses, all with different costs, benefits and risks. Indirect potable reuse can involve large pumping costs to bring treated wastewater to a dam, while direct potable reuse may be more difficult to manage. Using recycled water for different purposes becomes cost effective at different scales and locations. For example, purified recycled water for drinking may not be cost effective in small towns, but recycling the town's wastewater to a lower quality for agriculture may be. Similarly, purified recycled water for drinking may be feasible in larger centres, particularly if the distance to agricultural land makes supplying recycled water for agriculture too expensive.

The Far North Coast is in a relatively strong position to improve reuse of its wastewater streams. There are 24 municipal sewage treatment plants across the region, each with varying capacities but with a combined capacity of approximately 87 ML/day.[33] Industry and unsewered rural properties are also potential sources of additional wastewater.

The modelling and economic assessments undertaken for the Far North Coast regional water strategy have not been able to fully explore the range of reuse options available. Only options for potable recycled water in the Rous County Council system were considered, as well as some limited use by rural users. These were shown to be expensive for the benefit they provide. However, there may be other more cost-effective ways of improving our use of recycled water. Developing an informed regional view of all the possible sources of, and uses for, recycled water provides an opportunity to optimise our use of this valuable resource.

This action proposes to work collaboratively with local councils, industry and potential water users to identify the best uses of existing and potential recycled water streams around the Far North Coast region. It will build on the important work that many local councils have already been progressing, such as the *Byron Shire Recycled Water Management Strategy*.[34] It will also be informed by work delivered through the *NSW Water Strategy*[35] and the Town Water Risk Reduction Program, which are aimed at overcoming regulatory barriers to cost effective water recycling and at increasing community understanding and acceptance of the concept.

The output of this work would be a recycled water plan for the Far North Coast, which would:

- create clarity around which recycled water options are most feasible for the region and where they are most suited
- provide a framework to guide future investment in recycled water infrastructure
- support councils in their future integrated water cycle management planning
- support industry in its planning for future water access.

Have your say

- Could you use recycled water in your business or enterprise?
- Do you produce wastewater that can be reused?

33. This is current design capacity. Actual inflows to sewage treatment plants in the region are currently significantly less than this.
34. Byron Shire Council 2018, *Byron Shire Recycled Water Management Strategy 2017–2027*, Byron Shire Council
35. Department of Planning, Industry and Environment 2021, *NSW Water Strategy (PUB20/882)*, Department of Planning, Industry and Environment

Image courtesy of Destination NSW. Tweed Valley, NSW.

How to have your say

5

Image courtesy of Destination NSW. Tweed River, NSW.

When will the actions be implemented?

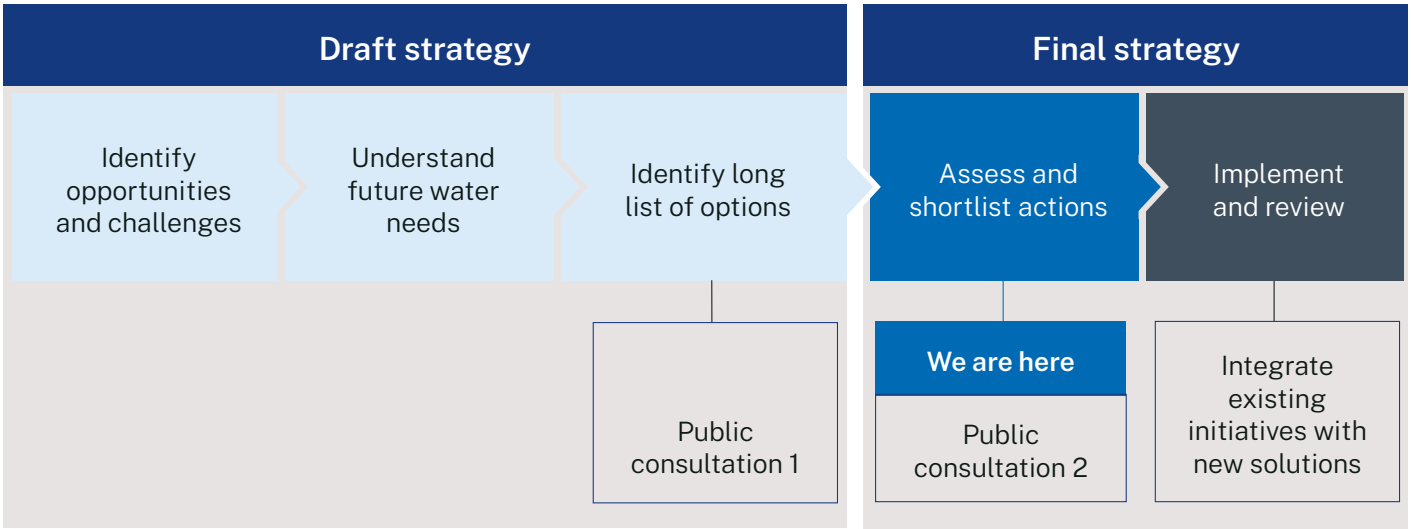
A critical feature of the final Far North Coast Regional Water Strategy is making sure we identify clearly what actions and investments are needed now and those that may be needed further into the future. The strategy considers a 20-year timeframe, aiming to chart a progressive journey that enables us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

After public consultation, we will develop an implementation plan that sets out when we will commence each action and what we will achieve by when. The implementation plan will also identify key partners for delivering these actions, including local councils, other government agencies, local community and industry groups and local Aboriginal communities.

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

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

Figure 16. Far North Coast Regional Water Strategy delivery timeline



The water security actions in this strategy have a strong focus on drought security following the experience of the 2018–2020 drought. However, this drought has been closely followed by major flood events across the state from 2020 to 2022.

Some of our proposed water security actions may also help 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 enhanced investment by governments in flood modelling and mitigation works.

In the interim, the floodplain management plans being developed for inland NSW valleys will provide a template for whole-of-catchment floodplain management across NSW. The Office of Local Government and the Department of Planning and Environment – Environment and Heritage both take leading roles in flood risk management for towns and regional centres across the state.

Your voice is important. This consultation paper is on public exhibition from 1 November to 11 December 2022. Supporting information is available at www.dpie.nsw.gov.au/water/plans-and-programs/water-management-in-far-north-coast-nsw

You can also have your say by providing written feedback to the Department of Planning and Environment by midnight on 11 December 2022 via:

Web: www.dpie.nsw.gov.au/water/plans-and-programs/water-management-in-far-north-coast-nsw

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

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

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

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

We will be holding community engagement sessions to give participants an understanding of the context for the regional water strategy and an overview of the key proposed priorities and actions. Details of these sessions can be found at the website listed above.

Image courtesy of iStock. Lismore, NSW.

Image courtesy of iStock. Lismore, NSW.

Attachments

6

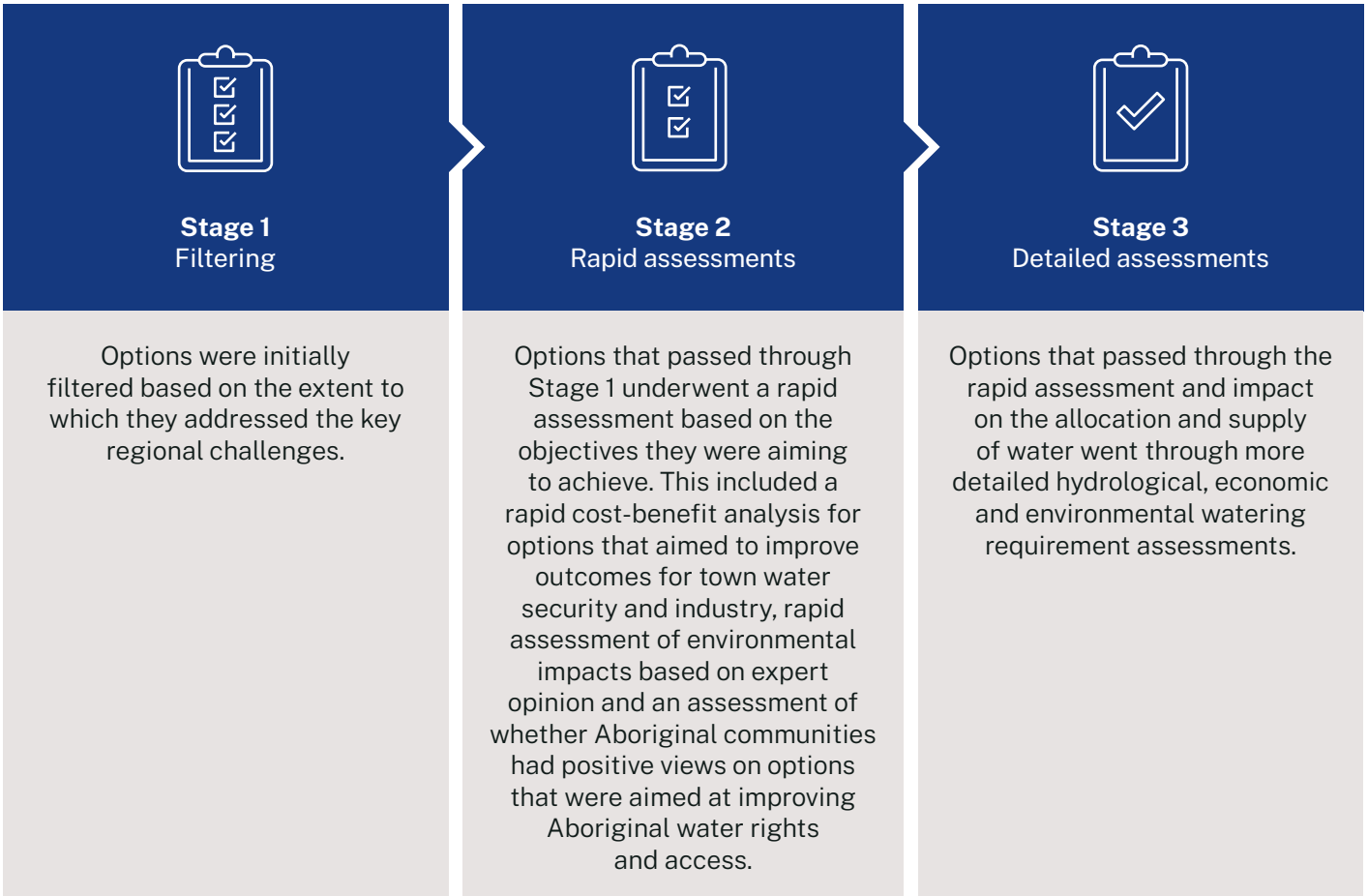
Image courtesy of iStock. Lismore, NSW.

Attachment 1: Summary of the options assessment

The Draft Far North Coast Regional Water Strategy identified 39 draft options. An additional 13 were identified during the public consultation process. During community consultation on this draft long list, we received feedback from a broad range of 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 12 new options to form the proposed shortlist.

The process we followed to move from the long list to the short list is summarised Figure 17 and described in the *Options Assessment Process: Overview.*[36]

Figure 17. Going from a long list to a final strategy of actions



36. Department of Planning and Environment 2022, *Options Assessment Process: Overview,* Department of Planning and Environment, www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/identifying-and-assessing

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

This attachment summarises the outcomes of our options assessment (see Table 5). Results from the cost benefit and environmental watering requirement analyses are 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. Funding will play a role in the sequencing of options.

Why is Dunoon Dam not featured in the Far North Coast Regional Water Strategy?

Dunoon Dam has attracted both strong opposition and support among some parts of the Far North Coast region's communities.

Dunoon Dam is not explicitly included in the shortlist of actions. The strategy's approach is to support local water utilities to progress their own town water supply options. Dunoon Dam has been analysed as part of a combination of water supply connection options.

Our analysis shows that the project has a low benefit-cost ratio as part of a combination of options. However, it also can provide some benefits in eliminating modelled town and community shortfalls under dry conditions. Rous County Council is undertaking separate investigations on Dunoon Dam as part of its integrated water cycle management plan implementation.

Provision of safe, secure, efficient, sustainable, and affordable water supply and sewerage services is primarily the responsibility of local councils. The Far North Coast Regional Water Strategy will support local councils to explore local and regional solutions for water security and reliability.

Image courtesy of WaterNSW. Toonumbar Dam, NSW.

Shortlisting process key

✓ Options progressed to next step

> To be considered in other NSW processes

✕ Option not progressed

Table 5. Assessment of the long list of options

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
1. Interconnection of independent water supplies in the region to the Rous County Council network	✓	✕	Minor/Moderate impact	✓	See proposed action 3.3: Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast.
2. Interconnection of Rous County Council and Tweed Shire Council bulk water supplies	✓	✕	Minor/Moderate impact	✓	See proposed action 3.3: Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast.
3. Use Toonumbar Dam to augment town water supplies	✓	✕	Major/Extreme impact	✓	See proposed action 3.3: Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast.
4. Connect the regional water system to the South East Queensland water grid	✓	Not assessed	Major/ Extreme impact	✓	See proposed action 3.3: Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast.

37. The rapid environmental assessments were based on assessments from 3 groups of agency environmental experts. The likely impacts of many options will depend on the implementation details. Due to the uncertainty in implementation and subsequent levels of impact from many options, the rapid environmental assessment column provides the average of these 3 assessments.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
5. Vulnerability of surface water supplies to sea level rise	✓	Not assessed	Minor/Moderate improvement	✓	Incorporated into: • proposed action 1.6: Assess the vulnerability of surface water supplies to sea level rise and saltwater intrusion • proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources.
6. Remove impediments to water reuse projects	✓	Not assessed	Minor/Moderate improvement	>	This option is being progressed through Action 6.7 of the NSW Water Strategy (Proactive support for water utilities to diversify sources of water).
7. Indirect potable reuse of purified recycled water	✓	✗	Minor/Moderate improvement	✓	See proposed action 3.8: Investigate a recycled water plan for the Far North Coast.
8. Direct potable reuse of purified recycled water	✓	✗	Minor/Moderate improvement	✓	See proposed action 3.8: Investigate a recycled water plan for the Far North Coast.
9. Managed aquifer recharge investigations and policy	✓	Not assessed	No/little change	✓	See proposed action 3.6: Investigate managed aquifer recharge in the Far North Coast region.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
10. Decentralised desalination	✓	✗	No/little change	✗	This action option has not been shortlisted at this time. However, economic assessments suggest that scaling up desalination over time may be more cost-effective than a large augmentation. This option will be reassessed in future reviews of the regional water strategy. See proposed action: 3.3: Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast.
11. Regional desalination	✓	✗	No/little change	✗	This option will be reassessed in future reviews of the regional water strategy.
12. Raise Clarrie Hall Dam level	✓	✗	Major/Extreme impact	>	Tweed Shire Council is progressing this project. Public consultation on the Environmental Impact Statement concluded in March 2021.
13. New dam on Byrrill Creek	✓	Not assessed	Major/Extreme impact	✗	This option has large ecological impacts and is no longer supported by the proponent (Tweed Shire Council).
14. New Dunoon Dam on Rocky Creek	✓	✗	Major/Extreme impact	✗	See proposed action 3.3: Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
15. Increased harvestable rights	✓	Not assessed	Catchment based assessments are being undertaken given changes to the Harvestable Rights policy (see comments).	✓	See proposed action 2.6: Address catchment-based impacts of increased harvestable rights limits. The environmental assessment of this option recognises the risk of new dams being constructed to the 30% limit prior to: a) local scale assessments having been undertaken; and b) the setting of sustainable extraction limits (see proposed action 2.4). The intent of this option has been changed to address these issues. Stakeholders have requested that the recent changes to harvestable rights be supported by further detailed assessments at the local scale to understand the impact of the change and that provision is made to adjust the limit depending on the outcome of the assessments. The revised action also describes management levers to ensure current and future uptake in harvestable rights is considered in updated coastal water sharing arrangements and plans, including long term average annual extraction limits, trade and water supply approval works. Provided these measures are put in place, it is expected risk ratings for the original option would be reduced to an acceptable level.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
16. Provide recycled wastewater for industry and rural users	✓	✗	Minor/Moderate improvement	✓	All options relating to recycled water have been merged into proposed action 3.8: Investigate a recycled water plan for the Far North Coast.
17. Increased on-farm water storage	✓	Not assessed	No/little change	✓	See proposed action 3.5: Investigate increased on-farm water storage.
18. A grid of off-stream storages in the Far North Coast region	✗	Not assessed	Major/Extreme impact	✗	Does not effectively address a regional challenge. Feedback during public exhibition was that *Option 17 Increased on-farm water storage* provided a more realistic alternative.
19. Raise Toonumbar Dam level	✓	✗	Minor/Moderate impact	✗	This option is not cost-effective at present. However, it may become more cost-effective if intensive horticulture increased in the regulated system, if Toonumbar Dam is accessed for town water supplies, or if a link to the Rous County Council bulk water supply system was pursued. This option will be reassessed in future reviews of the regional water strategy. See proposed action 3.3: Support regional-scale, adaptive decision-making for town water supplies in the Far North Coast.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
20. Establish sustainable extraction limits for Far North Coast surface water and groundwater sources	✓	Not assessed	Major/Extreme improvement	✓	See proposed action 2.4: Establish sustainable extraction limits for surface water and groundwater sources.
21. Establish and/or increase environmental water releases from major storages in the Far North Coast	✓	✗	Major/Extreme improvement	✓	This option has been incorporated into proposed action 1.7: Identify environmental water needs to support healthy coastal waterways.
22. Convert low flow water access licences to high flow water access licences	✓	Not assessed	Minor/Moderate improvement	✓	See proposed action 2.5: Reduce the take of low flows.
23. Improve stormwater management	✓	Not assessed	Minor/Moderate improvement	>	This option will be considered as part Management Initiative 1 of the Marine Estate Management Strategy.
24. Bringing back riverine and estuarine habitats and threatened species	✓	Not assessed	Major/Extreme improvement	✓	Incorporated into proposed action 1.4: Deliver a rehabilitation program.
25. Fish-friendly water extraction	✓	Not assessed	Major/Extreme improvement	✓	See proposed action 2.2: Implement fish-friendly water extraction.
26. Improve fish passage in the Far North Coast region	✓	Not assessed	Major/Extreme improvement	✓	See proposed action 2.1: Improve fish passage.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
27. Addressing cold water pollution	✓	Not assessed	Major/Extreme improvement	✓	See proposed action 2.3: Address cold water pollution.
28. Characterising coastal groundwater resources	✓	Not assessed	Minor/Moderate improvement	✓	See proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources.
29. Protecting ecosystems that depend on coastal groundwater resources	✓	Not assessed	Minor/Moderate improvement	✓	See proposed action 1.9: Protect ecosystems that depend on coastal groundwater.
30. Northern Rivers Watershed Initiative	✓	Not assessed	Major/Extreme improvement	>	Funding for these types of works is progressed through existing programs such as the Marine Estate Management Strategy and Coastal Management Plans. Local councils may be supported to implement this option through proposed action 1.3: Support whole-of-catchment governance. Many of the aims of this option will be addressed through proposed action 1.4: Deliver a river rehabilitation program.
31. River Recovery Program for the Far North Coast: a region-wide program of instream works, riparian vegetation and sediment control	✓	Not assessed	Major/Extreme improvement	✓	See proposed action 1.4: Deliver a river rehabilitation program.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
32. Improved data collection and information sharing*	✓	Not assessed	Minor/Moderate improvement	✓	Incorporated into: • proposed action 1.10: Improve monitoring of water extraction • proposed action 3.2: Provide better information about water availability and climate risks.
33. Active and effective water markets	✓	Not assessed	Minor/Moderate impact	✓	See proposed action 3.4: Enhance coastal water markets.
34. Regional demand management program	✓	Not assessed	Minor/Moderate improvement	›	Rous County Council supports regional demand management and drought planning for its constituent councils and the bulk supply system. Tweed Shire Council also actively implements demand management and drought planning. The barriers and opportunities for regional demand management planning identified by the Northern Rivers Water Group[38] will largely be addressed through the NSW Water Strategy Action 4.3 Improve drought planning, preparation and resilience, and Action 6.6 A new statewide Water Efficiency Framework and Program.

38. Northern Rivers Water Group 2015, *Regional Demand Management Plan*, Northern Rivers Water Group

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
35. Regional network efficiency audit	✓	Not assessed	Minor/Moderate improvement	>	This option will be considered through Action 6.6 of the NSW Water Strategy – A new statewide Water Efficiency Framework and Program.
36. Apply the NSW Extreme Events Policy to the Far North Coast region	✓	Not assessed	No/little change	>	This option is being considered through Action 4.3 of the NSW Water Strategy – Improve drought planning, preparation and resilience.
37. Protecting coastal groundwater resources for town water supplies and rural water users	✓	Not assessed	Major/Extreme improvement	✓	See proposed action 3.7: Protect coastal groundwater resources for town water supplies and rural water users.
38. Planning for climate change impacts on coastal groundwater resources	✓	Not assessed	Minor/Moderate improvement	✓	Incorporated into proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources.
39. Planning for land use pressures on coastal groundwater resources	✓	Not assessed	Minor/Moderate improvement	✓	See proposed action 1.12: Plan for land use pressures on coastal groundwater resources.
NC-1.7: Identify environmental water needs to support healthy coastal waterways	✓	Not assessed	Not assessed	✓	Option proposed for North Coast regional water strategy and adopted for all coastal strategies. See proposed action 1.7: Identify environmental water needs to support healthy coastal waterways.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
NC-1.5: Advisory services and projects that support landholder adoption of best practice land management	✓	Not assessed	Not assessed	✓	See proposed action 1.5: Support landholder adoption of best practice land management.
PE-1: Recognise and support Landcare programs that support volunteers and land managers to better manage the catchment in a whole range of issues	✓	Not assessed	Not assessed	>	Supported through proposed action 1.3: Support whole-of-catchment governance.
PE-2: Develop a whole-of-government position on historical floodplain drainage systems	✓	Not assessed	Not assessed	>	Addressed through a review of coastal drainage management being conducted as part of initiative 1 of the Marine Estate Management Strategy (improving water quality and reducing litter).
PE-3: Develop a detailed Richmond River catchment-wide flood model, including investigating and developing specific options for flood mitigation	✓	Not assessed	Not assessed	✓	See proposed action 1.11: Support councils to improve catchment-scale flood modelling in the Richmond River catchment.
PE-4: Renewable-powered solutions, such as Zero Mass Water, can roll out community by community, as needed, to solve drinking water shortage issues, with minimal environmental impact, at a cost which is now competitive with other solutions (for example, as used in Murrurundi, NSW)	✓	Not assessed	Not assessed	>	The selection of specific technologies for domestic supplies remains the responsibility of individual households and local councils. However, NSW Government aims to improve the adoption of new water sources and efficiency measures through the NSW Water Strategy Action 6.6 A new state-wide Water Efficiency Framework and Program and Action 7.1 Pilot new technologies to increase our water options.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
PE-5: Raise Rocky Creek Dam wall by 1+ metres	✓	Not assessed	Not assessed	✗	Engineering constraints make raising Rock Creek Dam very challenging and expensive.
PE-6: Increase height of Bray Park Weir to mitigate saltwater breaching the fresh water supply	✓	Not assessed	Not assessed	>	Tweed Shire Council is progressing the Bray Park Weir Tidal Protection Project. The preferred options recommended by the Project Reference Group is a hinged (moveable) barrier across the entire weir.
PE-7: Remove the concrete drainage channels and restore a functioning vegetated ecosystem instead	✓	Not assessed	Not assessed	>	The Marine Estate Management Strategy aims to improve stormwater management through Initiative 1: Improving water quality and reducing litter. Through this initiative, the Department of Planning and Environment – Environment and Heritage Group is piloting the risk-based framework with local councils to help identify the actions they can take to manage stormwater and improve the health of their waterways.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
PE-8: Investigate a combined infrastructure solution in the Tuckean Swamp area – high quality modelling would facilitate the evaluation of a water attenuation device to store flooding rains and run off from the Alstonville Plateau and the continual release of water through the Bagotville drainage system	✓	Not assessed	Not assessed	✗	The Bagotville Barrage currently discharges large volumes of acidic water and has major environmental impacts. The Tuckean Swamp Restoration is being pursued by OzFish. As part of the restoration project, a detailed model of the Tuckean Swamp area has been developed by the UNSW Water Research Laboratory. This study assessed a number of hydrologic options for improving water quality and drainage outcomes for the Tuckean Swamp.
PE-9: An off-creek storage in Byron Bay to supply Mullumbimby with water	✓	Not assessed	Not assessed	✗	This option would not be feasible based on the pipe and pumping costs compared to the benefit it would provide. Local councils identify additional water supplies for their local government areas. The department supports local councils to source additional water through a number of avenues including the integrated water cycle management planning process.
PE-10: A water audit of the area to see where water is being wasted. There are numerous leaking council mains	✓	Not assessed	Not assessed	>	This option will be considered through Action 6.6 of the NSW Water Strategy – A new state-wide Water Efficiency Framework and Program.

Long list option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis?	Rapid environmental assessment[37]		
PE-11: Invest in a research facility specifically for agricultural water security, focused on developing science and technologies for drought resilience	✓	Not assessed	Not assessed	✗	See proposed action 1.5: Support landholder adoption of best practice land management.
PE-12: Make it a requirement for any new or existing residential developments to use rainwater tanks in urban areas and recycled grey water systems; provide subsidies if appropriate	✓	Not assessed	Not assessed	>	This option will be considered through Action 6.6 of the NSW Water Strategy – A new state-wide Water Efficiency Framework and Program.
PE-13: Develop a map of mining to identify sensitive areas, drinking water catchments, heritage sites, and places of environmental significance, and scenic beauty, where mining simply should not occur, and declare them off-limits	✗	Not assessed	Not assessed	✗	The regulation of mining exploration is managed under the Mining Act 1992, and any new mining leases require that a development consent under the Environmental Planning and Assessment Act 1979 be in place before any title is granted. Statutory requirements, which may include community consultation and an Environmental Impact Statement, would also apply during the development consent process.

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 presented in the *Draft Far North Coast Regional Water Strategy*. It outlines the results of 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 stochastic and climate-change adjusted (NARCliM) data sets.[39] These results include the probability and timing of modelled water system shortfalls for the towns and communities of the Far North Coast region. They also consider modelled changes to flow regimes and their environmental impacts.

The concept of town shortfalls in the context of the regional water strategy differs from that referenced in the water security/secure yield analysis completed as part of the integrated water cycle management strategy for each town. Shortfalls for towns within the regional water strategy consider the availability of licensed extracted surface water only. Due to the different considerations between the 2 metrics, town shortfalls considered within this document should not be viewed as a replacement for a water security/secure yield analysis.

The results of the rapid CBA process did not highlight any particular option as preferred for improving town water reliability. As such, the combinations of options assessed through the detailed assessment process were selected subjectively based on the perceived needs of the region and the professional expertise of the assessment team.

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 Far North Coast.

Regional water strategy modelling and flood analysis

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

39. For details on these data set see water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/climate-data-and-modelling

Limitations of cost-benefit analysis

The analyses used in the regional water strategies follow the advice of NSW Treasury. This advice suggests using cost-benefit analysis (CBA) to understand how well options meet the service need in each region.

CBA analysis provides a method of evaluating options across the state in a consistent and reliable way. It also lets us compare the performance of different options for improving town water reliability with a state-wide perspective. This analysis is different from the methodology used by local water utilities to determine their water security and their ability to meet service standards (see above).

There are 2 key challenges that we face when applying the CBA analysis to the Far North Coast:

- It is not possible to obtain an accurate cost for a major town running out of potable water because it has not happened to any major industrialised city.[40] This makes it difficult to accurately capture the cost of not having water available, which might bias the CBA.
- The CBA analysis assumes perfect knowledge of the hydrology. It assumes that if shortfalls justify it, action can be taken 2 years before an emergency augmentation is required.

These 2 challenges mean that if shortfalls occur very infrequently they are not valued in a way that is captured by the state-wide approach. This is true regardless of the costs incurred by the shortfalls.

None of our hydrologic models in the Far North Coast resulted in shortfalls that lasted for 2 years or more. However, the region does not have the same levels of water storage that many other regions have available. For example, Rocky Creek Dam has just over 12 months supply with no restrictions. The dam has about 18 months supply if water restrictions are put in place.

The towns and communities in the Far North Coast are relatively large. This means that it can take a long time to make an emergency source of water available. Examples of emergency sources of water in the Tweed local government area are desalination and connecting to the City of Gold Coast or Seqwater networks.

These supply options have high capital costs and operational costs. Additional considerations are:

- If the Tweed area is in drought, it is likely that southeast Queensland will also be in drought. This would make it challenging to connect to these other networks and would reduce their effectiveness.
- During a drought there is likely to be a scarcity of membranes available for desalination. This would increase the time it would take to have a desalination plan operational.
- Planning and implementing these emergency measures can take 12 months or more.

To avoid running out of water, councils need to plan for emergency augmentations early in a drought. We recognise the hard work that councils are doing in this area. With current storage conditions, councils need to start planning these augmentations when storages are still quite full. For example, to allow for a 12-month planning horizon, Tweed Shire Council currently needs to plan for emergency supplies once Clarrie Hall Dam drops to about 97% capacity. As demand increases and climate change reduces inflows, dam levels will drop faster and they will need to start planning augmentations much earlier. Some models suggest that by 2030 Tweed Shire Council will need to start planning emergency augmentations when Clarrie Hall Dam is completely full.

There are many other factors to consider when assessing options for town water supplies. In particular, local councils have statutory requirements to provide certain levels of service for water provision. They also need to ensure that:

- communities are protected as much as possible from the risk of water system failure, and
- residents have continuous access to safe water for drinking and essential services.

Councils in the Far North Coast region must consider and plan for risks of these failures. To account for these factors in the Far North Coast, the department is progressing additional analyses that will better consider these risks and lead times. The analyses have not been completed in time for the release of this consultation paper. However, the results will be available to inform the final strategy.

40. Cape Town is frequently thought of as an industrialised town to run out of water. However, the 'Day Zero event' did not actually eventuate. It was only planned for.

Rapid cost-benefit analysis

Introduction

The following options from the *Draft Far North Coast Regional Water Strategy* were rapidly assessed for hydrologic and economic impacts and benefits:[41]

- Option 1: Connect independent water supplies in the region to the Rous County Council network
- Option 2: Connect the Rous County Council and Tweed Shire Council bulk water supplies
- Option 3: Use Toonumbar Dam to augment town water supplies
- Option 7: Investigate indirect potable reuse of purified recycled water
- Option 8: Investigate direct potable reuse of purified recycled water
- Option 10: Investigate decentralised desalination
- Option 11: Investigate regional desalination
- Option 12: Raise Clarrie Hall Dam level
- Option 14: Construct a new Dunoon Dam on Rocky Creek
- Option 16: Provide purified recycled wastewater for industry and rural users
- Option 19: Raise Toonumbar Dam level
- Option 21: Establish and/or increase environmental water releases from major storages in the Far North Coast.

There were 2 key limitations of the rapid cost-benefit analysis (CBA) relevant to all options:

1. 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.
2. No population growth was considered in rapid cost-benefit assessment. This is significant in the Far North Coast where populations are expected to rise substantially over the next 40 years.

These limitations mean that town water supplies in the Far North Coast do not display reliability issues under the rapid CBA. As a consequence, none of the options aimed at improving town water supply reliability were identified as suitable or valid.

Due to these limitations, we have not used the rapid CBA to select combinations of options for the detailed economic and ecological analyses.

41. Details of the rapid cost-benefit assessment methodology are provided in Department of Planning and Environment 2022, *Options Assessment Process: Overview*, Department of Planning and Environment, www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/identifying-and-assessing

Rapid cost-benefit analysis results

A summary of all the rapid cost benefit analysis results is provided below in Table 6. More context around these results is presented in the discussions that follow.

Table 6. Summarised results of rapid cost-benefit analysis for all options modelled

Option number	Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
	Towns	Perennial pasture	Total			
1	+0	+0	0.0	275	-274.5	<0.01
2 (version 1)	+0	+7.6 (1.4%)	7.6 (1.4%)	82	-82	0.1
2 (version 2)	+0	+7.6 (1.4%)	7.6 (1.4%)	82	-82	0.1
3 (version 1)	+0	+0	+0	$1 (nominal)	-$1	<0.01
3 (version 2)	+0	-2 (-0.4%)	-2 (-0.4%)	$162	-164	< 0.01
7 & 8	+0	+0	+0	881	-881	<0.01
10	+0	+0	+0	1597	-1,597	<0.01
11 (version 1)	+0	+0	+0	582.8	-582.7	<0.01
11 (version 2)	+0	+0	+0	938.0	-938.0	<0.01
11 (version 3)	+0	+0	+0	1,293.3	-1,293.2	<0.01
12	+0	+0	+0	141	-140.9	0.0
14	+0	+0	+0	541	-540.6	< 0.01
16	+0	+0.9 (0.2)	+0.9	$100	-$99	<0.01
19	+0	+0	+0	454	-453.6	< 0.01
21	+0	+0	+0.5	–	0.5	–

Option 1: Connect independent water supplies in the region to the Rous County Council network

Purpose	Increase security of town water supplies in the Far North Coast.
Description	Byron Shire, Ballina Shire, Lismore City, and Richmond Valley councils all operate at least one town water supply that is not connected to the Rous County Council bulk water supply network. Connection of these towns into the regional Rous County Council network would increase their water security and resilience. The regional water strategy assessed the connection of Casino, Kyogle, Mullumbimby and Nimbin/Channon water supplies to Rous County Council's bulk water supply network.
Results	This option gives a very low benefit-cost ratio. However, this option may be worth considering if it can help improve the overall reliability of towns and communities in the region and delay alternative augmentation options. The benefit to town water supplies is small because the instrumental record shows that water supply is relatively secure. This means the existing costs of economic shortfalls are less than the cost of the option.

Table 7. Option 1 – summary model results

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+0	0.0	275	-274.5	<0.01

Option 2: Connect the Rous County Council and Tweed Shire Council bulk water supplies

Purpose	Increase security of town water supplies in the Far North Coast.
Description	This option connects the Rous County Council and Tweed Shire Council bulk water supplies via a pipeline between Pottsville (Tweed) and Ocean Shores (Rous). This improves system resilience by increasing and diversifying the water supplies available in both the Tweed and Rous regions. Two variations of this option were modelled: • version 1 assumes the Tweed water supply system is operated to supply as much of the Rous bulk water demand as possible • version 2 assumes the Tweed water supply system would only supply water to the Rous bulk water supply system to overcome supply shortfalls.
Results – Version 1	Version 1 produces a very low benefit-cost ratio. This option may be worth considering if it can help improve the overall reliability of water supply to towns and communities in the region and delay alternative augmentation options. The benefit to town water supply is small because the instrumental record shows that Rous County Council's water supply is relatively secure. This means the existing costs of economic shortfalls are less than the cost of the option.
Results – Version 2	This version of the option also produces a very low benefit-cost ratio. However, like the previous version, it may be worth considering if it can help improve the overall reliability of towns and communities in the region and delay alternative augmentation options.

Table 8. Option 2 – summary model results – version 1

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+7.6 (1.4%)	7.6 (1.4%)	82	-82	0.1

Table 9. Option 2 – summary model results – version 2

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+7.6 (1.4%)	7.6 (1.4%)	82	-82	0.1

Option 3: Use Toonumbar Dam to augment town water supplies

Purpose	Connect Toonumbar Dam to town water supply networks to increase town water security for the region.
Description	The draft regional water strategy identified several variations of this option. Two variations were assessed: • version 1 supplies Casino from Toonumbar Dam by delivering water to Jabour Weir via the Richmond River • version 2 supplements Rous County Council's bulk water supply by delivering water from Toonumbar Dam to a pipeline located upstream of Jabour Weir via the Richmond River.
Results – Version 1	This version of the option produces a very low benefit-cost ratio. However, it may be worth considering if it can help improve the overall reliability of towns and communities in the region and delay alternative augmentation options.
Results – Version 2	This version of the option also produces a very low benefit-cost ratio. However, like the previous version, it may be worth considering if it can help improve the overall reliability of towns and communities in the region and delay alternative augmentation options.

Table 10. Option 3 – summary model results – version 1

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	**Perennial pasture**	**Total**			
+0	+0	+0	$1 (nominal)	-$1	<0.01

Table 11. Option 3 – summary model results – version 2

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	-2 (-0.4%)	-2 (-0.4%)	$162	-164	< 0.01

Options 7 and 8: Investigate reuse of purified recycled water

Purpose	Introduce purified recycled water into the Rous County Council bulk water supply system.
Description	Highly treated wastewater from sewage treatment plants has the potential to be a reliable, safe and mostly climate-independent water source. This option investigated the potential of existing wastewater sources to reduce shortfalls in the Rous County Council bulk water supply network. The wastewater sources modelled included:

Lismore City	Ballina Shire	Byron Shire
East Lismore (3.25 ML/day)	Ballina (13.5 ML/day)	Byron Bay (13.1 ML/day)
South Lismore (3.25 ML/day)	Lennox Head (10.5 ML/day)	Brunswick Heads (7.2 ML/day)
Perradenya Estate (0.2 ML/day)	Alstonville (3.6 ML/day)	

Water for drinking requires higher levels of treatment and purification than water used by agriculture and industry.

Results	This option produces a very low benefit-cost ratio. The cost to treat the water is generally higher than the value of the water produced.

Table 12. Option 7 and 8 – summary model results

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	Perennial pasture	Total			
+0	+0	+0	881	-881	<0.01

Option 10: Investigate decentralised desalination

Purpose	Introduce water produced from small, local-scale desalination into the Rous County Council bulk water supply system.
Description	Decentralised, small-scale, often modular desalination plants can be sited close to a water demand. It is possible to site several of these water plants across the region to supply local demands or to feed into the Rous County Council bulk water supply network. Decentralised desalination plants can be scaled up as the water demand of a town or region grows, or to respond to prolonged droughts or extreme events. Several sites have been identified as suitable for local-scale desalination, including Tyagarah and South Ballina. The assessment assumed the plants introduced a constant supply of 10 ML/day of desalinated water to the Rous County Council system.
Results	The option did not produce economic value, with a very low benefit-cost ratio. This may be due to the instrumental data having few town water supply shortfalls. *This option progressed to the detailed assessment.*

Table 13. Option 10 – summary model results

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+0	+0	1,597	-1,597	<0.01

Option 11: Investigate regional desalination

Purpose	Introduce water produced from a large, regional-scale desalination plant into the Rous County Council and Tweed Shire Council bulk water supply system.
Description	Desalination offers a virtually unlimited, climate-independent source of water. A regional desalination facility would be able to supplement supply for the entire region, connected to the bulk water supply network. A site south of Pottsville has been identified as a potential location, as it could service both the Rous and Tweed systems. Three variations of this option were assessed based on size: 10 ML/day, 20 ML/day and 30 ML/day.
Results	All 3 variations of this option produced a very low benefit-cost ratio. However, it may be worth considering if it can help improve the overall reliability of towns and communities in the region and delay alternative augmentation options. *Option progressed to the detailed assessment.*

Table 14. Option 11 – summary model results – version 1, 10 ML/day

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	Perennial pasture	Total			
+0	+0	+0	582.8	-582.7	<0.01

Table 15. Option 11 – summary model results – version 2, 20 ML/day

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	Perennial pasture	Total			
+0	+0	+0	938.0	-938.0	<0.01

Table 16. Option 11 – summary model results – version 3, 30 ML/day

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	Perennial pasture	Total			
+0	+0	+0	1,293.3	-1,293.2	<0.01

Option 12: Raise Clarrie Hall Dam level

Purpose	Augment the Tweed water supply system by raising Clarrie Hall Dam by 8.5 m.
Description	Raising Clarrie Hall Dam, located on Doon Doon Creek 15 km south-west of Murwillumbah, will increase its capacity from 16 GL to 42.3 GL. Tweed Shire Council has identified this as the best option for augmenting its water supply.
Results	The option does not appear to provide any benefits based on the instrumental climate record. However, planning for this project has already progressed significantly. We have therefore included it in the detailed assessments. Local councils have statutory requirements to meet certain levels of service for water provision. This analysis alone should not be definitive in councils' decision-making. Further information on the limitations of this analysis can be found on pages 117-8. *Option progressed to the detailed assessment.*

Table 17. Option 12 – summary model results

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+0	+0	141	-140.9	0.0

Option 14: Construct a new Dunoon Dam on Rocky Creek

Purpose	Augment the Rous County Council bulk water supply system by constructing a new dam on Rocky Creek.
Description	A new dam at Dunoon was first proposed in 1995. The proposed site is on Rocky Creek, downstream of the existing Rocky Creek Dam. Three different full-storage capacity variations have been proposed: 20 GL, 50 GL and 85 GL. Most recently, Rous County Council has assessed the 50 GL option. The *Draft Far North Coast Regional Water Strategy* assessed the 50 GL variation.
Results	The option does not appear to provide any benefits based on the instrumental climate record. However, planning for this project has already progressed significantly. We have therefore included it in the detailed assessments. *Option progressed to the detailed assessment.*

Table 18. Option 14 – summary model results

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+0	+0	541	-540.6	< 0.01

Option 16: Provide purified recycled wastewater for industry and rural users

Purpose	Supply purified recycled water to industry and rural water users.
Description	Highly purified recycled wastewater from sewage treatment plants has the potential to be a reliable, safe and climate-independent water source. The use of treated wastewater for industry and rural water users presents an opportunity to both support industry growth and reduce pressure on town water supplies and other water sources. This option investigated supplying recycled water to industry and rural water users from Lismore City's 3 sewage treatment plants at East Lismore (3.25 ML/day), South Lismore (3.25 ML/day) and Perradenya Estate (0.2 ML/day). Sites in Ballina Shire and Byron Shire were not chosen due to model limitations.
Results	The cost of purifying recycled water to a level suitable for industry or rural users currently appears to outweigh the benefits associated with it.

Table 19. Option 16 – summary model results

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+0.9 (0.2)	+0.9	$100	-$99	<0.01

Option 19: Raise Toonumbar Dam level

Purpose	Raise the Toonumbar Dam level to increase storage capacity and encourage higher water use in the regulated Richmond River system.
Description	Toonumbar Dam is located on Iron Pot Creek in the Richmond Valley and is used to supply rural water users in the regulated Richmond River system. WaterNSW has investigated 3 different dam-raising levels in the past – 6 m, 10 m and 20 m – and determined 6 m to be the optimum level. This assessment considered the costs and benefits of a 6 m variation to regulated system water users.
Results	This version of the option produces a very low benefit-cost ratio. This option progressed to the detailed assessment due to the potential to combine it with option 3 to increase security of town water supplies.

Table 20. Option 19 – summary model results

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+0	+0	454	-453.6	< 0.01

Option 21: Establish and/or increase environmental water releases from major storages in the Far North Coast

Purpose	Establish and/or increase environmental release requirements or environmental contingency allowances from major storages in the Far North Coast region.
Description	A 1,000 ML/year environmental contingency allowance (ECA) was set aside in Toonumbar Dam for the first 5 years of the Richmond River Water Sharing Plan to help manage critical environmental events downstream and to maintain aquatic ecosystem health. However, the ECA provision was never used and expired in 2016. This assessment modelled the Toonumbar ECA as if it had not expired.
Results	This option aims to achieve environmental outcomes. As a consequence, no rapid cost-benefit was calculated since the environmental benefits have not been quantified.
Limitations	The model has to make unrealistic assumptions about demand. The model assumes that the entire environmental contingency allowance is used as a planned release of 125 ML/day for 8 days each November. In reality, environmental contingency allowances are linked to water quality events.

Table 21. Option 21 – summary model results

Average change in economic outcomes ($ million, over 40 years and % change)			Option cost ($ million, over 40 years)	Net present value ($ million, over 40 years)	Benefit to cost ratio
Towns	**Perennial pasture**	**Total**			
+0	+0	+0.5	–	0.5	–

Detailed economic and ecological analysis

Base case hydrologic assessment

Overview

In the past, water infrastructure and policy changes have been assessed against the historic set of instrumental data. However, 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. 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 NARCliM[42] 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.[43] 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 Far North Coast 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. The town water supply systems that are represented within the hydrologic models and for which the CBA can be undertaken are:

- Tweed River catchment: Tweed Shire Council bulk supply system (Tweed Heads and Murwillumbah); independent systems for the towns of Uki and Tyalgum
- Richmond River catchment: Rous County Council bulk supply system (Ballina Shire Council, Byron Shire Council, Lismore City Council, Richmond Valley Council); Kyogle Council supply system; independent systems for the towns of Casino, Mullumbimby and Nimbin.

We know that population changes in the Far North Coast will also have a large impact on future water security. To address the uncertainty inherent in future population, the economic assessments were carried out using 2 different population projections (Table 22) which provide a likely lower and upper bound to population growth. The 2 different population projections are:

1. *Common planning assumptions:* The official NSW Government projections that are consistent with the NSW Treasury recommendations for estimating future populations across the state.
2. *Local government projections:* Some local councils in the Far North Coast have made their own estimates of future population. These typically predict higher population growth than the common planning assumptions projections.

Table 22. Far North Coast population projections: Common planning assumptions and local government forecast growth 2020–2060

LGA	Common planning assumptions projection increase	Local government projection increase
Rous County Council	8%	31%
Tweed Shire Council[44]	24%	83%

42. NARCliM (NSW and ACT Regional Climate Modelling) is a partnership between the NSW, ACT and South Australian Governments and the Climate Change Research Centre at the University of NSW. NARCliM produces robust regional climate projections that can be used to plan for the range of likely climate futures. Further information about NARCliM modelling can be found at www.climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/About-NARCliM
43. There are 1,000 realisations for each of the stochastic and NARCliM datasets. The realisations are drawn from 40-year rolling windows of the stochastically generated climate datasets, with a 9-year overlap between windows.
44. Projected increases are for Tweed Heads and Murwillumbah only

Some towns and communities across the region are currently predicted to experience very low population increases,[45] or a declining population, over the next 40 years. These towns – such as Casino, Kyogle, Nimbin and Uki – have been modelled using a static demand. For most of these towns, this provides a conservative estimate of future demand. Real life demands are likely to be less than what has been modelled.

The concept of town shortfalls in the context of the regional water strategy differs from that referenced in the water security/secure yield analysis completed as part of the integrated water cycle management strategies by different councils. Shortfalls for towns within the regional water strategy consider the availability of licensed extracted surface water only. Due to the different considerations between the 2 metrics, town shortfalls considered within this document should not be viewed as a replacement for a water security/secure yield analysis. It provides insights into surface water availability risks for towns and may be considered in future revisions of integrated water cycle management strategies.[46]

Results

The results below illustrate the performance of the region's town water supply systems. The discussion focusses primarily on modelled cumulative supply shortfalls.[47] For each of the town water supply systems we have presented the minimum shortfall (best-case realisation), median shortfall (the exact middle realisation) and the maximum shortfall (worst-case realisation).

These modelled cumulative shortfalls are presented in Figure 18 and Figure 19. The figures present the minimum, median and maximum cumulative shortfalls for the stochastic climate scenario and the NARCliM climate scenario for both population projections. These figures show the likely spread of plausible outcomes over all the 40-year realisations simulated for the region and the associated economic outcomes for town water supplies over time. The figures suggest that the shortfall volume for town water supplies over the next 40 years is likely to be between the 2 sets of dotted lines that indicate the minimum and maximum cumulative shortfall. It should be noted that the dotted lines may overlap where the models predict zero or very low shortfalls.

Our modelling shows that the projected town water supply shortfalls modelled under the stochastic climate scenario are typically low for both the population projections. This can be seen in Figure 18 and Figure 19 as the solid yellow line remains fairly flat over the 40-year periods for most town supplies.

The maximum shortfall (worst-case) realisation showed a significant spike in cumulative shortfalls after about 35 years. Using the common planning assumptions population projections, the magnitude of these shortfalls for most water supply systems was similar when modelled under both the stochastic and NARCliM climate scenarios. However, the maximum shortfall for the Tweed (Bray Park Weir) system was significantly higher for the NARCliM climate scenarios than for the stochastic climate scenarios.

For most systems, the maximum shortfall curve only deviates significantly from the median shortfall curve at about 35 years of simulation. At this point, the cumulative shortfalls grew by approximately 15 times which represents a sustained period of low water availability, albeit at low levels.

In summary, town water supplies across the region appear to be relatively secure across all modelled climate and population scenarios. In general, modelled supply shortfalls increased after approximately 35 years and were more frequent under the NARCliM climate scenario. Modelled shortfalls were also significantly worse using the local government population projections (higher population). This suggests that population increase is likely to be a major driver of future water supply risks in the region. However, the modelled shortfalls were relatively small in terms of the overall demands for the different supply systems.

45. Very low population increases means increases of less than 5% over the next 20 years. Very low population increases are not expected to substantially increase water demand.
46. For more details on how the IWCM and RWS relate, see water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/faqs
47. A supply shortfall is defined as the difference between the demand volume and the water that can be supplied. It is important to note that the models do not account for water restrictions or other efficiency measures put in place during drought. As such, these results will over-estimate the risks to town water supplies.

Tweed Shire Council system

For the Bray Park Weir system, both the stochastic and NARCliM climate scenarios had very low cumulative shortfalls under the common planning assumptions population projections. It is only towards the end of the 40-year period that shortfalls accumulated at all, but only for the extreme realisations (1% probability of occurring). Under the local government population projections, the shortfalls under the worst-case realisation were considerably greater even if they only appeared towards the end of the 40-year model period. The town water supply system for Uki behaved similarly and showed extremely low probabilities of shortfalls for most realisations.

Rous County Council system

The median model realisation for the Rous County Council bulk water supply system showed zero cumulative shortfalls over the 40-year period when using the common planning assumptions population projections. However, the model predicted earlier and higher shortfalls when using the local government population projections. The worst-case modelled realisations for both the stochastic and NARCliM climate scenarios showed shortfalls at about 35 years under both population projections.

Mullumbimby

The median realisation as modelled for Mullumbimby showed some water supply shortfalls under both the stochastic and NARCliM climate scenarios. However, the cumulative shortfalls remained at a relatively low level throughout the 40-year model period. The worst-case realisations for both the stochastic and NARCliM climate scenarios occurred just before 10 years. The minimum (best case) model realisations had zero shortfalls throughout the entire model period.

Kyogle

The models did not suggest any significant shortfalls for the median realisations for Kyogle.

Nimbin

The median realisation as modelled for Nimbin showed some water supply shortfalls under both the stochastic and NARCliM climate scenarios by the tenth year. However, the cumulative shortfalls remained at a relatively low level throughout the 40-year model period. The minimum (best case) model realisations had zero shortfalls throughout the entire model period.

Casino

The models showed Casino as experiencing significant water supply shortfalls throughout the 40-year model period. While the model suggested larger and earlier shortfalls under the NARCliM climate scenario (for both the maximum and median realisations), the shortfalls under the stochastic climate scenario were also significant. The worst-case realisations for the NARCliM and stochastic climate scenarios were very similar, with pronounced shortfalls occurring over the 40-year timeframe.

Figure 18. Town water supply cumulative 40-year shortfall series under common planning assumptions (log scale)

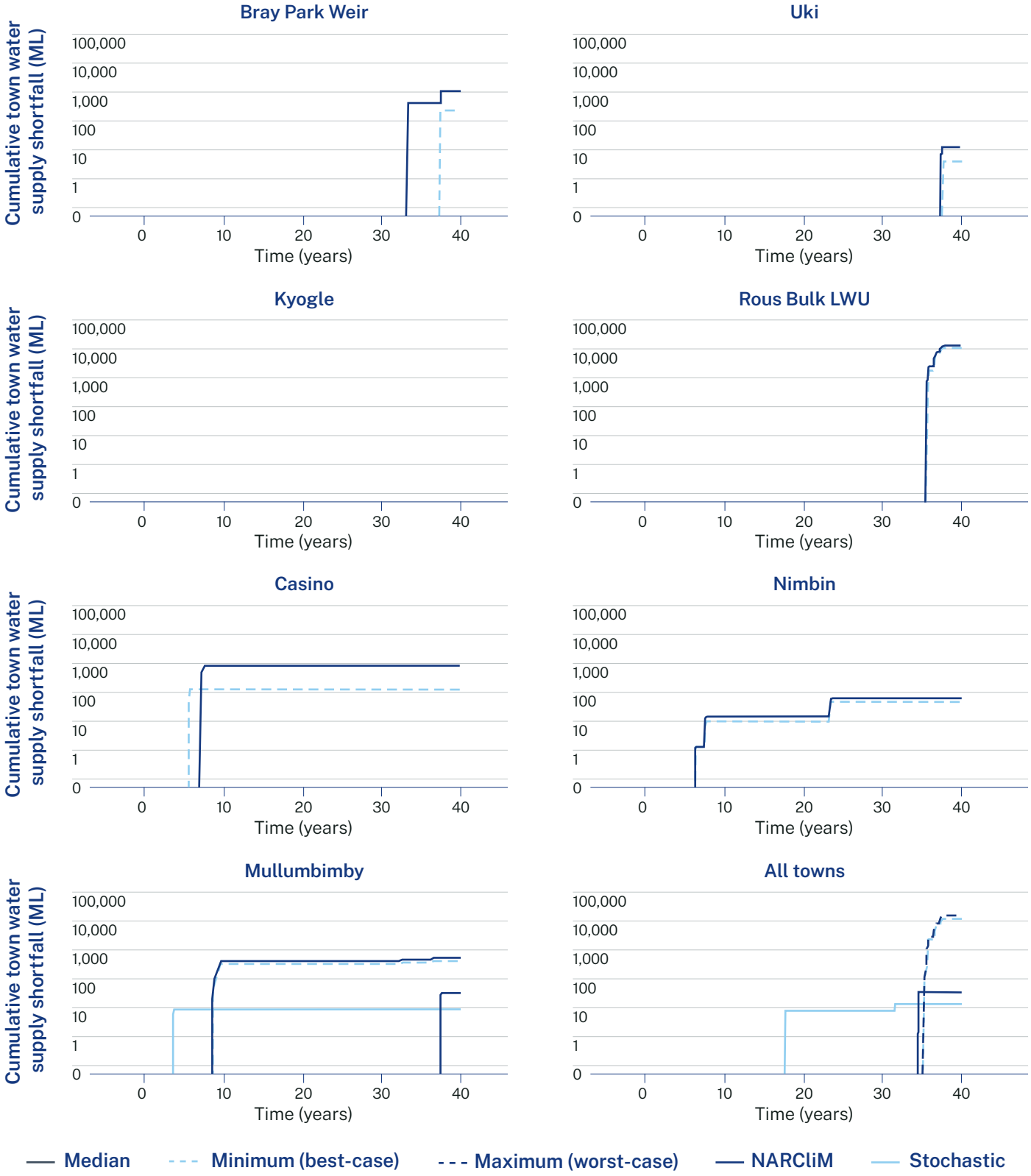
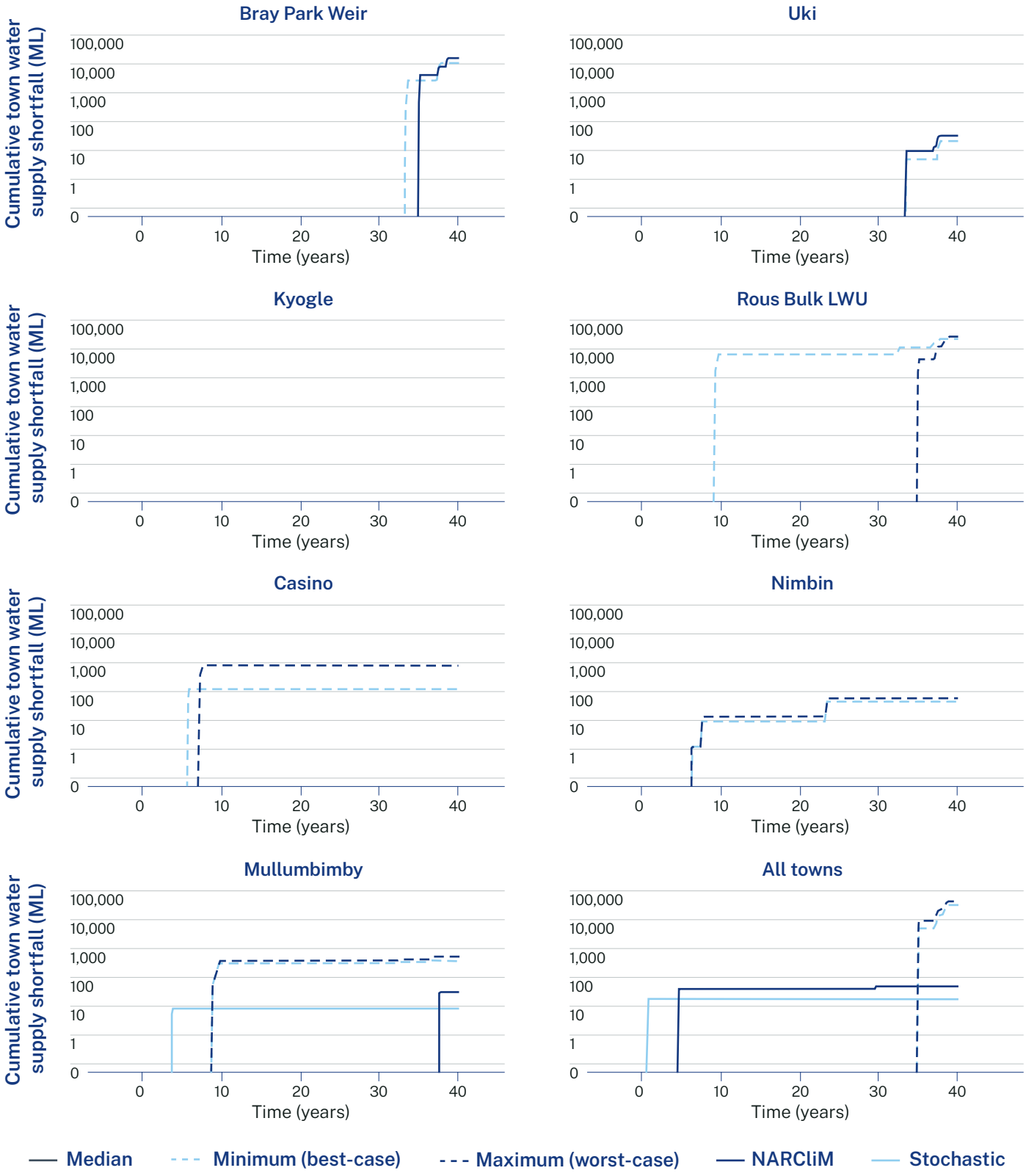


Figure 19. Town water supply cumulative 40-year shortfall series under local government population forecasts (log scale)



Modelled shortfall statistics

The models showed significant differences in water supply shortfalls under the average realisations compared to the extreme realisations for towns and communities in the Far North Coast (Table 23 and Table 24).

Table 23. Cumulative shortfall base-case outcomes under common planning assumptions population projections

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rous bulk	0 (0%)	2,100 (0.4%)	0 (0%)	3,190 (0.6%)
Casino	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nimbin	0 (0%)	20 (0.3%)	0 (0%)	30 (0.4%)
Mullumbimby	10 (0.1%)	150 (1%)	30 (0.2%)	200 (1.2%)
Tweed Shire Council bulk	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Uki	0 (0%)	0 (0%)	0 (0%)	0 (0%)

The median realisation for the base-case model using the common planning assumptions population projections only showed the Mullumbimby supply to experience shortfalls over the 40 years. In the extreme realisations (95th percentile, equivalent to the 950th driest stochastic hydrologic realisation) the Rous County Council bulk water supply system experienced the highest volume of shortfalls (2,100 ML).

Under the NARCliM climate scenario, Mullumbimby again was the only system to show shortfalls in the median realisation. At the extremely dry 95th percentile realisation, the shortfalls for the Rous County Council bulk water supply system increased by 50% to 3,190 ML. However, the shortfalls for the Rous County Council bulk water supply system were less than 1% of total cumulative demand. This suggests that there is plenty of water available in the system except under extreme climatic conditions.

Table 24. Cumulative shortfall base-case outcomes under local government population projections

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rous bulk	0 (0%)	5,960 (1%)	0 (0%)	7,720 (1.3%)
Casino	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nimbin	0 (0%)	20 (0.3%)	0 (0%)	30 (0.4%)
Mullumbimby	10 (0.1%)	150 (1%)	30 (0.2%)	200 (1.2%)
Tweed Shire Council bulk	0 (0%)	580 (0.1%)	0 (0%)	2,150 (0.3%)
Uki	0 (0%)	0 (0.1%)	0 (0%)	0 (0.2%)

Using the local government population projections, the average cumulative shortfalls were almost identical for both the stochastic and NARCliM climate scenarios. In both these cases the only town in the region to experience a small water supply shortfall was Mullumbimby.

In extremely dry conditions (95th percentile hydrologic realisation) Mullumbimby experienced shortfalls that amounted to about 1% of its cumulative demand over the 40 years. However, the Rous County Council bulk water supply system experienced the largest absolute shortfalls, with a total cumulative deficit of almost 6,000 ML under the stochastic climate scenario and over 7,700 ML under the NARCliM climate scenario.

The other system to experience large shortfalls under extreme climatic conditions was the Tweed Shire Council bulk supply system. Although it showed no shortfalls under the median realisation, it showed shortfalls of almost 600 ML in the stochastic climate scenario and over 2,100 ML in the NARCliM climate scenario. However, these shortfalls represented less than 1% of total cumulative demand in the NARCliM climate scenario.

The water supply systems in the Far North Coast also perform well when considering their long-term reliability and vulnerability.[48] These metrics suggest that although a larger population will put additional pressure on water supply systems in the Far North Coast, the systems should, on average, cope fairly well. These metrics are based on unrestricted demand. Drought measures like water restrictions will help reduce shortfalls and improve these metrics.

48. Reliability is a measure of the average frequency of shortfalls (the proportion of years in which supply meets demand). Vulnerability is a measure of the average magnitude of shortfalls (the average proportion of demand that is not met).

Table 25. Reliability and vulnerability for the NARCliM climate scenario for common planning assumptions (CPA) and local government (LGA) population projections

Towns	Reliability CPA (%)	Reliability LGA (%)	Vulnerability CPA (%)	Vulnerability LGA (%)
Kyogle	100	100	0	0
Casino	99.89	99.89	0.47	0.47
Nimbin	99.18	99.18	2.13	2.13
Mullumbimby	97.07	97.07	9.52	9.52
Rous bulk	99.58	99.02	2.50	5.55
Uki	99.93	99.60	0.11	1.00
Tweed bulk	99.90	99.11	0.06	1.44

Image courtesy of Destination NSW. Tweed River, Murwillumbah.

Detailed assessment of combined options

Some of the individual options evaluated under the rapid CBA analysis have been merged to make a series of combined options. These combined options have been modelled using the long-term stochastic and NARCliM climate scenario data sets and have undergone a more detailed level of economic and environmental analysis. The environmental assessment was based primarily on modelled changes to flows across the Richmond and Tweed river catchments. It considered whether these flow changes impacted the achievement of environmental flow targets in a positive or negative way.

Selection of combined options

The following combined options have been tested using the detailed hydrologic assessment process:

- Combined option 1: Expand Rous County Council's bulk water system through Dunoon Dam
- Combined option 2: Maximise use of the proposed Clarrie Hall Dam augmentation
- Combined option 3: Maximise use of Toonumbar Dam
- Combined option 4: Incrementally augment the Richmond system through desalination
- Combined option 5: Connect the region to the Rous water supply system.

The selection of combined options was informed by the rapid cost-benefit analysis. The rapid cost-benefit analysis considered the short-term average outcomes of current climatic conditions. However, the detailed assessment was able to consider the more extreme outcomes as it is likely that they will drive investment decisions in the Far North Coast.

The sections below describe the results of the detailed cost-benefit analysis of the 5 combined options. They draw together the hydrologic, environmental and economic assessments of the modelled combined options.

Ecological assessment methodology

The ecological effects of the combined options were modelled and assessed at 30 sites in the Richmond River catchment and at 17 sites in the Tweed River catchment. The sites were selected based on their relationship to the likely or potential ecological requirements of aquatic flora and fauna.

Flow metrics used for the 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 were assessed for both the stochastic and NARCliM climate scenarios. The environmental assessments were carried out only using current population levels. They did not consider the effects of increased population growth on flows as this would be negligible.

Flow impacts were categorised as significant if there was a change in value of 3% or more in either a positive or negative direction. Table 26 describes the impact categories used in the environmental assessments and their associated changes in hydrology. The Stage 1 categories are relevant to the rapid cost-benefit assessment. The Stage 2 categories are relevant to the detailed cost-benefit assessment.

Table 26. Explanation of categories used in environmental 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%)

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. However, flow-dependent species and communities often have different and more 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. While brief summaries of the analyses are presented below, more comprehensive and technical analyses are presented in the *Detailed economic and environmental analysis report* for the Far North Coast.

Combined option 1: Expand Rous County Council's bulk water system through Dunoon Dam

Economic assessment

Purpose	Increase water security for towns in the Richmond River catchment by augmenting the Rous County Council bulk water supply system and by extending its service area to include independent water supplies.
Description	This option combined option integrates the following options: • Construct a new Dunoon Dam on Rocky Creek (*Draft Far North Coast Regional Water Strategy*, Option 14). • Connect independent water supplies in the region to the Rous County Council network (*Draft Far North Coast Regional Water Strategy*, Option 1). Detailed assessment was carried out for 2 demand projection variations based on the common planning assumptions and local government population projections.
Results	The cost of the proposed action is estimated at approximately $815 million over the 40-year period. The average net present value is approximately the same which gives a benefit-cost ratio of zero. This was the average outcome under both the stochastic and NARCliM climate scenarios, and under both common planning assumptions and local government population projections. This combined option eliminates all cumulative shortfalls at the 95th percentile under the common planning assumptions projections, and shortfalls for all councils except the Tweed Shire Council bulk supply under the NARCliM climate scenario and local government population projections. This indicates that the proposed action has some benefits in eliminating town and community shortfalls under dry hydrologic realisations.
Key assumptions and Limitations	• Then Rous County Council bulk water supply system maintains priority within the model. • New town water supply connections take from the unregulated system when available before drawing from Rous County Council bulk water supply system. • The new Dunoon Dam has a capacity of 50 GL.

There were no cumulative shortfalls for any town or community when modelled using the common planning assumptions population projections for either the stochastic or NARCliM climate scenarios.

When modelled using the local government population projections, the Tweed Shire Council bulk supply system showed a cumulative shortfall over 40 years of 580 ML, or 0.1% of the total demand at the 95th percentile realisation. However, the system showed no shortfalls for this climate and population scenario at the median realisation.

When modelled using the NARCliM climate scenario, the Tweed Shire Council bulk supply system showed no cumulative shortfalls over the 40 years in the median realisation but resulted in 2,150 ML of cumulative shortfall (about 0.3% total demand) at the 95th percentile realisation.

Table 27. Combined option 1 – benefit-cost ratio (BCR) results for both population and climate scenarios

Climate scenario	Stochastic		NARCliM	
Population projection	**CPA**	**LGA**	**CPA**	**LGA**
Wettest realisation	0.00	0.00	0.00	0.00
Median realisation	0.00	0.00	0.00	0.00
Driest realisation	0.01	0.03	0.03	0.04

Environmental assessment

A summary of the flow impacts for this combined option is shown in Table 28. The major findings for the environmental analysis are:

- *No significant (3% or greater) effect* was found for mean annual discharge, the frequency of freshes or the size of larger flows (2.5- and 5-year annual recurrence interval).
- *Minor to moderate environmental impacts* are predicted for the frequency of low flow periods and the size of base and very low flows.
- *Minor improvements (reductions)* in duration of no-flow periods: At Goolmangar Creek a 3.4% improvement was observed in both climate scenarios. This could be due to reduced drawdown at the Goolmangar Creek – Terania Creek junction. The more continuous low flows modelled downstream of the Rocky Creek – Dunoon Dam system boost the water levels in Goolmangar Creek. No-flow duration at Rocky Creek reduced by only 2.4% in the stochastic climate scenario.
- The strongest impact on the Richmond system *was a minor increase in the number of days where flow occurred below the low flow threshold*. This overall result was almost entirely driven by Terania Creek at Keerong (below Rocky Creek Dam) where under the NARCliM climate scenario the number of these lower flow days increased from 4 to 16 days.

Table 28. Combined option 1 – summary of flow impacts for both climate scenarios across all relevant gauges

Flow metric	Long-term stochastic model (10,000 years)	Long-term dry climate change model (10,000 years)
Mean annual discharge (ML/year)	no effect – no effect	no effect – no effect
No-flows (duration, days)	minor improvement (decrease) – no effect	minor improvement – no effect
No-flows (frequency over 130 years)	no effect – minor impact (increase)	no effect – minor impact
Number of days below low flow (median, days)	no effect – extreme impact (increase)	no effect – extreme impact
Very low flows (size of 95th percentile, ML/day)	moderate impact (decrease) – no effect	moderate impact – no effect
Base flows (size of 80th percentile, ML/day)	moderate impact (decrease) – no effect	moderate impact – no effect
Freshes (20th percentile, frequency)	no effect – no effect	no effect – no effect
Size (ML/day) of flows (2.5-year size of annual return interval)	no effect – no effect	no effect – no effect
Size (ML/day) of flows (with 5-year return interval)	no effect – no effect	no effect – no effect

Image courtesy of Destination NSW. Tweed River, Chinderah.

Combined option 2: Maximise use of the proposed Clarrie Hall Dam augmentation

Purpose	Increase water security for towns across the Tweed and Richmond River catchments by augmenting the Tweed water supply system and linking it with the Rous bulk water supply system.
Description	This combined action integrates: • Raise Clarrie Hall Dam level (*Draft Far North Coast Regional Water Strategy,* Option 12). • Connect the Rous County Council and Tweed Shire Council bulk water supplies (*Draft Far North Coast Regional Water Strategy,* Option 2). • Connect independent water supplies in the region to the Rous County Council network (*Draft Far North Coast Regional Water Strategy,* Option 1). Detailed assessment was carried out for 2 demand projections variations based on common planning assumptions and local government population projections.
Results	The cost of this option is estimated to be approximately $357 million over the forecast 40-year timeframe. The average net present value is the same under both the stochastic and NARCliM climate scenarios as well as for the common planning assumptions and local government population projections. Even under the driest hydrologic realisations the cost-benefit ratio is barely more than zero. The model predicted the Mullumbimby and Rous County Council bulk supply systems would still experience shortfalls with this option. This occurred in the driest realisations with the common planning assumption population projections. However, the magnitude of projected shortfalls reduces rapidly by the 95th percentile realisation. In this realisation, the size of shortfalls for Mullumbimby was 74–85% lower than in the driest realisation. The size of shortfalls for the Rous County Council supply system was 30% lower than in the driest realisation.
Key assumptions and Limitations	• Raising the dam wall at Clarrie Hall Dam is assumed to be progressing independently of this study and is not included in the cost of the combined option. These works increase the full storage capacity of Clarrie Hall Dam to an assumed level of 42.3 GL. • The maximum capacity of the pipeline connecting the Tweed and Richmond catchments is 11.25 ML/day. • Water from the Tweed Shire Council bulk water supply system cannot be used as additional storage for the Rous County Council bulk water supply system. Further information on the limitations of this analysis can be found on pages 117-8.

Table 29. Combined option 2 – outcomes under common planning assumptions population projections

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle, Casino, Tweed Shire Council bulk, Uki and Nimbin	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rous bulk	0 (0%)	1,470 (0.3%)	0 (0%)	2,260 (0.4%)
Mullumbimby	0 (0%)	20 (0.1%)	0 (0%)	50 (0.3%)

Table 30. Combined action 2 – outcomes under local government population projections

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle, Casino, Tweed Shire Council bulk and Uki	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rous bulk	0 (0%)	4,380 (0.8%)	0 (0%)	5,750 (1%)
Mullumbimby	0 (0%)	80 (0.5%)	0 (0%)	100 (0.6%)

Table 31. Combined action 2 – benefit-cost ratio (BCR) results for both population scenarios

BCR	Stochastic		NARCliM	
	CPA	LGA	CPA	LGA
Wettest	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00
Driest	0.01	0.02	0.02	0.03

Environmental assessment – Tweed River catchment

A summary of the flow impacts for this combined option for the Tweed River catchment is shown in Table 32. The major findings for the environmental analysis are:

- *No significant (at 3% or greater) effect* was found for mean annual discharge and the size of very low flows.
- *Minor to moderate environmental impacts* are predicted for base flows, which are likely to have little impact on ecological communities.
- *Minor improvements in no-flow (cease-to-flow) duration:* This was the most evident under the stochastic scenario for Bray Park Weir where the duration of the no-flow period changed from 1.06 to 1.00 day. This change is unlikely to have a meaningful ecological effect for any single event. However, since these are averaged values, they could be masking large, infrequent events that affect species survival ecosystem composition.
- *Minor improvements for larger (2.5 or 5-year recurrence) flows,* which could be bankful or overbank flows, were recorded. For example, 5-year return flows increased from 7,981 ML/day to 8,644 ML/day over the modelling period for Doon Doon Creek at downstream Clarrie Hall. This could have a meaningful ecological effect if it better enables fish, invertebrate, carbon and nutrient movement by allowing flows to connect over barriers.
- *The strongest effect (negative impact)* was on the number of days where flow occurred below the low flow threshold. This overall result was almost entirely driven by the impact at Doon Doon Creek downstream of Clarrie Hall Dam where under the NARCliM climate scenario the number of these low flow days increased from 115 to 149 days.

Table 32. Combined option 2 – summary of flow impacts for both climate scenarios across all relevant gauges (Tweed River catchment)

Flow range	Long-term stochastic model (10,000 years)	Long-term dry climate change model (10,000 years)
Mean annual discharge (ML/year)	no effect – no effect	no effect – no effect
No-flows (duration, days)	minor improvement (decrease) – no effect	no effect – no effect
No-flow (frequency over 130 years)	moderate improvement (decreases) – no effect	major improvement – no effect
Number of days below low flow (median, days)	no effect – extreme impact (increase)	no effect – extreme impact
Very low flows (size of 95th percentile, ML/day)	no effect – no effect	no effect – no effect
Base flows (size of 80th percentile, ML/day)	minor impact (decrease) – no effect	no effect – no effect
Freshes (20th percentile, frequency)	minor impact (decrease) – no effect	minor impact – no effect
Size (ML/day) of flows (2.5-year size of annual return interval)	no effect – minor improvement (increase)	no effect – minor improvement
Size (ML/day) of flows (with 5-year return interval)	no effect – minor improvement	no effect – minor improvement

Image courtesy of Destination NSW. Richmond River, Casino.

Environmental assessment – Richmond River catchment

A summary of the flow impacts for this combined option for the Richmond River catchment is shown in Table 33. The major findings for the environmental analysis are:

- *No significant (at 3% or greater) effect* was found for most metrics.
- *Minor improvements (reductions)* in duration of no-flow periods with small decreases in the average total annual low flow duration. Minor improvements (reductions) were also observed in the frequency of no-flow periods.

Table 33. Combined option 2 – summary of flow impacts for both climate scenarios across all relevant gauges (Richmond River catchment)

Flow range	Long-term stochastic model (10,000 years)	Long-term dry climate change model (10,000 years)
Mean annual discharge (ML/year)	no effect – no effect	no effect – no effect
No-flows (duration, days)	minor improvement (decrease) – no effect	minor improvement – no effect
No-flow (frequency over 130 years)	no effect – no effect	minor improvement (decrease) – no effect
Number of days below low flow (median, days)	no effect – no effect	no effect – no effect
Very low flows (size of 95th percentile, ML/day)	no effect – no effect	no effect – no effect
Base flows (size of 80th percentile, ML/day)	no effect – no effect	no effect – no effect
Freshes (20th percentile, frequency)	no effect – no effect	no effect – no effect
Size (ML/day) of flows (2.5-year size of annual return Interval)	no effect – no effect	no effect – no effect
Size (ML/day) of flows (with 5-year return interval)	no effect – no effect	no effect – no effect

Combined option 3: Maximise use of Toonumbar Dam

Purpose	Augment Toonumbar Dam to increase water security for Casino and water users on the regulated Richmond River system, and reinstate the environmental contingency allowance from Toonumbar Dam.
Description	This combined action integrates: • Use Toonumbar Dam to augment town water supplies – version 1 (*Draft Far North Coast Regional Water Strategy,* Option 3). • Raise Toonumbar Dam level (*Draft Far North Coast Regional Water Strategy,* Option 19). • Establish and/or increase environmental water releases from major storages in the Far North Coast (*Draft Far North Coast Regional Water Strategy,* Option 21).
Results	*Note: this combined option was only modelled using the common planning assumptions population projections.* The cost of this option is estimated to be approximately $454 million over the 40-year timeframe, with an average net present value of approximately negative $452 million under both the stochastic and NARCliM climate scenarios. Even under the driest hydrologic realisations the cost-benefit ratio is barely more than zero. This option eliminates cumulative shortfalls in all towns and communities except for Mullumbimby in the median realisations of both stochastic and NARCliM climate scenarios. However, under the 95th percentile realisation, the Rous County Council bulk water supply system, Nimbin and Mullumbimby all experience cumulative deficits over the 40-year model period. These cumulative shortfalls are the same as those seen in the base case model because this combined option does not affect those parts of the Richmond catchment.
Key assumptions and Limitations	• Toonumbar Dam delivers water to Casino along the existing river system and no built infrastructure is required. • Toonumbar Dam level is raised to give the dam a capacity of 19.8 GL. • Environmental releases are made available through use of the expired Toonumbar environmental contingency allowance account. These simulate releases after a water quality event like blue-green algae or a bushfire. The releases are modelled as occurring in November each year.

Table 34. Combined option 3 – outcomes under common planning assumptions

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle, Casino, Tweed Shire Council bulk and Uki	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rous bulk	0 (0%)	2,100 (0.4%)	0 (0%)	3,190 (0.6%)
Nimbin	0 (0%)	20 (0.3%)	0 (0%)	30 (0.4%)
Mullumbimby	10 (0.5%)	150 (1%)	30 (0.2%)	200 (1.2%)

Table 35. Combined option 3 – benefit-cost ratio (BCR) results for both climate scenarios

BCR	Stochastic		NARCliM	
	CPA	LGA	CPA	LGA
Wettest	0.00	N/A	0.00	N/A
Median	0.00	N/A	0.00	N/A
Driest	0.02	N/A	0.02	N/A

Environmental assessment

A summary of the flow impacts for this combined option is shown in Table 36. The major findings for the environmental analysis are:

- The model suggested this combined option may lead to a reduction in the number of no-flow events at Iron Pot Creek and downstream at Eden Creek, both of which are below Toonumbar Dam. This tended to be more pronounced under the stochastic climate scenario, but still observed under the NARCliM climate scenario. For example, a 75% improvement under the stochastic climate scenario compared to 67% improvement under the NARCliM climate scenario for Ironpot Creek at Toonumbar. However, these values are coming off a very low baseline, with typically a chance of about one in 10 for an event over the modelling period for the base case, with the average duration of no-flow reducing from 25 to 13 days. These are very modest changes, but the direction of these changes could be expected to occur under an increase in water orders down to Casino as would occur in this scenario.
- *The largest impact* of this combined option is seen in the number of days below low flow levels (80th percentile flow). This is about a 2% average increase across all sites under both scenarios. For the Ironpot Creek at Toonumbar gauge, which increases by just over 50% under both climate scenarios this represents an increase from 31 days per year to 47 days per year.
- *There are some moderate improvements* in the frequency of large flows, particularly in the size of flows with a 5-year average recurrence interval. This represented an increase from 5,527 ML/day to 6,109 ML/day at Iron Pot Creek for the stochastic climate scenario.

Table 36. Combined option 3 – summary of flow impacts for both climate scenarios across all relevant gauges

Flow range	Long-term stochastic model (10,000 years)	Long-term dry climate change model (10,000 years)
Mean annual discharge (ML/year)	no effect – no effect	no effect – no effect
No-flows (duration, days)	extreme improvement – moderate impact	major improvement – moderate impact
No-flow (frequency over 130 years)	extreme improvement – no effect	extreme improvement – no effect
Number of days below low flow (median, days)	minor improvement – extreme impact	minor improvement – extreme impact
Very low flows (size of 95th percentile, ML/day)	no effect – minor improvement	no effect – minor improvement
Base flows (size of 80th percentile, ML/day)	moderate impact – minor improvement	moderate impact – minor improvement
Freshes (20th percentile, frequency)	no effect – no effect	no effect – no effect
Size (ML/day) of flows (2.5-year size of annual return interval)	no effect – minor improvement	no effect – minor improvement
Size (ML/day) of flows (with 5-year return interval)	no effect – moderate improvement	no effect – moderate improvement

Combined option 4: Incrementally augment the Richmond system through desalination

Purpose	Introduce water produced from decentralised, scalable desalination plants into the Rous County Council bulk water supply system, as needed over time.
Description	This combined action is a variation on decentralised desalination (*Draft Far North Coast Regional Water Strategy,* Option 10). It considers progressively introducing desalinated water into the Rous County Council bulk water supply system over time as the impacts of population growth and climate change increase. The water would be sourced from decentralised desalination plants situated near to increasing water demands. The assessment assumed the plants introduced constant supplies into the Rous County Council system of: • 5 ML/day from year 5 onwards • 10 ML/day from year 10 onwards • 15 ML/day from year 15 onwards.
Results	This proposed action is expected to cost approximately $128 million over the 40-year timeframe. On average the action does not return high economic value for the Rous County Council bulk water supply, at less than $50,000 under common planning assumptions, and $100,000 under local government population assumptions. Accounting for the benefit it produces, the average net present value of the proposed action in both cases is approximately negative $128 million, essentially the cost of the option. This results in a cost benefit ratio of effectively zero under the stochastic and NARCliM climate scenarios with both population projections. This option only has the ability to reduce town water supply shortfalls in the Rous County Council bulk water supply system. It decreases cumulative shortfalls by approximately 3.6% in the stochastic and 5.5% in the NARCliM climate scenarios on average under common planning assumptions population projections. Using local government population projections this increases on average to 6.7% and 8.5% respectively for the stochastic and NARCliM climate scenarios.
Key assumptions and Limitations	• The desalination plants provide water to alleviate Rous County Council bulk water system shortfalls and do not add additional flows to existing storages. • The cost of this option includes the desalination plant and omits required additional ancillary infrastructure, and is therefore a lower-bound value

Table 37. Combined option 4 – outcomes under common planning assumptions population projections

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle, Casino, Tweed Shire Council bulk and Uki	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rous bulk	0 (0%)	1,290 (0.3%)	0 (0%)	2,020 (0.4%)
Nimbin	0 (0%)	20 (0.3%)	0 (0%)	30 (0.4%)
Mullumbimby	10 (0.1%)	150 (1.0%)	30 (0.2%)	200 (1.2%)

Table 38. Combined option 4 – outcomes under local government population projections

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle, Casino	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rous bulk	0 (0%)	3,960 (0.7%)	0 (0%)	5,020 (0.9%)
Nimbin	0 (0%)	20 (0.3%)	0 (0%)	30 (0.4%)
Mullumbimby	10 (0.1%)	150 (1%)	30 (0.2%)	200 (1.2%)
Tweed Shire Council bulk	0 (0%)	580 (0.1%)	0 (0%)	2,150 (0.3%)
Uki	0 (0%)	0 (0.1%)	0 (0%)	0 (0.2%)

Table 39. Combined option 4 – benefit-cost ratio (BCR) results for both population and climate scenarios

BCR	Stochastic		NARCliM	
	CPA	LGA	CPA	LGA
Wettest	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00
Driest	0.02	0.04	0.05	0.09

Environmental assessment

This combined option is unlikely to have any impacts on modelled flows. Therefore, the flow-based metrics used for the environmental assessments will not deviate significantly from the base case. Other environmental considerations are beyond the scope of this assessment.

Image courtesy of iStock. Clarrie Hall Dam, NSW.

Combined option 5: Connect the region to the Rous water supply system

Purpose	Increase water security for towns in the Richmond River catchment by extending the Rous County Council service area to include currently independent water supplies.
Description	This combined option combines the Rous bulk water supply network with a range of independent supplies for towns in the Far North Coast – specifically Mullumbimby, Casino, Kyogle, and Nimbin. This may help improve supply security for these systems during extended dry periods by giving them access to water from Rocky Creek Dam and other future network improvements and augmentations that Rous County Council may implement.
Results	The benefit-cost ratios of these proposed actions are generally close to zero, even under the driest 95th percentile outcomes. While the benefit-cost ratio does not reach the breakeven point, even under the driest years, these proposed actions almost completely eliminate cumulative shortfalls in the Far North Coast.
Key assumptions and Limitations	• The towns rely on water from the Rous system only when they are unable to meet their demand from the unregulated water supplies. • The demands of Kyogle, Nimbin, and Mullumbimby are considered to be individually too small to materially impact the supply of the Rous bulk water supply, and any impact on this system is considered to be zero. • Conversely, the demand of Casino is assumed to impact the supply of water to the Rous County Council bulk water supply network. This study includes the demands of the smaller towns in the system and is an overestimate of the impact to the Rous County Council system.

Table 40. Combined option 5 – outcomes under common planning assumptions population projections

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle, Casino and Nimbin	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mullumbimby	0 (0%)	20 (0.1%)	0 (0%)	50 (0.3%)

Table 41. Combined option 5 – outcomes under local government population projections

Towns	Cumulative shortfall over 40 years (stochastic)		Cumulative shortfall over 40 years (NARCliM)	
	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)	Median total shortfall volume (ML) (% of total demand)	95th percentile total shortfall volume (ML) (% of total demand)
Kyogle, Casino and Nimbin	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mullumbimby	0 (0%)	80 (0.5%)	0 (0%)	100 (0.6%)

Table 42. Combined option 5 – benefit-cost ratio (BCR) results for both climate scenarios (Mullumbimby, Kyogle, Nimbin)

BCR	Stochastic			NARCliM		
	Wettest	Median	Driest	Wettest	Median	Driest
Mullumbimby	0	0	0.08	0	0	0.06
Kyogle	0	0	0.01	0	0	0.01
Nimbin	0	0	0.03	0	0	0.02

Table 43. Combined action 5 – benefit-cost ratio (BCR) results for both population and climate scenarios (Casino)

BCR	Stochastic		NARCliM	
	CPA	LGA	CPA	LGA
Wettest	-0.01	-0.07	-0.02	-0.01
Median	0.00	0.00	0.00	0.00
Driest	0.01	0.01	0.01	0.01

Environmental assessment

This combined option is unlikely to have measurable impacts on modelled flows. Therefore, the flow-based metrics used for the environmental assessments will not deviate significantly from the base case. Other environmental considerations are beyond the scope of this assessment.

Image courtesy of Destination NSW. Tweed River, Tumbulgum.

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