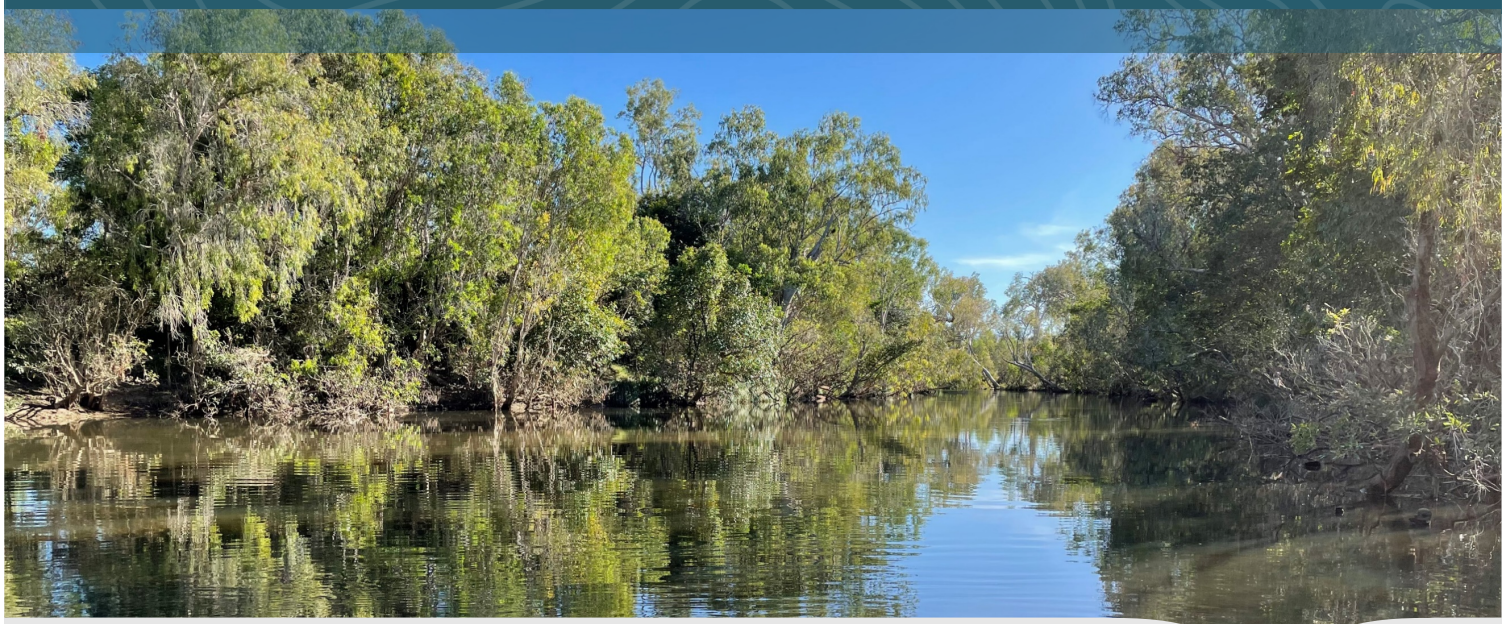
Queensland Government

Department of Regional Development, Manufacturing and Water



Water Plan (Mitchell) 2007

Minister's Performance Assessment Report

2023

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Acknowledgement of Traditional Owners

We respectfully acknowledge the Aboriginal and Torres Strait Islander peoples as the Traditional Owners and Custodians of this Country – the lands and seas on which we meet, live, learn, work and play. We acknowledge those of the past, the Ancestors whose strength has nurtured this land and its people, and we recognise their connection to land, sea and community. We pay our respects to them, their culture and to their Elders past and present.

This publication has been compiled by Water Planning and Science, North Region of Water Resource Management, Department of Regional Development, Manufacturing and Water.

Interpreter statement:

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Minister’s foreword

As the Minister for Water, I will continue to ensure that Queensland’s catchment-based water plans strike that balance between water for the environment and water for consumptive use.

Queensland has successfully developed and implemented 23 water plans that sustainably manage and allocate the state’s water resources.

More than 95 per cent of Queensland is managed under a water plan.

Water plans and their supporting implementation documents specify the amount of water available and regulate the allocation and management of water in an area.

Water plans balance regional development, social, cultural, and environmental water needs.

There is regular monitoring and reporting to determine whether the plan is meeting its objectives and outcomes.

As part of this regular monitoring, I am pleased to publish this report which assesses the effectiveness of the Water Plan (Mitchell) 2007 (the water plan) and its implementation since my last report in 2018. The water plan is scheduled to be replaced with a new plan prior to 1 November 2027.

The process for developing water plans is underpinned by the best available science through hydrologic, climate change, social, economic, cultural, and environmental assessments and extensive community consultation.

Agriculture remains the primary economic activity for the Mitchell River catchment, particularly with beef cattle production and water availability is key to unlocking the sector’s potential.

Given the Mitchell River is also the largest river discharging into the Northern Prawn Fishery, I also acknowledge the importance of getting the balance right between water for consumptive use and water for the environment.

This report confirms that the water plan and its implementation continue to be effective in advancing the sustainable management of water resources in the Mitchell catchment. No adverse impacts on water entitlement holders or natural ecosystems in the water plan area are expected from continuing with the current water plan until it expires on 1 November 2027.

In the meantime, my department will continue to oversee the water plan. Ongoing monitoring will continue, enabling any new or emerging risks to be identified and addressed, to ensure the water plan continues to effectively allocate the water resources in the water plan area.

Residents in the Mitchell catchment can be assured that the water resources in your region are being managed responsibly and sustainability. I encourage anyone with an interest in water management in the Mitchell catchment to read this report.

Hon. Mr Glenn Butcher MP

Minister for Regional Development and Manufacturing and Minister for Water

Executive summary

Under section 49 of the *Water Act 2000* (the Water Act), a Minister must prepare a report on each water plan at least every five years to assess its effectiveness and its implementation. This is in accordance with requirements stated under section 22(4) of the Water Regulation 2016 (the Regulation).

This report provides an assessment of the performance of the Water Plan (Mitchell) 2007 (the water plan), which is scheduled to expire on 1 November 2027. A summary of the assessment is provided in Table 1.1.

The assessment shows that the water plan remains fit for purpose and continues to advance the sustainable management of water resources. Implementation has been effective in achieving most of the water plan's outcomes.

A risk assessment was undertaken to identify the issues that threaten the ability of the water plan to achieve its intended outcomes. While most of the water plan's outcomes are being achieved, there was insufficient information to fully assess the achievement of outcomes relating to supporting the water-related cultural values of Aboriginal and Torres Strait Islanders peoples (further referred to as the First Nations peoples).

Of the 27 water plan outcomes assessed, two could not be fully assessed due to knowledge gaps, and the remainder were ranked as low risk (Appendix A).

Opportunities and emerging matters for future consideration relate to the need to:

- update the water plan outcomes in accordance with the latest Water Act requirements and contemporary water planning policies
- consider climate change impacts on water availability in the water plan
- incorporate best-available science and information, including the latest hydrological modelling and improved understanding of water requirements for key environmental assets
- assess the impacts of the existing and any future water management arrangements across and policy decisions in the water plan area using a new hydrologic model that incorporates the latest science and new hydrologic data
- undertake targeted consultation with First Nations peoples to improve our understanding of their cultural water values, aspirations and uses of water and the associated water requirements across the water plan area
- improve understanding of groundwater resources, particularly connectivity to surface water, as well as groundwater dependant ecosystems.

It is recommended that the above matters be considered as part of a formal review to replace the current water plan, prior to its expiry in 2027. The learnings gained from implementing the existing water plan will be used to improve water management arrangements under the replacement water plan, as part of an adaptive management cycle based on revised future water needs, improved science knowledge and targeted stakeholder consultation.

Table 1.1: Summary of the performance assessment of the Water Plan (micthell) 2007).

	Completed		On track		Some issues
	Some major issues		Not achieved		Insufficient information available

Matters to be addressed	Comment	Section of the report	Status
Effectiveness of the water plan in advancing the sustainable management of Queensland's water resources	Overall, this assessment indicates that the water plan is achieving the purposes of the Water Act.	Section 3	On track
Effectiveness of the implementation of the water plan in achieving its outcomes	A risk assessment found that most water plan outcomes have been achieved. Of the 27 outcomes, 24 were assessed as low risk of not being achieved, one as medium risk, and two outcomes (related to making water available to First Nations communities to achieve their economic and social aspirations and supporting their water-related cultural values) could not be fully assessed due to limited information.	Section 4	On track
Summary of water usage and entitlements including those taken or interfered with under statutory authorisations	Information on water use under metered entitlements is collected and reported. No issues are identified as water use and demand is low in the water plan area, compared with the water availability.	Section 5	On track
Summary of research and monitoring findings	The department prioritises state-wide monitoring programs based on the level of risk to aquatic ecosystems resulting from water resource development. Due to the low level of development, there was limited specific ecological monitoring conducted across the catchment over the past five years. Knowledge gaps associated with groundwater and surface water interaction and riparian vegetation water use have been identified through the risk assessment process. Filling these knowledge gaps would provide greater confidence in the assessment of water plan ecological outcomes.	Section 6	On track
Summary of identified risks to water plan outcomes	Of the 27 outcomes, 25 were assessed as low risk of not being achieved and two outcomes (related to making water available to First Nations Communities to achieve their economic and social aspirations and supporting their water-related cultural values) could not be fully assessed due to limited information available on cultural water values of First Nations peoples in the water plan area, as well as their economic and spiritual aspirations and the associated water needs. Consultation with the First Nations peoples to fill the identified knowledge gaps will be undertaken as part of the review and replacement of the water plan by 2027.	Section 11	Some issues
Summary of amendments to the water plan since its commencement	Several minor, consequential amendments have been made to the water plan since its commencement. In 2018, its's expiry was postponed to 1 November 2027.	Section 10	On track
Summary of non-compliances under a water entitlement or other authorisation in the water plan area	Over the past five years, there were 26 instances of non-compliance, most of which related to failure to supply a meter reading. All issues have been resolved.	Section 13	On track
Overall status and recommendation for the water plan	While overall risks to water users and the environment remains low, the assessment has identified some opportunities and emerging matters to consider addressing during the review and replacement of the water plan by 2027.	Section 14	On track

Contents

Figures

Tables

1. Purpose of the report

The Water Act (s49) requires the Minister to prepare reports for each water plan, to ensure their implementation and effectiveness is regularly assessed as part of an adaptive management/water planning cycle. This cycle is comprised of plan development, implementation, monitoring, reporting and reviewing.

The Regulation (s22(4)) requires these reports to be prepared at least every five years and address the following matters:

- if the water plan is advancing the sustainable management of Queensland's water resources
- the effectiveness of implementation in achieving the water plan's outcomes
- information on water usage and authorisations in the water plan area, including water entitlements and water taken or interfered with under statutory authorisations
- a summary of the findings of research and monitoring for the water plan
- any identified risks to achieving the water plan's outcomes
- what amendments, if any, have been made to the water plan since its commencement
- any noncompliance under a water entitlement or other authorisation in the water plan area.

This report is prepared to assess the performance of the water plan and its implementation to meet the above statutory requirements, with an emphasis on progress since the previous Minister's report in 2018. It also identifies the potential drivers for change and emerging matters or pressures that the replacement water plan may need to accommodate, as well as issues that should be considered as part of the next performance assessment. Consideration was also given to whether the water plan's outcomes and strategies continue to be appropriate for the water plan area.

A risk assessment was conducted in October 2022 to assess the likelihood and consequences of not achieving the water plan's outcomes. The risk assessment approach used was consistent with the ISO 31000:2018 Risk Management Guideline. This approach ensures a consistent, repeatable and defensible consideration of risks. It also ensures outcomes of the assessment are documented for future reference. The details and outcomes of the risk assessment are provided in section 11 and Attachment A of this report.

2. Water plan area

The water plan area covers approximately 72,000km^2 in Far North Queensland with river systems flowing into the Gulf of Carpentaria (Figure 2.1). It supports a population of approximately 6,000 people. First Nations peoples represent a substantial and growing proportion (up to 25 per cent) of the population in the water plan area, particularly in the lower catchment.

Streamflow in the water plan area is mostly natural and not modified by large instream structures. The major streams include the Mitchell (part), Lynd, Walsh (part), Alice and Palmer Rivers and their tributaries. The Mitchell River has the largest annual stream flow of any river in northern Australia (Petheram, 2018). However, about 95 per cent of run off occurs during the wet season.

The upper reaches of the Mitchell and Walsh Rivers are not included in the water plan area. Although they are within the Mitchell River catchment, they are part of the Mareeba–Dimbulah Water Supply Scheme (MDWSS) and have been included in the Water Plan (Barron) 2023 to deal with the scheme (supplemented) water under one water plan.

The streams in the upper catchments in the east are mainly perennial. Streamflows in the lower catchments are highly seasonal, and there can be extensive flooding in the monsoon season. In the dry season, streams contract to waterholes.

Rainfall in the region is predominantly seasonal or monsoonal, with about 80 per cent of falls occurring from December to March. Average annual rainfall across the water plan area varies from 1,340mm per annum (mm/a) in the upper catchment areas and 1,255 mm/a on the coast to 825 mm/a in the central plains. Evaporation (about 2,225 mm/a in central parts) is relatively high, which has consequences for crop water use and water harvesting storage losses.

Water supplies from sub-artesian aquifers are highly variable in quantity and quality. In most areas, groundwater is used mainly for stock or domestic purposes.

The main consumptive water uses in the water plan area are small-scale irrigation and small mines. Communities and towns add to the overall consumption of water in the area. Non-consumptive uses with a social, economic, or cultural value include recreation, commercial fisheries and a growing tourism industry.

Figure 2.1: Mitchell water plan area boundary

3. How the water plan advances the sustainable management of Queensland's water resources

The water plan manages unsupplemented surface water, overland flow water and underground water and is implemented through the Mitchell water management protocol (the protocol).

It advances the sustainable management of Queensland's water resources by establishing a framework for the allocation and management of water resources in the water plan area for the economic, physical, and social wellbeing of the people of Queensland. In particular, the water plan provides outcomes and strategies to advance the sustainable management of ecosystems, water quality, water-dependent ecological processes and biological diversity associated with watercourses, lakes, springs, aquifers, and other natural water systems.

Table 3.1 provides a summary of the water plan's framework and how it advances sustainable management of water. For a more detailed summary of the linkages between water plan outcomes, strategies and rules see Appendix A.

Table 3.1. The Mitchell water plan's framework for advancing the sustainable management of water.

Water plan framework	How is this achieved?	Comment
Ecologically sustainable development	The water plan includes ecological outcomes to ensure ecologically sustainable development in the water plan area. These outcomes identify key ecological assets and functions and seek to minimise changes to flow regimes within the water plan area, particularly in areas of high ecological value. They also seek to minimise changes, as far as practicable, to the volume and seasonality of freshwater flows in the water plan area. The rules in the protocol implement the strategies in the water plan to protect environmental flows and maintain the ecological integrity of the river systems to achieve water plan outcomes.	The water plan was developed based on a long-term hydrologic model to enable a better understanding of the patterns of water use and availability for both consumptive and non-consumptive uses.
Allocation and use of water resources for economic, physical, and social wellbeing of the people of Queensland	The water plan provides a framework for taking water under the water entitlements, which balances the interest of all water users in the water plan area. It also provides a framework for making unallocated water from the Indigenous, strategic and general reserves available, as well as a water trading framework for temporary trades. The seasonal water assignment framework and the process for making unallocated water available for use is stated in the protocol. Water in the plan area can also be accessed without a water entitlement for cultural, stock and domestic purposes and prescribed activities, subject to limitations outlined in the water plan, the Water Act or the Water Regulation.	Unallocated water volumes have been reserved for future development to provide certainty for water users to promote economic development while also supporting population and industry growth, as well as aesthetic, recreational and cultural values.
Sustain the health of ecosystems	The water plan contains ecological outcomes which aim to support the ongoing protection of ecological assets and their habitats.	The risk assessment identified the ecological outcomes were achieved in the reporting period. It also ranked the risks to sustaining the health of ecosystems in the water plan area as low. Targeted research and monitoring data informed the assessment (see section 6 for details).
Recognise the interests of	The water plan contains economic and social outcomes to support water-related cultural values of First Nations peoples in the water plan area. The water plan also includes strategies for minimising negative impacts of	The risk assessment identified knowledge gaps in assessing effectiveness of the water plan's framework in recognising the interests

Water plan framework	How is this achieved?	Comment
First Nations peoples	taking, or interfering with, water under the water entitlements on cultural values. The water plan also provides Indigenous reserves of unallocated water to help First Nations communities achieve their economic and social aspirations. The Water Act allows First Nations peoples to take or interfere with water for traditional activities or cultural purposes without an entitlement.	of First Nations peoples in the water plan area (Appendix A). Namely, the values and aspirations of First Nations peoples are not well known, and further engagement is required as part of the water plan review process prior to its expiry. This engagement will aim to better understand cultural values and aspirations and their linkages to water management. This will enable all groups to be included in the engagement and meaningful outcomes and strategies be developed.
Enable water resources to be obtained through fair, transparent, and orderly processes	Water in the plan area can be obtained through seasonal water assignment or through access to unallocated water reserved for specific purposes. The plan identifies volumes of unallocated water available across the water plan area and establishes a framework for making these reserves available for use. Fair and transparent processes for making unallocated water available have been established under the protocol and the Regulation. The water plan also provides a seasonal water assignment framework, as outlined in the water management protocol.	The seasonal water assignment framework and unallocated water frameworks were developed in consultation with all interested parties and aim to balance their water needs and interests.
Build confidence regarding availability, security and value of water entitlements and authorisations	The water plan states outcomes which aim to provide, protect, and improve access to available water resources. It also provides for the continued use of existing water entitlements and other authorisations to take or interfere with water. The water plan's strategies and objectives provide certainty and security for current water users while also ensuring water is available to support towns, communities, and industrial and agricultural growth. The water plan prevents decisions (excluding water permits or the release of unallocated water reserves) regarding the allocation or management of water that would increase the average volume of water available to be taken. An application for a new entitlement must therefore be refused, unless it is for granting water released from an unallocated water reserve or a temporary water permit. This strategy protects existing water entitlements and authorisations.	There are many rural and rural residential properties that do not have access to a reticulated supply, and they access water from an on-site tank or dam, underground water, run of river or other storages. Due to the nature of the raw water sources, these water supplies can be more sensitive to changes in weather conditions, resulting in a quick decline of water security. Options for water supply during low water availability are varied.
Promote efficient use of water through water markets, allocation, risk assessments and community education	The water plan and the protocol provide for water licences to be seasonally assigned (temporary trading) within certain zones. This enables: • water users to temporarily lease water without selling land, • water users to increase water supplies and improve reliability • new industries to acquire water without jeopardising the environment or affecting other water users. Water use efficiency is one of the considerations taken when reviewing proposals and granting water entitlements from unallocated water reserves. When the State releases unallocated water, a price is set, encouraging the recognition of water as a valuable resource and promoting its highest value and efficient use.	Water trading data for the reporting period is provided in section 5.3 and Attachment B of this report. Over the years, general community education about water saving practices has helped to promote efficient use of water. Self-regulation due to factors outside of the water plan control (i.e., power costs, different crop requirements) also helps to encourage efficient use of water.

Water plan framework	How is this achieved?	Comment
Facilitate community involvement in planning for the management and allocation of water	Community involvement was ensured through the consultation and engagement processes in developing and finalising the water plan and the protocol in line with the requirements of the Water Act.	The water plan and the protocol were developed in consultation with key stakeholders and all other interested parties in line with the requirements of the Water Act. Further community consultation will occur to inform the water plan review prior to its expiry and to underpin the development of the new water plan.

4. Assessment of the effectiveness of implementation in achieving the water plan's outcomes

Since the commencement of the water plan in 2007, the department has monitored its implementation to ensure the outcomes are being achieved. Appendix A provides details of an assessment of the effectiveness of the water plan's implementation in achieving its outcomes since the Minister's report in 2018. This assessment was based on analysis of data and new scientific information.

Overall, the risk assessment shows that implementation has been effective in achieving the water plan's outcomes. Of the 27 water plan outcomes assessed, two could not be fully assessed due to knowledge gaps, and the rest were ranked as low risk (Appendix A).

These two outcomes relate to making water available to First Nations communities to achieve their economic and social aspirations, and to support their water-related cultural values in the water plan area. These outcomes are partly met through:

- unallocated water (UAW) reserves
- environmental flow provisions, where key ecosystems protected by the water plan are likely to overlap with cultural values
- provisions in the Water Act which allow First Nations peoples to take or interfere with water for traditional activities or cultural purposes without an entitlement.

Engagement with First Nations peoples will be undertaken as part of the water plan review and replacement by 2027. This will aim to fill the identified knowledge gaps including, to improve understanding and recognition of the cultural values, aspirations and uses of water and associated water requirements.

Key achievements in implementing the water plan include:

- management of overland flow
- establishment of volumetric water entitlements
- metering of active licences
- a framework for UAW reserves
- seasonal water trading framework.

5. Information on water use and authorisations

Water users in the water plan area have access to water taken under a water licence or under a statutory authorisation through the Water Act. Water licences are not needed for low-risk activities such as stock and domestic or prescribed activities such as washing down equipment, plant or vehicles to prevent the spread

of weed seeds, or for safety purposes. UAW is reserved and can be made available for future use with consideration to protecting existing entitlements and flows for the environment.

5.1 Water entitlements

There are no water allocations or water supply schemes in the water plan area. Active water entitlements include water licences to take unsupplemented surface water, as summarised in Appendix B-1. Overland flow is managed under the water plan through the regulation of works and a licence to take may be required for a particular water use. A licence to take underground water is required for uses other than stock or domestic in the Chillagoe Groundwater Management Area.

Within the reporting period 2017-2022, there were a total of 46 water licences in the water plan area. Forty of these licences authorised the take of water for rural purposes, five for any purpose and one for stock purposes (Appendix B-1, Table B-1.2). All licences for rural or any purposes are volumetric entitlements and the licence for taking water for stock purposes does not state a nominal entitlement. Approximately 93 per cent (5,020ML) of the total volume allocated under the volumetric entitlements were for rural purposes.

Approximately 70 per cent of all licences in the water plan area were for taking water in the Upper Mitchell catchment. The volume allocated under these licences (3,263.5ML) was approximately 60 per cent of the volume allocated in the entire water plan area.

5.2 Water use

In accordance with section 107 of the Water Regulation, all water licences in the water plan area, other than licences solely for stock or domestic purposes, are metered entitlements. Of the 45 licences prescribed as metered entitlements, 17 had a water meter installed and the remainder have not activated their water take and are therefore not required to be metered.

In the reporting period (2017/18 - 2021/22), the total metered water usage in the Lower Mitchell area ranged from approximately 6.9 to 16.3 per cent of the total allocated volumes. In the Upper Mitchell area this usage ranged from 6.8 to 15.7 per cent (Appendix B-2). Such low level of use indicates that the demand for water was not high across the water plan area and there was some opportunity to meet the potential growth in demand for additional water through the existing underutilised entitlements.

5.3 Water trading

Permanent water trading is not provided for in the water plan area. However, seasonal assignment of water licences (temporary trade) is provided for in the Upper Mitchell River catchment within highly allocated zones (Mary, Rifle and Bushy Creeks).

Over the last five years, no seasonal water assignments occurred in the water plan area. Combined with the low level of utilisation of the existing water licences across the water plan area (as outlined in section 5.2), this indicates low demand for additional water in the water plan area, including in areas where temporary water trading is provided for under the water plan.

5.4 Entitlements granted from the unallocated water (UAW) reserve

The plan provides for 70,000ML of UAW held in general, Indigenous (in the Cape York Peninsula Region) and strategic reserves, to meet demands for additional water across the plan area. The details of each UAW reserve are provided in Appendix B-3.

To date, water from these reserves has not been made available for use. Interested parties can register their interest in UAW.

The amount of UAW provided under the water plan (70,000ML) is almost 13 times greater than the total entitlement volume (5,403.5ML) currently allocated under all water licences in the water plan area.

5.5 Water taken or interfered with under statutory authorisations

The Water Act (sections 93 to 103) authorises water to be taken or interfered with without an entitlement for certain purposes such as stock or domestic take and other low risk activities. The volume of water taken under statutory authorisations (basic rights) is not required to be measured. This makes an accurate quantitative assessment difficult. However, by identifying broad trends in consumptive water use behaviour as well as relevant water flow patterns, it is possible to infer whether these trends pose any risks to existing water users' rights or the environment.

Take of water for stock and domestic use was also estimated by assuming this take is primarily driven by how much water the household or livestock requires, per hectare. The stocking rate of the catchment was determined using the latest stock figures from the agricultural commodities data available from the Australian Bureau of Statistics. An estimate of population accessing domestic supplies from watercourse and groundwater sources was estimated using census data. Major population centres (e.g. Chillagoe and Mount Molloy) were excluded as they generally have access to a reticulated supply network.

Appendix C provides an assessment of the risk to water users and the environment from the use of water under statutory authorisations. The assessment indicates that there is no identified increase in take due to statutory authorisations in the Mitchell water plan area.

6. Research and monitoring findings for the water plan

6.1 Summary of ecological monitoring

The water planning framework is supported by water monitoring activities that include an assessment of the water quantity and quality of surface freshwaters and groundwater systems across Queensland. This information, together with targeted ecological monitoring for water plans conducted by DRDMW under the Environmental Flows Assessment Program (EFAP), is vital for the continued improvement of water planning.

EFAP assesses the ecological performance of each water plan in meeting its stated ecological outcomes. EFAP projects are generally targeted to water plan areas where significant knowledge gaps have been identified or previous risk assessments have indicated that ecological outcomes are at high or medium-high risk of not being achieved. For this reason, over the life of the Mitchell water plan, EFAP activities were mostly limited to projects conducted prior to previous Minister's reporting.

Of exception is a recent bathymetric survey conducted at Node 2 of the water plan area (Mitchell River at Cooktown Crossing). A summary of earlier monitoring results and its relevance to the water plan ecological outcomes can be found in the Review of Water Plan (Gulf) 2007 & Water Plan (Mitchell) 2007 Summary of Monitoring.

The EFAP is supported by other research programs and reports, with a wealth of recent research directed at the Mitchell catchment available from:

- the Northern Australia Environmental Resources Hub (operating under the National Environmental Science Program (NESP))
- CSIRO's Northern Australia Water Resource Assessment (NAWRA)
- the National Groundwater Dependent Ecosystems (GDE) Atlas (Bureau of Meteorology)
- the Queensland Wetlands Program (Queensland Government).

This research, summarised below, has highlighted the ecological significance of flood flows to the Mitchell catchment and the freshwater flow-dependence of marine fisheries of the Gulf of Carpentaria (i.e., banana prawns and barramundi).

Over 90 per cent of algal-derived primary productivity occurs in floodplain wetlands rather than river channels, largely due to the large surface area of these wetlands, which provide space for aquatic plants to

grow. This provides increased surface area for algae to attach and proliferate. This then forms a vital base to riverine food webs as macroinvertebrates consume the algae and concentrate this energy (enriched with high levels of essential fatty acids) into high-quality food for fish.

Upstream flows and rainfall provide for the inundation of floodplain wetlands and enhanced aquatic plant biomass, with about 60 per cent of variation in floodplain inundation explained by inter-annual variation in river discharge. Hydrodynamic models developed under the NAWRA indicated that when river flows facilitated floodplain wetland connectivity, up to 58 per cent of the floodplain wetland algal productivity was connected to main river channels and available to provide potential energy subsidies to riverine food webs. Fish consume food provided in these wetlands by using the often-short periods of inundation to access these habitats. However, the inundation windows may be so short that fish cannot return to river habitats until the next wet season. Fish movement varies with species across the catchment and different parts of the catchment were accessed by non-migratory species, with most individuals having made at least one large-scale movement.

Given these scales of movement, new dams may have an even greater impact than previously thought. For example, most of the fish captured in the upper Palmer and Walsh Rivers had moved there from other parts of the catchment. Modelling indicated that shorter periods of floodplain inundation would occur in drier years and dam development scenarios were predicted to reduce the availability of algae on the floodplain by up to 26 per cent. Further, drier years and dam development scenarios in combination have the potential to cause extreme fragmentation of the floodplain landscape. Modelling also indicated that the severity of impact from dam construction on fish movement was influenced by location of the dams, with highest impact predicted to occur if Pinnacles Dam was constructed on the Mitchell River.

These and other studies have highlighted dependence of marine fisheries of the Gulf of Carpentaria (i.e., banana prawns and barramundi) on freshwater flows. Application of this research to ecological outcomes of the water plan and more detailed summaries of the reports (including citations to the relevant publications) are presented in Appendices A and G, respectively.

While the assessment completed for this report indicates that all ecological outcomes of the water plan are being achieved, the recent risk assessment has identified some uncertainty associated with the lack of mapping and monitoring data available. These uncertainties relate to:

- Waterholes - the identification of small, refugial waterholes; information about drawdown thresholds; local validation of risk thresholds determined by completed waterhole modelling.
- Connectivity and interactions between groundwater and surface water flows.
- Connectivity between groundwater and riparian vegetation (and any associated thresholds).
- GDE mapping. The National Groundwater Dependent Ecosystem Atlas currently plots areas as being of high or moderate ‘potential’ GDEs but further refinement and ground-truthing is required to determine ‘actual’ GDEs. GDE mapping available on Queensland’s WetlandInfo is incomplete for large areas of the state and requires refinement and ground-truthing.
- Poor understanding of ecosystem low flow dependencies (particularly those related to bed sands and the effect of water take on these ecosystems).
- The general paucity of gauging stations and groundwater monitoring bores across such a large plan area adds to uncertainty at local scales (i.e., actual groundwater use).
- Insufficient ecological data available to set robust rules for the take of UAW due to remoteness of the sites.

There will always be uncertainties relating to the management of water resources at a local scale. Targeted monitoring of ecological assets that are potentially at risk from water management can help improve uncertainty over time. Where possible, further targeted studies will be completed to support the evaluation and review of the water plan.

6.2 Summary of water monitoring

The department manages, operates, and maintains 12 stream gauging stations in the water plan area. Streamflow measurements are an integral part of producing volumetric data at gauging stations, and measurements are taken throughout a full range of low and high flow conditions to enable derivation of accurate streamflow volumes.

Although two groundwater management areas (GMAs)–Great Artesian Basin and the Chillagoe GMA–were added to the water plan area, there is currently a lack of groundwater monitoring. Bore development is managed through the requirement to submit bore information when bores are drilled. Water monitoring data can be accessed online at the water monitoring portal.

Groundwater levels are also monitored by mining operators to satisfy the conditions of their environmental authority to drawdown groundwater levels.

7. Socio-economic assessment

The water plan supports growth in population and industries and aims to maintain flows that support water-related social and economic values in the plan area. The water plan area is sparsely populated and relatively undeveloped. There are no major urban centres, and the major settlements are Kowanyama and Chillagoe.

7.1 Population trends

The estimated total population for the water plan area, based on 2021 census data sourced from Australian Bureau of Statistics (ABS), was approximately 6,000 people with approximately 25 per cent of the population being First Nations peoples (ABS, 2021).

The total general population in the water plan area since plan commencement has trended downwards, based on the ABS census data for years 2006, 2011, 2016 and 2021. However, since 2016, a slight increase occurred in Kowanyama area due to growth in the population of First Nations peoples, which constitute approximately 90 per cent of the total population in this part of the water plan area (Figure 7.1). During high tourist seasons (early September to mid-November), the total residential population may temporarily increase across the water plan area, particularly in the Chillagoe area, which may put more pressure on local water resources.

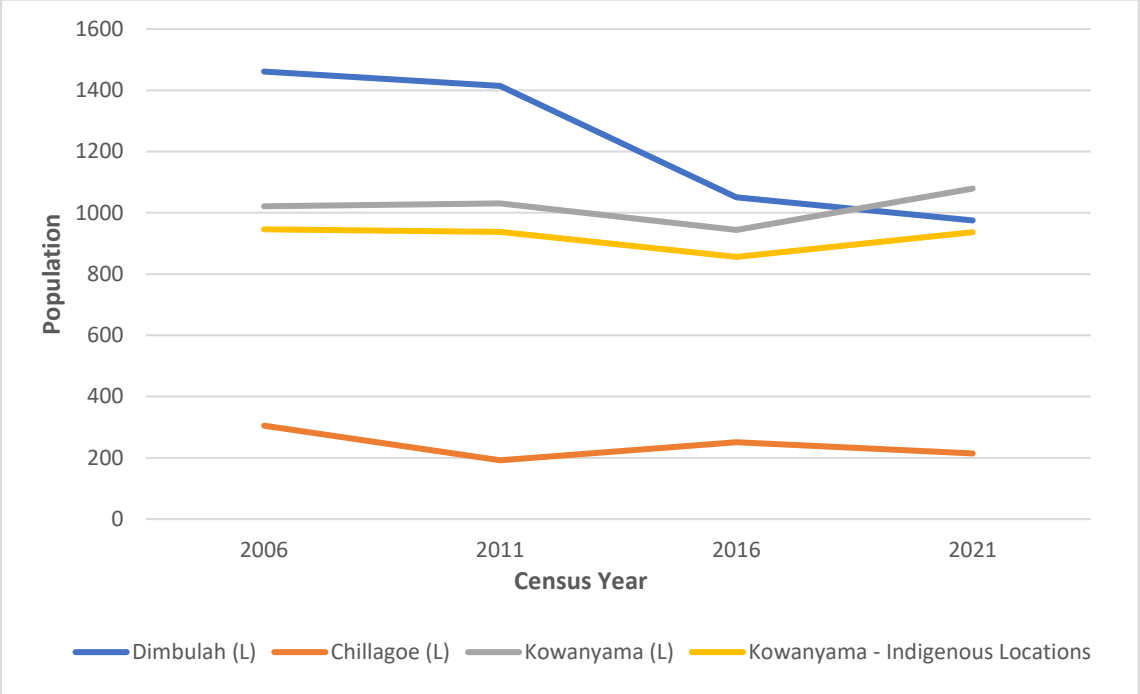

Figure 7.1 Population trends in major urban centres and localities in the Mitchell water plan area in 2006-2021

7.2 Economic profile

Agriculture remains the primary economic driver of the Mitchell River catchment with beef cattle production dominating. Beef cattle grazing is characterised by large leases operated by a mixture of family enterprises and larger pastoral companies. There is also significant ownership of pastoral holdings and some freehold ownership by First Nations peoples, with the freehold properties being smaller and located in the eastern part of the water plan area (Ash et al., 2018).

As the Mitchell River discharges a large amount of water into the Gulf of Carpentaria, this has, over the decades, raised the potential for irrigated agriculture. However, given the relative remoteness of the Mitchell catchment, irrigated agriculture has been largely confined to the Upper Walsh River (within the Mareeba Dimbulah Water Supply Scheme managed under the Barron water plan) and the Upper Mitchell River areas. The irrigated agriculture is currently dominated by mangoes, bananas, avocados, sugarcane and a range of other tree, field and horticultural crops (Ash *et al*., 2018).

The Mitchell River is also the largest river discharging into the Northern Prawn Fishery and contributes significantly to total annual prawn catches (Turschwell *et al*., 2022). Protected areas such as nature reserves, conservation areas and National Parks contribute to the tourism industry in the water plan area. There are also several active mines, such as copper and other metals near Mount Garnet, Chillagoe and Mount Carbine (Stokes *et al.,* 2017).

7.3 Land use

Grazing of native vegetation remains the primary land use in the water plan area (with pastoralism comprising over 90 per cent of land use), followed by irrigated agriculture, mining and forestry (*Ash et al.*, 2018).

8. Cultural assessment

While the water plan includes a framework for protecting water resources of cultural values and to support economic and spiritual aspirations of the First Nations peoples, there was insufficient information available to fully assess the effectiveness of water plan's implementation in achieving its relevant outcomes. These are the water plan provisions under sections 12(j) and 12(h).

While no detailed cultural assessment has been undertaken in the water plan area since the water plan was developed, work has been completed by the National Environmental Science Program (NESP) Tropical Water Quality Hub and the Northern Australia Water Futures Assessment (NAWFA)–Cultural and Social Program, commissioned by the Australian Government. The results of consultation with First Nations peoples through the NESP program are captured in this interactive story map.

Engagement with the local First Nations peoples will be undertaken by the department in the future to improve our understanding of the cultural values, aspirations and water uses by First Nations peoples as part of the next water plan review and replacement process.

9. Climate change assessment

The Queensland Government is committed to incorporating the best available science on climate change into water planning activities. The department aims to build a shared understanding with the community of the risk that climate change may pose to future availability of water resources, helping water users and businesses better manage the risk from an increasingly variable and extreme climate. This section outlines climate change trends in the water plan area over the reporting period (2017-2022) and provides outlook of the anticipated future climate change patterns (climate change projections).

9.1 Recent climate variation in the water plan area

Rainfall data from the Bureau of Meteorology (BoM) and streamflow data from the department's gauging stations were used to assess impacts of recent climate variations on water resources in the plan area (Vitkovsky, 2022). For the past four years, annual rainfall totals ranged from average to above average, depending on the location within the water plan area (Figure 9.1).

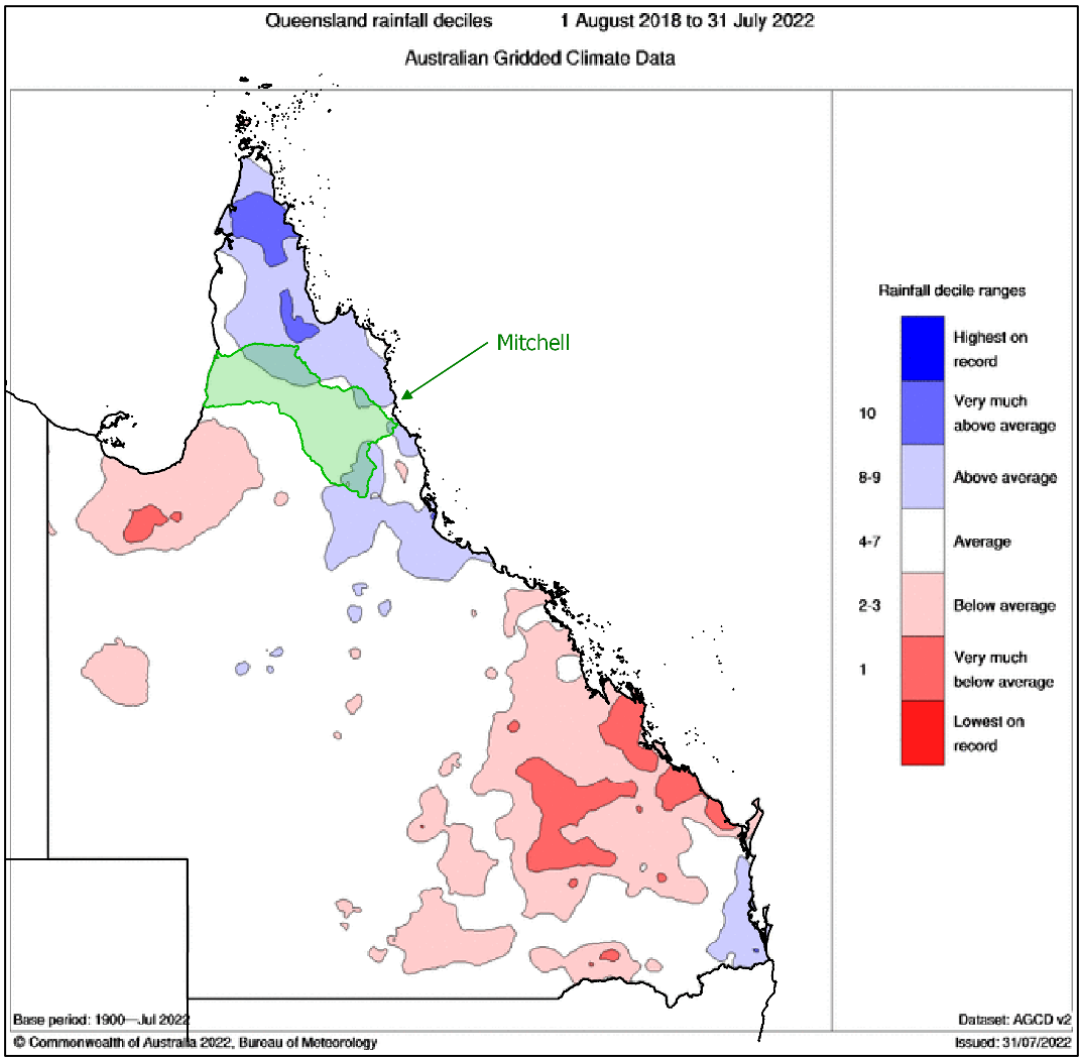

Figure 9.1: Catchment rainfall over the past four years (Source: BOM)

The Palmer River tributary and northern catchment received the largest annual rainfall total on record in 2010/11 followed by average to below average annual totals, and the lowest annual rainfall was recorded in 2014/15 (Figure 9.2). Annual rainfalls in the upper Mitchell River and southern catchment varied significantly in the reporting period, but within the historical average range (Figure 9.3).

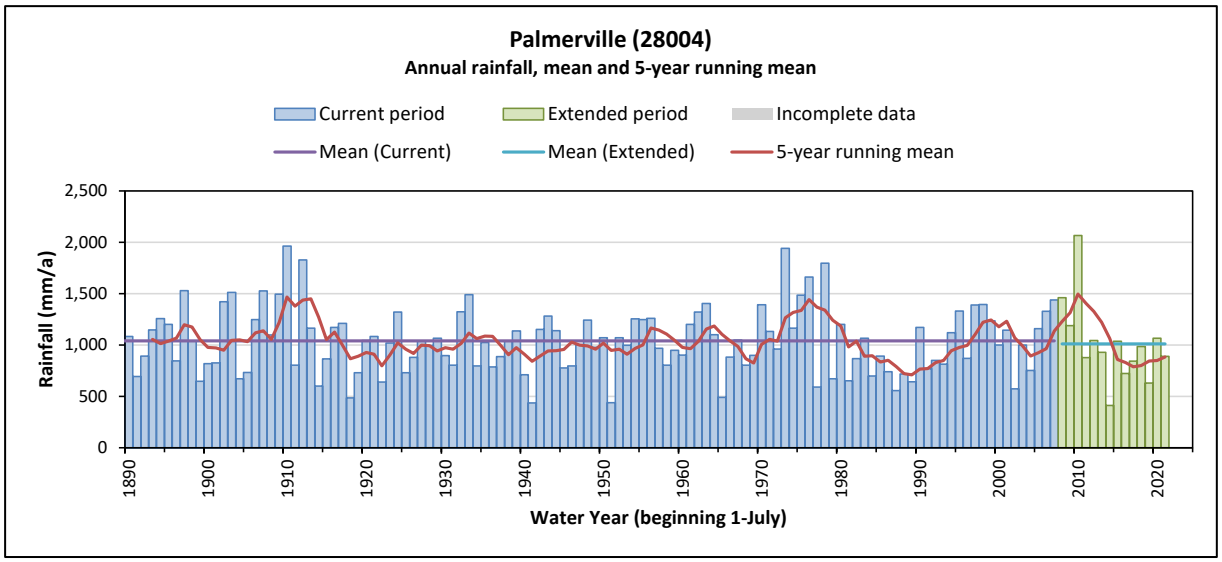

Figure 9.2: Annual rainfall totals for the Palmerville station, representing Palmer River tributary and the northern catchment.

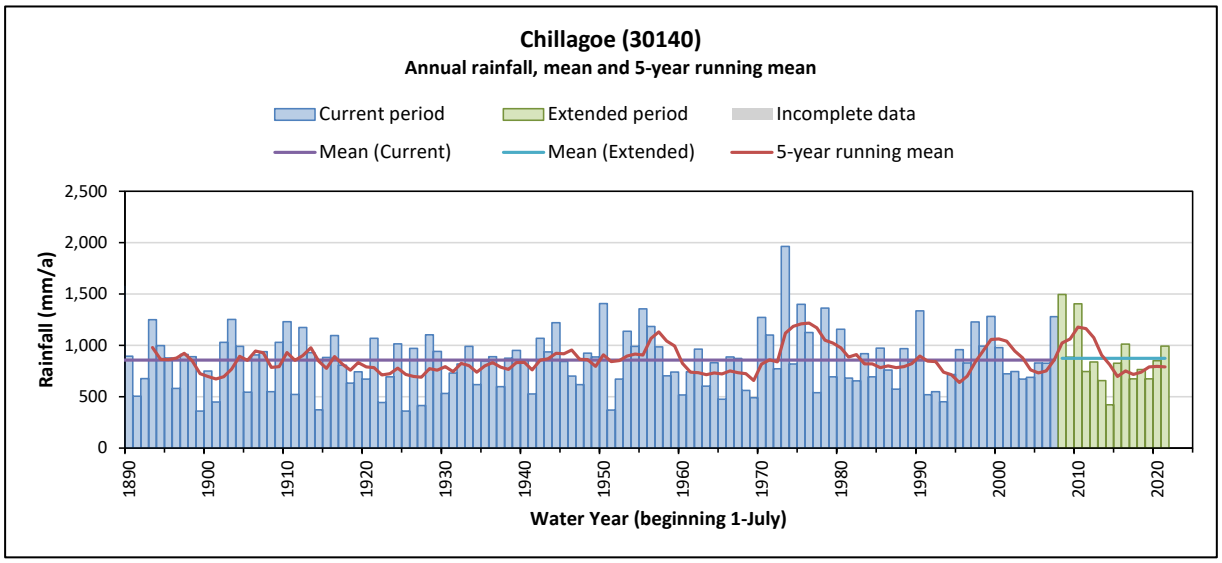

Figure 9.3: Annual rainfall totals for the Chillagoe station, representing the upper Mitchell River and the southern catchment

Streamflows were assessed at gauging stations where long-term climate data were available. Streamflows for the Palmer River, as represented by the gauge at Drumduff, were above average (with large variability) in recent years (Figure 9.4). The 2010/11 annual total flow was the largest on record and the 2014/15 total was the second lowest on record. Streamflows for the Mitchell River, as represented by the gauge at Gamboola, were average with large variability (Figure 9.5). This variability is evident in the following figures. The blue bars represent data which are included in the department's water plan simulation model for the Mitchell (spanning the period 1890-2003), while the green bars are recent data (2003-2022) not included in the water plan assessments.

Over the past 12 years, the flows fit reasonably well within the distribution of existing data. This suggests that despite recent extreme events, there has been no dramatic change in either rainfall or streamflow in the past 12 years compared to historical records.

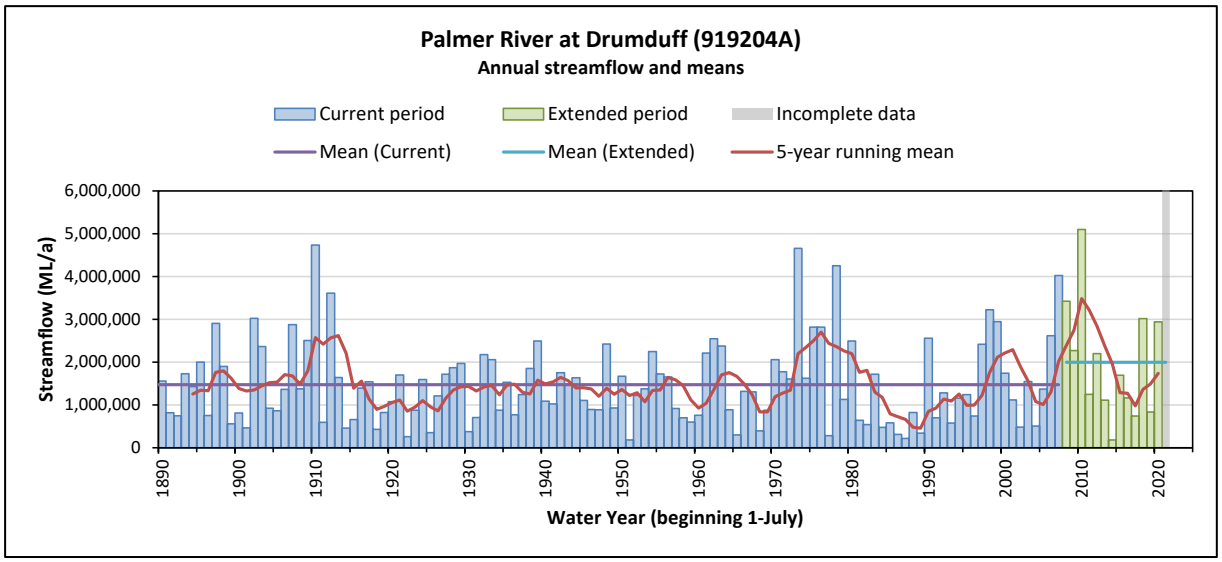

Figure 9.4: Annual streamflow at Palmer River at Drumduff (919204A)

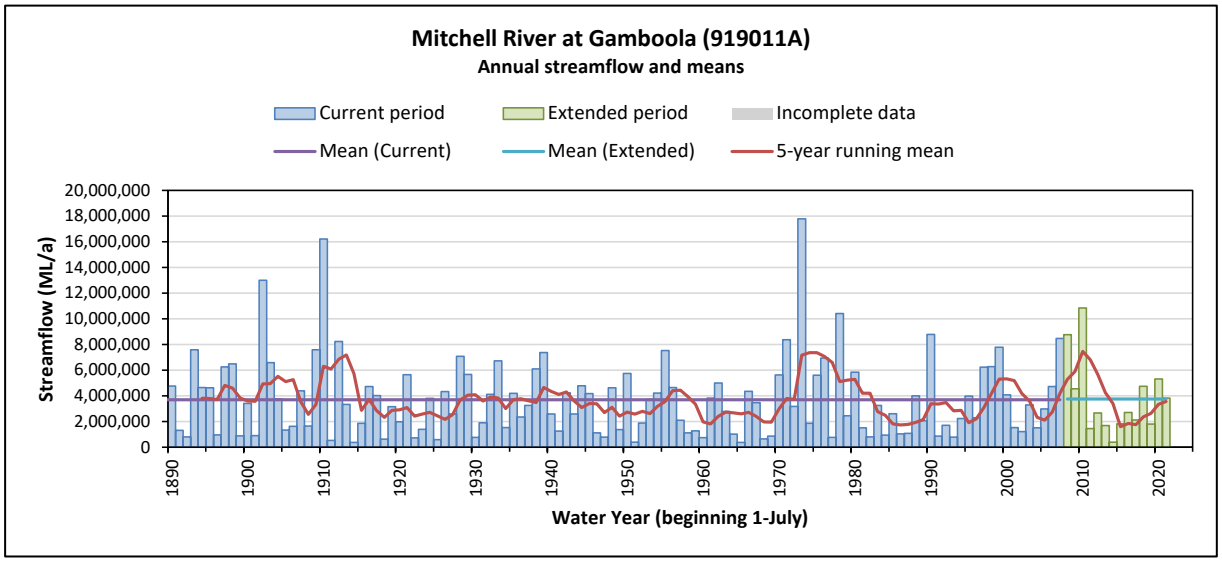

Figure 1.5: Annual streamflow at Mitchell River at Gamboola (919204A)

9.2 Climate change projections for the water plan area

9.2.1 Overview of assessment approach

An assessment of the climate change projections for the water plan area was undertaken to inform this report (Vitkovsky, 2022). General Circulation Models (GCM) were used to predict climate variables such as average daily temperatures, annual potential evapotranspiration (PET) and annual rainfall. The GCMs were sourced from the Coupled Model Intercomparison Project, phase 5 (CMIP5) of the Intergovernmental Panel on Climate Change (IPCC), Assessment Report 5 (AR5). The GCMs consider a trajectory of greenhouse gas emissions using numerous scenarios. Emission scenarios chosen for this assessment are Representative Concentration Pathway (RCP) 4.5 and RCP 8.5.

RCP 4.5 represents a future scenario where action is taken to reduce greenhouse gas emissions (for example, by way of technologies and strategies) resulting in a peak of emissions around 2040 and then followed by a decline. It is described by IPCC as an “intermediate” scenario.

RCP 8.5 represents a future scenario where emissions continue to rise throughout the 21st century. It is considered to be a “worst case” climate change scenario.

It is important to note that climate models are predictive models that simulate possible future outcomes. As such, these models are not perfect replicas of reality, but “what if” representations of real-life situations. All models have some degree of scientific uncertainty.

9.2.2 Overview of projected changes

Prior to considering possible future climate change it is useful to look at what has occurred climatically in the past, especially since the water plan was first implemented. A time-of-emergence analysis is used on climate variables (e.g., air temperature, sea level, rainfall) to help identify the time when climate change may have caused local conditions to deviate from past conditions. The time-of-emergence analysis identifies when the signal of the variable appears above background “noise”, thereby reflecting the onset of change (Walker *et al.*, 2022). The results of the time-of-emergence analyses undertaken for the Mitchell water plan area indicate that a temperature increase emerges around the 1990s (Figure 9.6). There was no emergence for annual evapotranspiration (Figure 9.7) or annual rainfall (Figure 9.8).

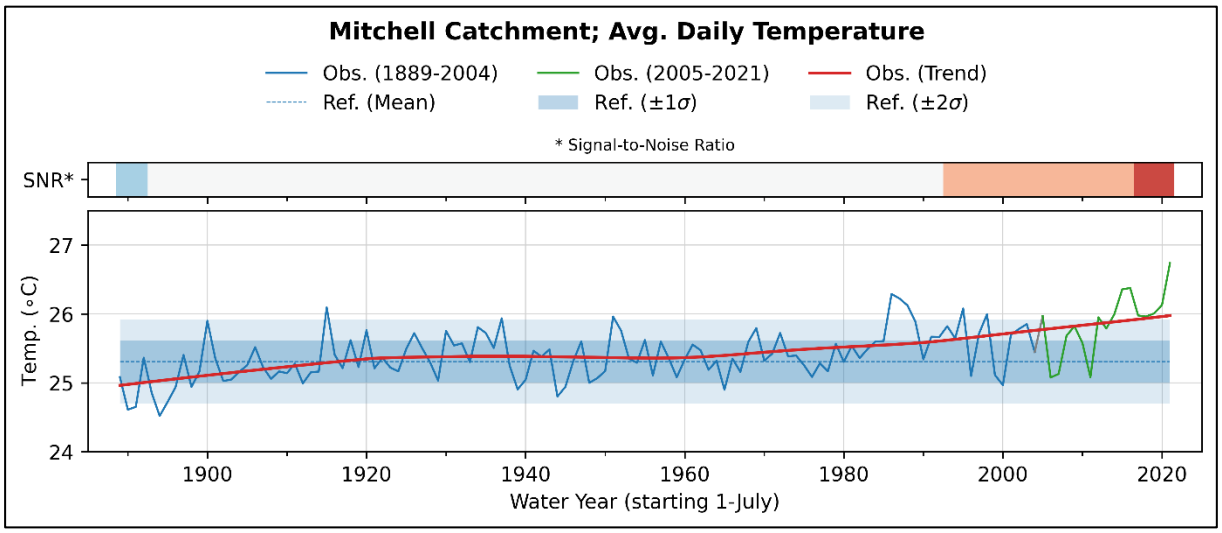

Figure 9.6: Time of emergence analyses: average daily temperature

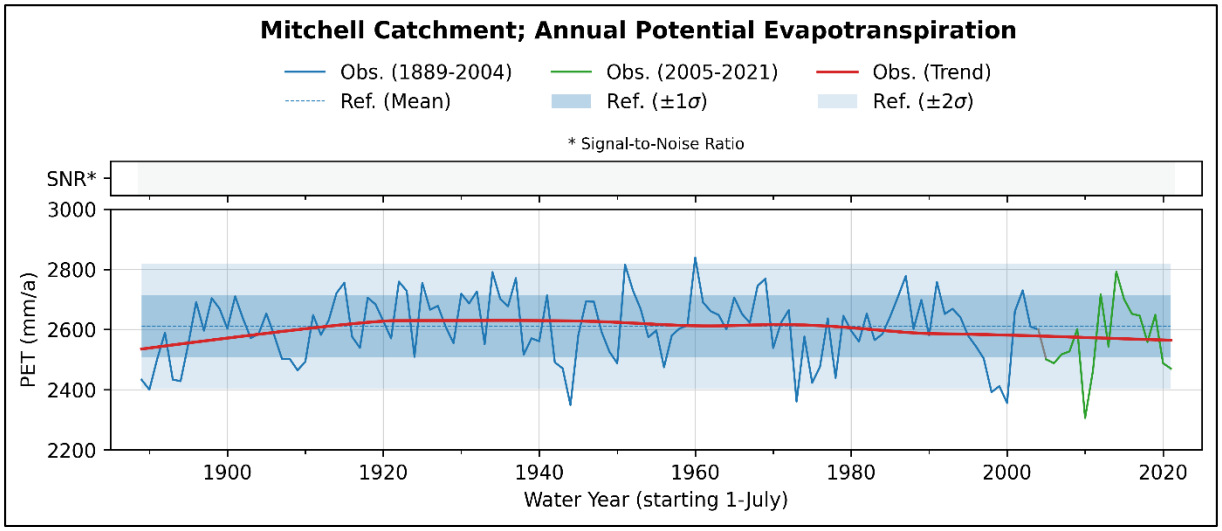

Figure 2: Time of emergence analyses: potential evapotranspiration

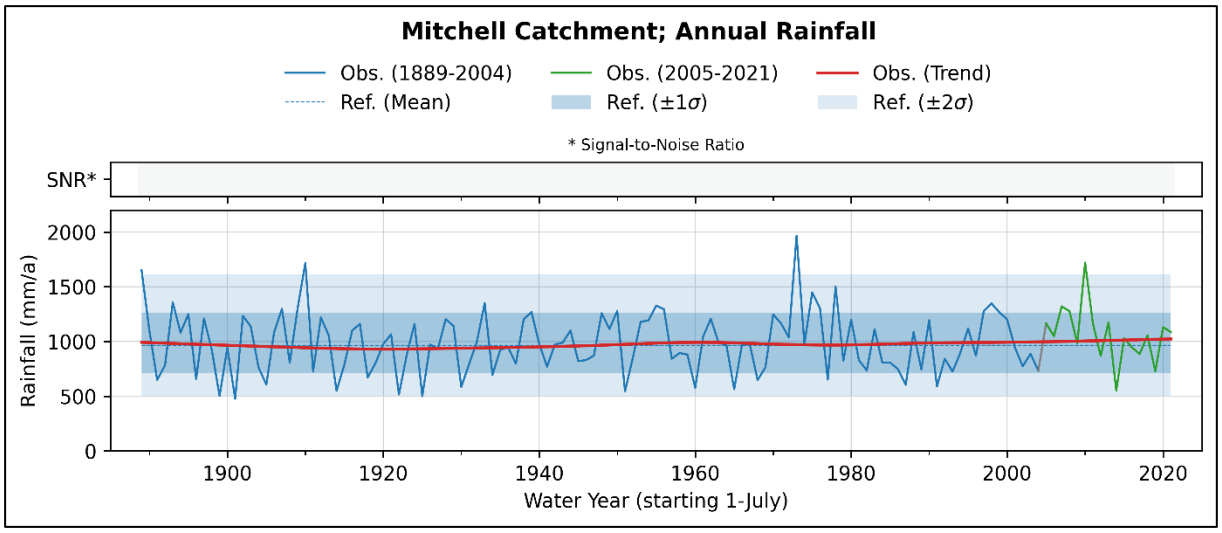

Figure 3: Time of emergence analyses: annual rainfall

Climate projections at the catchment scale using the GCMs are presented below. Temperature projections show an increase with the two scenarios diverging around 2040, meaning that some temperature rise is now inevitable (Figure 9.9). There is also an associated increase in potential evaporation across the catchment (Figure 9.10). There is no predicted trend in annual rainfall amongst a large amount of uncertainty. The recently observed climate data falls within the projections (Figure 9.11). The shaded coloured bands represent the uncertainties in the model structures.

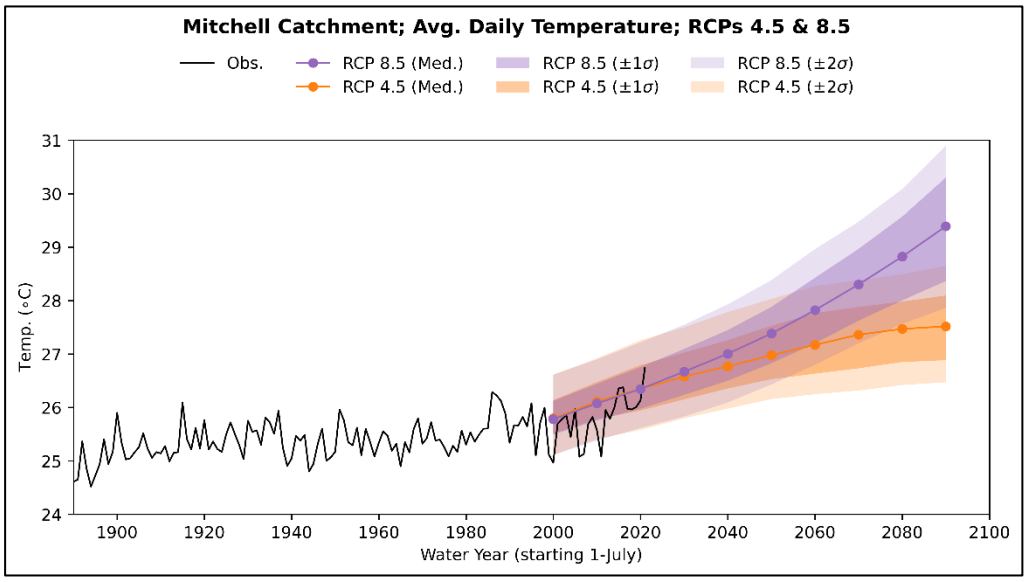

Figure 4: Observed and projected catchment average annual climate: average daily temperature

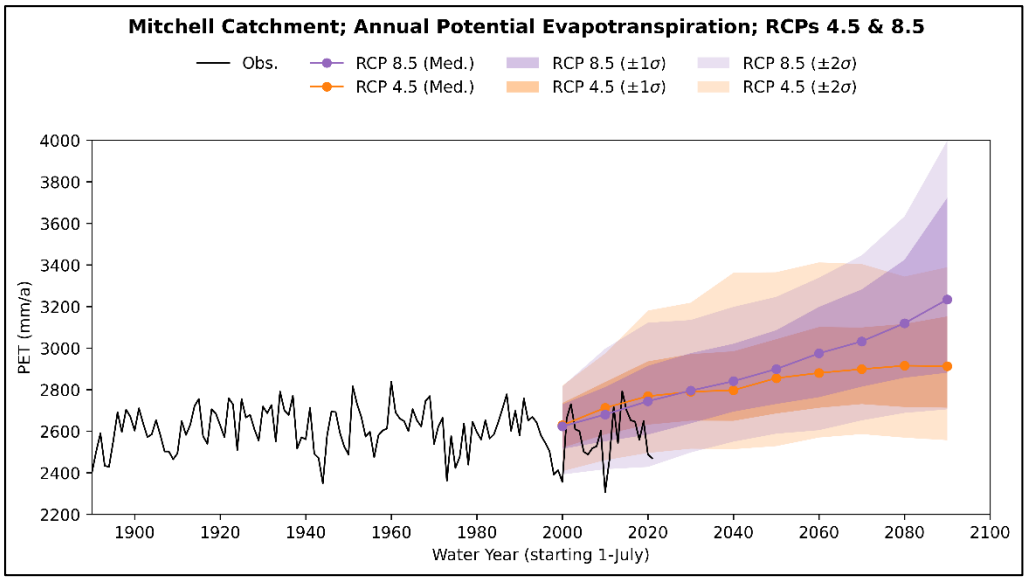

Figure 9.10: Observed and projected catchment average annual climate: annual potential evaporation

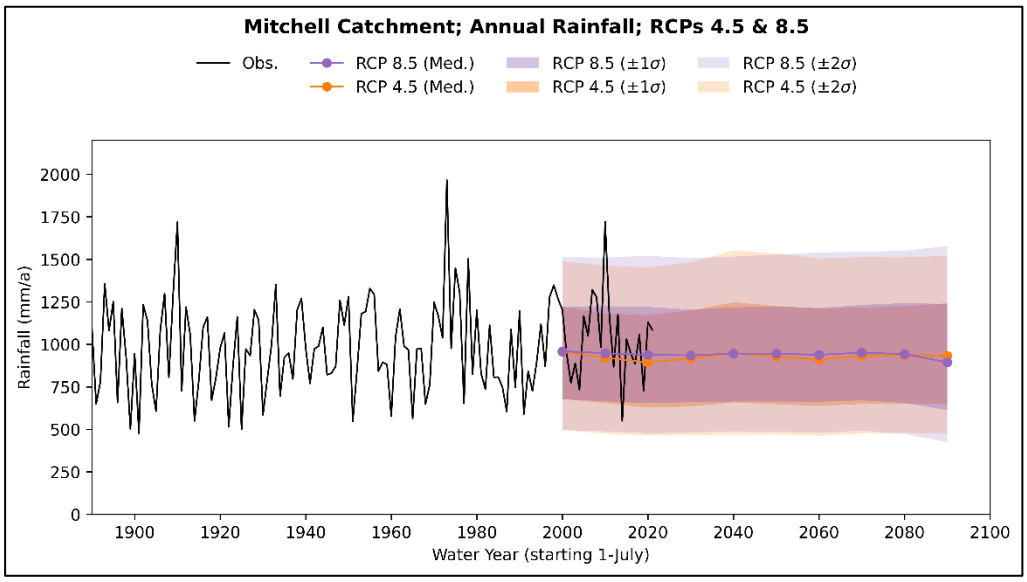

Figure 9.11: Observed and projected catchment average annual climate: annual rainfall

Projections were also undertaken to investigate seasonal changes in climate variables. The temperature and evapotranspiration projections broadly show increases for all months. The monthly rainfall has more variability but is trending towards a small increase in spring/summer months for both scenarios and small decreases in the autumn/winter months. These monthly changes result in a similar annual rainfall, but a potentially drier catchment leading into the wet season. This may have some effect on streamflow generation.

There is evidence that climate change is occurring in the Mitchell water plan catchments as indicated by the time-of-emergence analysis for temperature and the GCM climate projections for temperature and evapotranspiration. The recent record high and low flows observed for some gauges may be evidence of emerging climate change in the Mitchell, however these flows fit within the highly variable flows recorded previously, and a variability analysis would be required to confirm this fit.

An increase in temperature has been observed since around 1990 and it is expected that this will eventually lead to an increase in evapotranspiration. This may already be occurring but the high variability within annual potential evapotranspiration makes it difficult to detect changes. Projected changes in climate

may lead to an increase in evaporation from dams, affecting reliability of water for water supply schemes. Reliability may also be affected by a probable reduction in streamflow. Climate change is also likely to alter water being generated within catchments and could lead to more extreme wet season events.

Climate change analysis is an evolving field with new understandings, models and syntheses published regularly. The information in this assessment represents the best understanding at the time and is subject to change as new science becomes available.

10. Water plan amendments and previous reports

Several amendments have been made to the water plan since it commenced, including consequential amendments to reflect administrative changes relating to the Water Act. After the last Minister's report in 2018, the water plan expiry was postponed until 1 November 2027.

The milestones since the water plan commenced are detailed in Appendix D.

11. Identification of potential risks to the water plan's outcomes

In October 2022, a risk assessment was undertaken to identify any potential risks to the water plan's outcomes that could emerge within the lifetime of the plan. An analysis of changes in the water plan area over and beyond the life of the plan was used to identify future water demands, any potential risks and emerging matters. Data and expert opinion were used to rank the likelihood and consequence of risk from a standardised list of threats, and the risk level and rationale for this ranking were documented (see Appendix A). Under this assessment framework, the level of risk, along with other factors, such as a water plan's ability to achieve its outcomes were considered in proposing appropriate actions to mitigate the risks.

Of the 27 water plan outcomes assessed, two[1] could not be fully assessed due to limited information available and the rest were ranked as low risk (Appendix A).

These two outcomes relate to making water available to First Nations communities to achieve their economic and social aspirations, and to support their water-related cultural values in the water plan area. These outcomes are partly met through:

- unallocated water (UAW) reserves
- environmental flow provisions, where key ecosystems protected by the water plan are likely to overlap with cultural values
- provisions in the Water Act which allow First Nations peoples to take or interfere with water for traditional activities or cultural purposes without an entitlement.

A risk level was unable to be assigned to this outcome as there is insufficient information on First Nations people's cultural values and uses of water in the plan area. Hence, engagement with First Nations peoples will be undertaken as part of the next plan review and replacement. This will aim to fill the identified knowledge gaps by improving understanding and recognition of the cultural values, aspirations and uses of water and associated water requirements.

12. Opportunities and emerging matters

The risk assessment underpinning this report identified knowledge gaps that could be addressed through further research and/or monitoring to inform future assessments and decision making. It also identified

[1] The outcomes under sections 12(h) and 12(j) relating to supporting water-related cultural values.

matters potentially emerging over or beyond the lifetime of the current water plan that should be considered under the plan's framework. These include:

- The need to update the water plan outcomes in accordance with the latest Water Act requirements and contemporary water planning policies and emerging matters.
- The need to incorporate best-available science and information, including the latest hydrological modelling and improved understanding of water requirements for key environmental assets.
- Consideration of climate change impacts on water availability in the plan area. Scientific modelling projections conducted by the Queensland Government forecast an increase in temperature and evapotranspiration and uncertainty regarding rainfall patterns. These changes may result in similar overall annual rainfall totals, trending towards small increases in rainfall in the summer months and small decreases or no change in the dry season. Changes in climate may lead to increases in consumption and losses from storages and watercourses and reduced persistence of waterholes through time.
- The need to assess the impacts of the existing water management arrangements and future policy decisions across the plan area using a new hydrologic model, to address identified priority issues and emerging matters.
- The need to better understand cultural water values of First Nations peoples, as well as their economic and spiritual aspirations and the associated water needs.
- The need to review water availability and UAW volumes across the plan area to address growing demands for additional water to support economic growth, town water supplies and economic and cultural aspirations of First Nations peoples.
- The need to better understand groundwater resources, particularly connectivity to surface water, as well as groundwater dependant ecosystems.

It is proposed that these matters will be considered as part of the next plan review underpinning its replacement with a new plan due by 2027. The learnings gained from implementing the existing plan to date will be used to make improvements to the new plan as part of an adaptive management cycle based on revised future water needs, enhanced scientific information and targeted stakeholder consultation.

The department is also aware of two projects in the water plan area that would require unallocated water. One of these projects, the Kowanyama Biofutures proposal, is at concept stage, and the other is the Lakeland Irrigation Project, which aims to expand irrigated agriculture in the Lakelands region. There is some unallocated water available within the water plan area and the department will continue to assist proponents with their water needs.

13. Any non-compliance under a water entitlement or other authorisation in the water plan area

Over the past five years, there were 23 non-compliance incidents, 17 of which were resolved without taking any compliance action and six required compliance action. Most incidents related to failure to supply a meter reading. Appendix E provides details on the number and type of alleged non-compliance incidents and the outcome of departmental investigations and compliance response that occurred over the reporting period (2017/18-2021/22 water years).

The department uses a range of methods to monitor for compliance against entitlements including field and desktop audits, metering, and third-party notification. These activities support public confidence in how water is managed and protects the rights of all entitlement holders and the broader community.

To ensure our water resources are managed fairly and responsibly the department has developed a Regulatory Strategy Water Resource Management – Water 2022 – 2024 that establishes our regulatory approach for the delivery of our regulatory functions and activities. The strategy explains the principles underlying our regulatory approach, the tools we utilise and our compliance and enforcement pathway. The

objectives and principles set out in the Regulatory Strategy sets the foundation for our annual compliance planning.

The department's Annual Compliance Plan 2023-2024 identifies activities that support department's compliance approach, including compliance outcomes, performance measures, focus areas, activities, targets and measures. The compliance plan supports the department to take a risk-based, transparent and consistent approach to how we regulate Queensland's water resources.

In addition, the work being done under the Rural Water Futures Program will support improved compliance outcomes.

14. Way forward

This assessment shows that the water plan continues to be fit for purpose and there are no high risks to the achievement of the outcomes within its scheduled lifetime. The water plan is therefore expected to continue to be effective in advancing the sustainable management of water resources and minimising the adverse impacts on the existing water entitlement holders and natural ecosystems in the plan area until its expiry date in 2027. The emerging matters identified in the report may however impact the water plan's continued effectiveness in the future. These will be best addressed as part of the water plan review and replacement due by 2027.

In addition, more contemporary and comprehensive social, economic, environmental, and cultural outcomes will be developed when the water plan is reviewed and replaced by 2027.

In the meantime, the department will continue to implement the water plan until it is reviewed and replaced with the new plan. The learnings gained from implementing the water plan will be used to make improvements to the new plan as part of an adaptive management cycle based on revised future water needs, increased scientific information and targeted stakeholder consultation.

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Appendix A Assessment of water plan outcomes

Table A-1 Risk assessment for general outcomes in the Mitchell water plan

Water plan outcome	Water plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative assessment of risk to the outcome being achieved
12 Each of the following is a general outcome for water in the plan area —			
(a) to provide for the use of all water entitlements and other authorisations in the plan area;	The plan itself does not limit or restrict existing users, or the taking of water under statutory authorisations.	The protocol provides for the following: • seasonal assignment rules • granting water licences to take overland flow water • dealing with water licence applications.	**Low Risk.** This outcome is being achieved. The plan provides ongoing access to water under existing and new water entitlements.
(b) to provide for the continued use of all existing overland flow works;	The plan manages overland flow.	The protocol provides for the granting water licences to take overland flow water	**Low Risk.** This outcome is being achieved. The plan provides ongoing access to water under existing water entitlements.
(c) to provide for the continued use of all existing water bores;	The plan itself does not limit or restrict existing users, or the taking of water under statutory authorisations.	The protocol provides for the seasonal assignment rules granting water licences to take underground water.	**Low Risk.** This outcome is being achieved. The plan provides ongoing access to water under existing and new water entitlements.
(d) to make water available to support growth in industries dependent on water in the plan area	The plan provides for UAW reserves.	The protocol provides a process for dealing with UAW and seasonal assignment rules.	**Low Risk.** This outcome is being achieved. The plan provides ongoing access to water under existing and new water entitlements.
(e) to make water in Lake Mitchell available to be taken;	The plan provides for strategic water reserves.	The protocol provides a process for dealing with UAW.	**Low Risk.** This outcome is being achieved. The plan provides ongoing access to water under existing and new water entitlements.
(f) to make water available to support population growth in towns and communities dependent on water in the plan area;	The plan provides for strategic water reserves.	The protocol provides a process for dealing with UAW.	**Low Risk.** This outcome is being achieved. The plan provides ongoing access to water under existing and new water entitlements that would satisfy the needs of the community over the next 10 years.

Water plan outcome	Water plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative assessment of risk to the outcome being achieved
(g) to make water available to support growth in irrigated agriculture;	The plan provides for UAW general reserves.	The protocol provides a process for dealing with UAW and seasonal water assignment rules.	**Low Risk.** This outcome is being achieved. The plan provides ongoing access to water under existing and new water entitlements.
(h) to make water available for helping indigenous communities in the Cape York Peninsula Region area to achieve their economic and social aspirations;	The plan establishes 'Indigenous reserves' of UAW consistent with the Provisions of the *Cape York Peninsula Heritage Act 2007*.	The protocol provides a process for dealing with UAW.	This outcome is partially met through UAW reserves and environmental flow provisions where key ecosystems protected by the plan are likely to overlap with the economic and social aspirations of the First Nations peoples. This is supported by the provisions in the Water Act which allow First Nations peoples to take or interfere with water for traditional activities or cultural purposes without an entitlement. However, there is insufficient information on the economic and social aspirations of the First Nations peoples to properly assess this outcome. Further engagement with First Nations peoples, to identify these aspirations and the cultural values and uses of water and associated water requirements to support evaluation of this outcome and inform the review of the water plan, will be required.
(i) to encourage continual improvement in the efficient use of water;	The plan provides a framework for amending water licences, including consideration for efficient water use in plan area.	The protocol provides for seasonal water assignment rules.	**Low Risk.** This outcome is being achieved. The plan provides ongoing access to water under existing and new water entitlements.
(j) to support water-related cultural values of First Nations communities in the plan area;	The plan provides for consideration of cultural values of First Nations communities in the setting of environmental management rules and dealing with licence applications to interfere with water and to take water from waterhole or	The protocol provides a process for dealing with UAW, including consideration of cultural values and seasonal water assignment rules, operating and environmental management rules, e.g., waterhole management to	**Unable to be assessed.** While the outcome is being partly met through assessment criteria for an UAW release process under the plan and protocol that include consideration of water related cultural values, there is insufficient

Water plan outcome	Water plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative assessment of risk to the outcome being achieved
	lake, to ensure these will not adversely affect cultural values of the watercourse, waterhole, lake or spring.	provide for both the environmental and cultural values of waterholes	information on cultural values and uses of water to assess this outcome. Further engagement with First Nations peoples, to attain a more detailed understanding of the cultural values and uses of water and associated water requirements to support evaluation of this outcome will be required
(k) to support tourism in the plan area, including, for example, by protecting flows that support the natural aesthetics of watercourses and their surroundings;	The plan outlines the volumes of UAW that may be accessed. The plan also limits the level of interference to flow through either diversion structures or excavation of the stream bed. Furthermore, there are limitations possible for new licences that restrict the level of drawdown of waterholes. Groundwater and overland flow are managed.	The protocol outlines the process for the granting of UAW. The protocol also establishes annual volumetric limits in water management areas as well as setting flow conditions for the seasonal assignment of water.	**Low Risk.** This outcome is currently being achieved. The plan provides the framework for the management of the water resource. The volume of UAW and the restrictions on the access conditions for the UAW provide for this outcome.
(l) to support commercial fishing in the Gulf of Carpentaria, including, for example, by protecting flood flows that may deliver nutrients and water to estuarine and marine environments to stimulate growth and movement of native aquatic animals, including fish, prawns and crabs;	The plan outlines the volumes of UAW that may be accessed.	The protocol outlines the process for the granting of UAW.	**Low Risk.** This outcome is currently being achieved. The plan has set maximum UAW reserves.
(m) to ensure water is available to support natural ecosystem processes;	The plan outlines the volumes of UAW that may be accessed. Furthermore, there are limitations for new licences that restrict the level of drawdown of waterholes. There are further management of groundwater and overland flows.	The protocol outlines the process for the granting of UAW.	**Low Risk.** This outcome is being achieved. The plan manages overland flow, groundwater and surface water. Only a small proportion of available water resources are allocated.
(n) to allocate and manage water in the upper Walsh River and the upper Mitchell River in a way that is compatible with the outcomes of the Water	The plan specifies that this matter is to be considered.	The protocol provides for chief executive data collection and assessment	**Low Risk.** This outcome is being achieved. The department will continue to monitor developments with the Nullinga Dam detailed

Water plan outcome	Water plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative assessment of risk to the outcome being achieved
Resource (Barron) Plan 2002 to the greatest practicable extent.			business case for any change in risk.

Table A-2 Risk assessment to ecological outcomes in the Mitchell water plan

Water plan outcome	Water plan strategies and Resource Operations Plan rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative assessment of risk to the outcome being achieved
Section 13 of the water plan (General ecological outcomes for both surface water and groundwater) **Each of the following is a general ecological outcome for water in the plan area—**				
(a) to maintain the natural variability of flows that support the habitats of native plants and animals and migratory birds in watercourses, floodplains, wetlands, lakes and springs;	The plan: • identifies the volumes of UAW that may be accessed. • establishes management of overland flow as well as management of groundwater broadly and through groundwater management areas. • limits the level of interference to flow through either diversion structures or excavation of the stream bed. The WMP outlines the process for the granting of UAW and the terms and conditions on the licences granted as UAW	• Floodplain vegetation • Floodplain wetlands • Fluvial geomorphology and river forming processes • Southern Mitchell Aggregation/Southeast Karumba Plain Aggregation • Brackish estuarine habitat • Floodplain energy subsidy to riverine foodwebs • Riffles • Waterholes	Rivers within the plan area have highly variable and seasonal flow regimes and the biota found in these systems would be expected to be resilient to natural levels of flow variability at a variety of times scales (i.e., daily, seasonal, annual). Recent work by the NESP hub has demonstrated the importance of natural flow variability in supporting ecosystems in the plan area. Inter-annual variation in discharge of the Mitchell River explains about 60% of variation in floodplain inundation. There are relatively few licences to take water in the plan area and there are no large storages. Therefore, changes to flow variability are more likely to be occurring at small spatial scales (e.g., waterholes within reaches). With few gauging stations and monitoring bores in the basin there is uncertainty concerning hydrology and flows. GDE mapping would also assist in reducing uncertainty.	**Low risk.** This outcome has been achieved. Current water use is low, and the water plan contains performance indicators and environmental flow objectives to protect flows throughout the plan area.
(b) to provide for the continued capability of one part of a river system to be connected to another, including by maintaining flood flows that— (i) allow for the movement of native aquatic animals between	Water licences are granted from general reserves with flow thresholds. The plan: • allows for restrictions to be placed on new licences regarding the take of water from waterholes or lakes • limits the level of interference to flow through either diversion structures or excavation of the stream bed. The WMP:	• Floodplain vegetation • Floodplain wetlands • Fluvial geomorphology and river forming processes • Southern Mitchell Aggregation/Southeast Karumba Plain Aggregation • • Brackish estuarine habitat • • Riffles	Connectivity is an essential component of the ecology of river systems and underpins a number of ecological processes including nutrient processing and estuarine productivity. Floodplains are the drivers of productivity and an essential part of the ecology. Recent research has highlighted critical information on the importance of floods flows for habitat connectivity and productivity (e.g., aquatic plants on floodplains, and sand and mudflats used by migratory birds). At present, there is little large-scale water take in the plan area and connectivity is not adversely impacted. But there is uncertainty at the local scale (e.g., UAW – there is insufficient ecological data available to set robust rules for water take due to the remoteness of sites). With few gauging stations in the	**Low risk.** This outcome has been achieved. Current water use is low, and the water plan contains performance indicators and environmental flow objectives to protect flows throughout the plan area.

Water plan outcome	Water plan strategies and Resource Operations Plan rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative assessment of risk to the outcome being achieved
riverine, floodplain, wetland, estuarine and marine environments; and (ii) deliver nutrients and organic matter throughout the plan area to support natural processes such as breeding, growth and migration in riverine, floodplain, wetland, estuarine and marine environments; and (iii) deliver water and sediment throughout the plan area to support river-forming processes;	• outlines the process for the granting of UAW and the terms and conditions on the licences granted as UAW • outlines the process for managing overland flow.	• • Migratory aquatic biota • • Freshwater turtles	basin there is also some uncertainty concerning hydrology and flows.	
(c) to minimise changes to natural variability in water levels and to support natural ecological	The plan: has implemented groundwater management areas as well as declaring groundwater within 1km of prescribed watercourses to be water in the watercourse.	• Floodplain vegetation • Floodplain wetlands • Fluvial geomorphology and river forming processes	Permanent waterholes occur throughout the plan area. These are a major feature of the landscape in the wet-dry tropics and are important refugial habitats, providing for repopulation of the system when flows re-commence. More information is required about waterhole drawdown thresholds and local validation of risk thresholds for waterhole	**Low risk.** This outcome has been achieved. Current water use is low, and the water plan contains

Water plan outcome	Water plan strategies and Resource Operations Plan rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative assessment of risk to the outcome being achieved
processes, including maintaining refugia associated with waterholes and lakes;	allows limited UAW. manages overland flow. allows for restrictions to be placed on new licences in unsupplemented reaches regarding the take of water from waterholes or lakes. The WMP: outlines rules for seasonal assignment of water licences within volumetric limits and zones. imposes flow conditions on licences either established through season water assignment or granted from UAW.	• Southern Mitchell Aggregation/Southeast Karumba Plain Aggregation • Brackish estuarine habitat • Riffles • Migratory aquatic biota • Freshwater turtles • Waterholes as refugia	modelling already undertaken needs further work. There is also uncertainty around the identification of "small" permanent waterholes (e.g., those too small for detection by present remote sensing methods).	performance indicators and environmental flow objectives to protect flows throughout the plan area.
(d) to maintain the permanence of water in naturally perennially flowing watercourses and in river bed sands that provide water to support native plants and animals, particularly during dry seasons;	Groundwater within 1km of prescribed watercourses (including the Mitchell and Walsh rivers) is declared to be managed as water in the watercourse. The Plan: established maximum volumes for UAW reserves. requires that local availability of water in the bed sands is considered when establishing water sharing rules. states monitoring requirements. The WMP: outlines the need for chief executive data collection and assessment.	• Riffles • Migratory aquatic biota • Freshwater turtles • Waterholes as refugia • GDEs	Perennial systems have high ecological value and contain different species to intermittent systems. Perennial streams are highly sensitive to flow modifications and changes from perennial to intermittent would thus have major impacts on aquatic ecosystems. High uncertainty in relation to this outcome would be reduced by greater understanding of: • connectivity between groundwater—surface water, and • the locations where these connections may occur, and • the low flow dependencies of related ecosystems, particularly those associated with bed sands.	**Low risk.** This outcome has been achieved.
(e) to promote improved understanding of	The plan includes monitoring and reporting requirements. The minister must regularly report on	All	The Queensland government contributes to and invests in programs which improve understanding of flow and the ecosystems of the Mitchell water plan area - RDMW's	**Low Risk.**

Water plan outcome	Water plan strategies and Resource Operations Plan rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative assessment of risk to the outcome being achieved
the matters affecting flow-related health of ecosystems within the plan area.	matters affecting the environment and water users, as well as on the performance of the plan and effectiveness of its implementation.		Environmental Flows Assessment Program (EFAP), Tropical Rivers and Coastal Knowledge (TRaCK) research consortium, National Environmental Science Program (NESP), Northern Australia Water Resource Assessment (NAWRA). These programs have provided a substantial body of ecological information and a number of these are continuing to provide additional and transferrable information. However, there has been only limited specific ecological and water monitoring associated with plan strategies and WMP rules within the plan area to this time.	The outcome is being achieved. The Water Planning Science Plan outlines the Queensland government approach to providing the science to inform the water planning process.
Section 14 of the water plan (General ecological outcomes for groundwater only) **Each of the following is a general ecological outcome for groundwater in the plan area—**				
(a) to maintain groundwater contributions to the flow of water in watercourses, lakes and springs;	Groundwater within 1km of prescribed watercourses (including the Mitchell and Walsh rivers) is declared to be managed as water in the watercourse. In addition, water licences in the Chillagoe groundwater management area are required to have an annual volumetric limit as well as other conditions. The WMP: defers to the water plan that states that water licences will be required for all bores that are not used for stock and domestic purposes. states that the chief executive may require a person interested in obtaining a water licence to take unallocated underground water from the Chillagoe Groundwater Management Area to investigate the likely impact the proposed	• Riffles • Freshwater turtles • Waterholes as refugia • GDEs	Spring discharge, baseflows and groundwater—surface water interactions are poorly understood across much of the plan area. While water licences to take unallocated underground water from the Chillagoe Groundwater Management Area are allowed for under the water plan, there are currently no groundwater licences that have been granted in the plan area. Groundwater extraction in the Mitchell catchment has potential to reduce stream baseflows, deplete thin aquifers and permit saltwater intrusion. Changes from perennial to intermittent flows would cause major ecological impacts. High uncertainty in relation to this outcome concerns lack of: • GDE mapping • groundwater monitoring • understanding concerning the degree of groundwater utilisation • understanding of groundwater—surface water connectivity.	**Low risk.** This outcome is being achieved.

Water plan outcome	Water plan strategies and Resource Operations Plan rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative assessment of risk to the outcome being achieved
	taking of water may have on underground water or surface water flows and give the result of the investigation to the chief executive.		Hotspots of potential emerging risk include Bushy Creek, Rifle Creek and Chillagoe.	
(b) to support the ecosystems dependent on groundwater, including, for example, riparian vegetation, wetlands and waterholes;	Groundwater within 1km of prescribed watercourses (including the Mitchell and Walsh Rivers) is declared to be managed as water in the watercourse. In addition, water licences in the Chillagoe groundwater management area are required to have an annual volumetric limit as well as other conditions. The WMP: defers to the water plan that states that water licences will be required for all bores that are not used for stock and domestic purposes. states that the chief executive may require a person interested in obtaining a water licence to take unallocated underground water from the Chillagoe Groundwater Management Area to investigate the likely impact the proposed taking of water may have on underground water or surface water flows and give the result of the investigation to the chief executive.	• Riffles • Freshwater turtles • Waterholes as refugia • GDEs • Riparian vegetation	Although a previous desktop assessment of potential GDEs within the plan area identified: dry-season stream flows; instream waterhole persistence; and groundwater-fed vegetation, there has been no specific research or monitoring to confirm the presence of these GDEs, nor to identify their water needs. Ecosystems dependent on groundwater could be impacted by the lowering of groundwater tables. Groundwater extraction in the Mitchell catchment has potential to reduce stream baseflows, deplete thin aquifers and permit saltwater intrusion. High uncertainty in relation to this outcome concerns lack of: • GDE mapping • groundwater monitoring • understanding concerning the degree of groundwater utilisation • understanding of groundwater—surface water connectivity.	**Low risk but high uncertainty.** This outcome is being achieved.
(c) to allocate and manage groundwater in a way that is compatible with	The plan manages bores in the Chillagoe groundwater management areas. The declaration of the groundwater management areas is consistent	• Waterholes • Riffles • GDEs	The Mitchell Water Plan identifies the water that applies to the plan and states in section 10 that the plan does not include water of the Great Artesian Basin.	**Low risk.** This outcome is being achieved.

Water plan outcome	Water plan strategies and Resource Operations Plan rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative assessment of risk to the outcome being achieved
the outcomes of the Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017 to the greatest practicable extent.	with the extent of the managed GABORA Plan aquifers. The WMP outlines that the plan does not apply to water in a spring connected to GAB artesian or subartesian water or directly from GAB artesian or subartesian water.		Both plans seek to achieve a sustainable balance between plan outcomes providing for economic, social, cultural and environmental values. The outcomes of both plans are consistent in their protection of flow to support groundwater dependent ecosystems, the continued use of authorisations, and the aspirations of First Nations peoples. Outcomes of both plans also encourage the efficient use of water and the facilitation of efficient water markets.	
Section 15 of the water plan (Specific ecological outcomes) **Each of the following is a specific ecological outcome for water in the plan area—**				
(a) to maintain the cultural, ecological and tourism values of the cave ecosystems of the Chillagoe-Mungana Caves National Park;	The plan restricts licences to take water within the Chillagoe groundwater management area. The WMP states that the chief executive may require a person interested in obtaining a water licence to take unallocated underground water from the Chillagoe Groundwater Management Area to investigate the likely impact the proposed taking of water may have on underground water or surface water flows and give the result of the investigation to the chief executive.	• Groundwater dependent ecosystems	This area comprises subterranean wetland habitats associated with a limestone cave and karst tower complex. The site is a good example of a karst wetland. This type of wetland has a restricted distribution in Australia and karst towers are particularly rare. There are high ecological values associated with this complex which support rare biota such as the endemic blind amphipod (*Chillagoe thea*). The area has high cultural value and high geoheritage value (elements of natural geodiversity which are of significant value to humans but do not involve the extraction or degradation of those elements). The complex thus has high economic value (through significance to tourism and recreation). Dewatering of the limestone aquifer has occurred previously in connection with mining. This activity is regulated under Environmental Authorities which stipulate that the extraction of groundwater must not cause environmental harm to any groundwater dependent ecosystem or other environmental value. High uncertainty exists concerning: – Water levels in the aquifer and their dynamics – Lack of information regarding the dependencies of the values on the groundwater.	**Low risk** that this outcome may not be achieved. While overall this outcome is being achieved across the plan area, there is high uncertainty around this assessment due to a lack of understanding of the affects that dewatering might have on limestone aquifers

Water plan outcome	Water plan strategies and Resource Operations Plan rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative assessment of risk to the outcome being achieved
			At present as there is a low level of non-mining take in the area coupled with the control through the Environmental Authorities the likelihood of water resource development threats negatively impacting on the system is considered to be rare and therefore the risk low. Consolidation of existing knowledge and greater understanding of groundwater-surface water interactions are required. More targeted science may improve the department's knowledge of the cave ecosystems and improve the ability to assess this outcome in the future	
(b) to maintain flood flows to the estuarine and marine environments of the Gulf of Carpentaria to stimulate breeding, growth and migration of native aquatic animals;	The plan: established maximum volumes for UAW reserves. established overland flow storage volumes. The WMP: outlines the requirements for water licences for overland flow. outlines the need for chief executive data collection and assessment.	• Floodplain vegetation • Floodplain wetlands • Fluvial geomorphology and river forming processes • Southern Mitchell Aggregation/Southeast Karumba Plain Aggregation • Brackish estuarine habitat • Migratory aquatic biota	Changes to estuarine inflows would have significant impacts to estuarine productivity and salinity gradients. Previous work indicates that high flows are correlated with high growth rates and high fishery catches (barramundi and banana prawns). Recent work indicates that estuaries in the Gulf of Carpentaria are chronically nutrient-limited. Although flood flows have nutrient concentrations only slightly higher than dry season values, it is the first flush flows as well as the sheer volume of flood discharge that deliver substantial loads of nutrients to the estuary and nearshore zone to drive coastal productivity, both directly and indirectly. Risk to this outcome is low as there is a large UAW reserve and current water use and demand are low, with a relatively slow development "ramp" expected over the next five years. However, recent research (i.e., NESP output) needs to be incorporated into plan evaluations to better reflect fisheries requirements. Monitoring is currently limited by a lack of gauging stations in the lower part of the catchment and updates to the hydrological model are required.	**Low risk.** This outcome is being achieved.
(c) to maintain the natural variability of flood flows that inundate, and	The plan: established maximum volumes for UAW reserves.	• Floodplain vegetation • Floodplain wetlands	These aggregations are systems of high ecological value where flood flows are vital to the delivery of nutrients to downstream habitats. Changes to estuarine inflows would have significant impacts to estuarine productivity and salinity gradients (i.e., there would be ramifications to commercial	**Low risk.** This outcome is being achieved.

Water plan outcome	Water plan strategies and Resource Operations Plan rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative assessment of risk to the outcome being achieved
deliver nutrients, organic matter and sediment to, the wetlands of the areas known as the Mitchell River Fan Aggregation and the Southeast Karumba Plain Aggregation.	established overland flow storage volumes. The WMP: outlines the requirements for water licences for overland flow. outlines the need for chief executive data collection and assessment.	• Fluvial geomorphology and river forming processes • Southern Mitchell Aggregation/Southeast Karumba Plain Aggregation	fisheries if nursery habitats were impacted). Estuarine productivity also includes the growth of macroinvertebrate communities which support extensive populations of waterbirds. The Southeast Karumba Plain Aggregation has varied habitats (tidal flats, stream channels, ephemeral and permanent wetlands). The area provides important waterbird breeding habitat and supports the second largest summer population of wader birds in Australia. Flood flows in the Mitchell River Fan Aggregation spread extensively across numerous deeply incised distributary channels and permanent waterholes of the floodplain. This delta is home to a wide range of waterbirds. Risk to this outcome is low, as there is a large UAW reserve in the Mitchell plan area and current water use and demand are low, with a relatively slow development “ramp” expected over the next five years. However, recent research (i.e., NESP output) needs to be incorporated into plan evaluations to better reflect fisheries requirements. For example, estuarine systems provide more dynamic habitat when conditioned by brackish, euryhaline (variable) salinities which allow juvenile banana prawns to utilise the full range of estuarine habitats, thus enhancing production. Monitoring is currently limited by a lack of gauging stations in the lower part of the catchment and updates to the hydrological model are required.	

Appendix B Water entitlements and use

B-1 Water entitlements

Table B-1.1 Summary of water licences to take water in the Mitchell water plan area

Water classification	Volume based licences		Area based licences		Other
	Number of water licences	Total nominal entitlement (ML)	Number of water licences	Total nominal entitlement (Ha)	Number of licences with no volume or area specified
Surface water	45	5,403.5	0	0	1
Groundwater	-	-	-	-	-
Overland flow water	-	-	-	-	-

Table B-1.2 Summary of water licences to take water per purpose type

Total nominal entitlement (ML)			Number of water licences		
Any	Rural	Stock	Any	Rural	Stock
383.5	5,020	0	5	40	1

B-2 Water use

Table B-2 Metered water use in the Mitchell water plan area

Metered area	Water year	Number of metered entitlements	Authorised volume under metered entitlements (ML)	Metered water use (ML)	Water use as a percentage of authorised entitlement (%)
Lower Mitchell	2017-2018	4	740	50.46	6.82
	2018-2019	2	670	55.19	8.24
	2019-2020	2	670	109.26	16.31
	2020-2021	2	670	57.13	8.53
	2021-2022	2	670	64.11	9.57
Upper Mitchell	2017-2018	11	1,620.5	255.06	15.74
	2018-2019	11	2,060.5	231.32	11.23
	2019-2020	11	2,060.5	245.62	11.92
	2020-2021	11	2,060.5	277.21	13.45
	2021-2022	11	2,060.5	141.09	6.85

B-3 Unallocated water

Table B-4 Unallocated water reserved in the Mitchell water plan area

Reserve name	Purpose	Area	Initial reserve (ML)	Remaining reserve (ML)
General	Any	Upper Mitchell River sub catchment	20,000	20,000
		Other than Upper Mitchell River sub catchment	35,000	35,000
Indigenous	To support economic and social aspirations of First Nations peoples	Cape York Peninsula Region	5,000	5,000
Strategic	State	Water plan area	10,000	10,000

Appendix C Water taken or interfered with under statutory authorisations

Table C-1 Information on water authorisations in the Mitchell water plan area

Form of take	Catchment information sources
Authorisations that may not be limited by water planning instrument	
S93 General authorisations to take water (e.g., firefighting, watering travelling stock)	There have been no major increases in take of water for incidences of firefighting or travelling stock. Stock routes are predominantly serviced by state-controlled bores. The stock network in this area is classified as either 'minor' or 'unused', with little use by travelling stock over the last 5 years.
S94 General authorisations to interfere with overland flow water or interfere by impoundment for structures used for collecting monitoring data	There are no new departmental gauging stations that interfere with water from a watercourse, lake or spring by impounding for the purpose of collecting monitoring data. Monitoring data is collected at natural controls. There is no observed increase in structures that interfere with overland flow, e.g., those use for stock water or ponded pasture.
S95 First Nations parties	No impacts identified under this authority. These activities deal with very low quantities of water, which present a low risk to plan outcomes. The department is not aware of an increase in water take or interference for traditional activities or cultural purposes.
S96 Landowners may take water for stock or domestic purposes	No impacts identified under this general authorisation. A landholder may take water for stock or domestic purposes from an overland flow dam or from a watercourse adjoining their land. Stock and domestic dams are self-assessable development and must be notified.
S97 Environmental authorities to take or interfere with overland flow	No identified change in water taken under this general authorisation. Notification for the construction of overland flow storages to satisfy an environmental authority or a development permit for carrying out an environmentally relevant activity is required under the Planning Regulation 2017 and Water Regulation 2016. No overland flow dams constructed for these purposes have been notified and recorded in the department's database.
S98 Resource activities that interfere with the flow of water by diversion of a watercourse	No identified change in interference with watercourses under this general authorisation. The impacts of interference by diversion are assessed through requirements of the *Environmental Protection Act 1994.*
S99 Constructing authorities and water service providers	Limited volumes of water as required for road and rail construction and maintenance, and public amenities. Nine construction authority entities have been identified in the plan area. Limited volumes of water are required for road and rail construction and maintenance and public amenities. No significant increase in infrastructure or and amenities has been identified.
s101 Authorisation that may be altered or limited by water planning instrument or regulation.	No impacts identified for water taken under these authorities. s101(1)(a) Prescribed activities: Grazing is the major land use in the plan area. Prescribed activities that would be most utilised are washing down equipment, plant or vehicles, filling spray units to apply herbicides or pesticides, using stock dips and spray chases for controlling parasites on livestock. The Water Plan has not set the limit for prescribed activities. s101(1)(b) Take of overland flow: Only permitted using existing works (constructed prior to June 2001); for stock or domestic purposes; for prescribed activities; to comply with an environmental authority; to comply with a development permit for an environmentally relevant activity; or for contaminated agricultural runoff. Notification for the construction of overland flow storages is required under the Water Regulation 2016. The construction of one 50ML stock

Form of take	Catchment information sources
Authorisations that may not be limited by water planning instrument	
	dam has been notified and recorded in the department's database since 2016-17. s101(1)(c) Take of underground water: Only permitted under a water licence or water permit, for stock or domestic purposes or for a prescribed activity. Additional water licences may only be granted from UAW. No water permits have been granted for the take of groundwater in the plan area since 2016-17. s101(1)(d) Take of water from a dam not on a watercourse: Refer to notes under s101(1)(b) above. s101(3) Take of contaminated agricultural run-off: No development permits have been granted for contaminated agriculture runoff dams in the plan area.
s102 Authorisations under water plans or regulation	Not applicable to this plan area.
s103 Authorisations to take water for stock or domestic purposes may be limited	Not applicable to this plan area.

Appendix D Water plan amendments and milestones

Table D-1 Water planning milestones for the Mitchell water plan

Effective date	Milestones
November 2007	The water plan commenced on 1 November 2007. The plan: • provided for the regulation of surface water, including overland flow water, and subartesian water. • recognised the cultural values water holds for First Nations peoples • set out framework for establishing volumetric water licences • provided for 70,000ML of UAW held in Indigenous strategic and general reserves • set out a range of factors that must be considered in granting new licences to protect existing water users and environmental and cultural values
November 2009	The ROP commenced in November 2009 and the Sustainable Planning Regulation 2009 made consequential amendments to plan to align cross references and sections in the plan with relevant sections in the regulation. The ROP: • set out processes for dealing with UAW, including the requirement to consider the impact of granting water entitlements for irrigation on cultural water values. • established seasonal water assignment rules for water licences in areas of high • water demand • established a process for granting or amending entitlements to take overland flow water • outlined water and natural ecosystem monitoring and assessment requirements • outlined monitoring and reporting requirements that will be used to assess the • effectiveness of the implementation of the water resource plan.
November 2011	The *Water and Other Legislation Amendment Act 2011* amended the plan to update a section number cross references with amended legislation.
May 2013	The *Land, Water and Other Legislation Amendment Act 2013* amended the plan to update a section number cross reference with the Water Act.
June 2014	The plan was amended by the Water Resource Plans Amendment Plan (No. 1) 2014 which: • changed the Minister's reporting period on the plan to five years • removed unnecessary prescription while retaining policy intent
December 2016	The plan was amended by the *Water Reform and Other Legislation Amendment Act 2014* and the Water Regulation 2016 to update the short title of the plan, clarify the definition for water to which the plan applies, and provide an interim definition for the term subartesian water until such time as the plan is reviewed and replaced, and to update cross references.
August 2018	A notice was published postponing the expiry date of the water plan to 1 November 2027.

Appendix E Overview of non-compliance by entitlement holders

Table E-1 Summary of non-compliance incidents in the Mitchell water plan area in 2017/18 - 2021/22 water years

Type of alleged non-compliances	Number of alleged non-compliances	Outcome
Non-supply of meter readings	22	17 incidents of a 'non-supply of meter reading' were resolved and meter readings were subsequently supplied, where required. Five incidents required compliance action (four advisory letters were sent, and one formal warning provided).
Overuse under entitlement	1	Two advisory letters were sent to each person registered on the entitlement, and education provided.

Appendix F Annual streamflow for DRDMW gauging stations in the water plan area

Table F-1 List of current DRDMW gauging stations in the Mitchell water plan area

Gauging station number	Gauging station
919003A	Mitchell River at O.K. Bridge
919005A	Rifle Creek at Font Hill
919009B	Mitchell River at Dunbar
919011A	Mitchell River at Gamboola
919013A	McLeod river at Mulligan Highway
919014A	Mitchell River at Cooktown Crossing
919201A	Palmer River at Goldfields
919204A	Palmer River at Drumduff
919305B	Walsh River at Nullinga
919309A	Walsh River at Trimbles Crossing
919310A	Walsh River at Rookwood
919311A	Walsh River at Flatrock

Appendix G Summary of research and monitoring conducted in 2018-2022

Table G-1 General ecological outcomes for both surface water and groundwater

(13) Each of the following is a general ecological outcome for water in the plan area -	
Ecological Outcomes	**Summary of Monitoring and Research**
(a) to maintain the natural variability of flows that support the habitats of native plants and animals and migratory birds in watercourses, floodplains, wetlands, lakes and springs;	The plan area includes intermittent and perennial waterways and hence natural flow variability would be expected to vary across the plan. Although there are many similarities in physical characteristics of the Mitchell, Gilbert and Flinders estuaries, the Mitchell River has historically displayed more consistent year-to-year flow and a more extended period of flow each year (Burford et al 2020; Burford et al 2021a). Recent work by the NESP hub has demonstrated the importance of natural flow variability in supporting ecosystems in the Mitchell catchment (Burford et al 2020; Burford and Faggotter 2021; Cramer and Burford 2021). Ndehedehe et al (2021) assessed floodplain productivity in the Mitchell catchment by integrating remotely sensed biophysical indicators (vegetation and inundation) with hydrological data (rainfall and river discharge). With longer periods of inundation than the Flinders and Gilbert, flows in the Mitchell provide more time annually for vegetation to establish and become productive (Burford et al 2021b). Upstream flows and rainfall provide for floodplain inundation and aquatic plant growth. About 60% of variation in floodplain inundation is explained by inter-annual variation in river discharge (Stewart-Koster et al 2021). Stewart-Koster et al (2021) found that over 90% of algal derived primary productivity occurs in floodplain wetlands of the Mitchell catchment rather than river channels, largely due to the large surface area of these wetlands. Macrophytes growing in the wetlands provide substrate for algal attachment and growth. This fuels the base of aquatic food webs as macroinvertebrates consume the algae and concentrate this energy (enriched with high levels of essential fatty acids) into high-quality food for fish. Molinari et al (2021a) also found that the majority of algal production on the Mitchell floodplain occurred in wetlands, outside of main channel habitats, where relatively high levels of light in these shallow waterbodies favoured phytoplankton production and dense macrophyte cover provided for the attachment and growth of periphyton. Higher algal productivity was predicted for peak inundation days and/or wetter years when floodplain wetlands are inundated for longer periods. Molinari et al (2021a) indicated that lateral connectivity between floodplain wetlands and the river channel is important for supporting instream secondary production, thus emphasizing the importance of floodplain wetlands in sustaining ecosystem function of the Mitchell River. Molinari et al (2021b) assessed physical, chemical, and biological variables across a range of wetland (palustrine, lacustrine, and riverine) and habitat types (emergent, floating and submerged- macrophyte habitats and open water habitats). They found the phytoplankton productivity of open water habitats (average C of 113.0 $mg.m^{-2}.d^{-1}$) was consistently higher than the epiphyton productivity of emergent and floating habitats, but lower than epiphyton productivity assessed for submerged macrophyte habitats across the wetlands. Further, (Molinari et al 2021b) found that algal productivity could be predicted from habitat type and turbidity, thus remote sensing could be used to identify hot spots over broad spatial scales. **Implications for flow management** Work by the NESP hub has shown that flood flows are critical for estuarine and floodplain wetland productivity, hence reductions in flood flows reaching these habitats will have negative flow on effects for productivity.

(13) Each of the following is a general ecological outcome for water in the plan area -	
Ecological Outcomes	**Summary of Monitoring and Research**
	UAW reserves are available in the plan area. Water utilisation in the plan area is low and at present changes to flow variability are expected to be minor.
(b) provision for the continued capability of a part of a river system to be connected to another part, including by maintaining flood flows that— (i) allow for the movement of native aquatic animals between riverine, floodplain, wetland, estuarine and marine environments; and (ii) deliver nutrients and organic matter throughout the plan area to support natural processes such as breeding, growth and migration in riverine, floodplain, wetland, estuarine and marine environments; and (iii) deliver water and sediment throughout the plan area to support river-forming processes;	See comments for outcome 13(a) above. The ecological value of a particular river reach is directly linked, in quantity and quality, to the longitudinal movement of resources such as water, sediment and debris and the migration, recruitment and distribution of species. This also applies to lateral movement between the river and off-channel wetland habitats on the floodplain (DES 2020). Connectivity is thus an essential component of the ecology of river systems and underpins a number of ecological processes. Recent research has provided critical information on the importance of flood flows for habitat connectivity, productivity and the movement of aquatic fauna. Fish consume food provided in floodplain wetlands during periods of inundation, but inundation windows may be so short that fish cannot return to river habitats until the next wet season. Sufficient wet season flows must be provided to replenish floodplain wetland habitats enough to persist through the dry season (Stewart-Koster et al 2021). Molinari et al (2022) explored the effects of altered landscape connectivity on algal production in the Mitchell River catchment. They predicted that drier years and a water resource development (WRD) scenario with three new dams would result in floodplain fragmentation that would potentially constrain movement by higher order consumers. Drier years resulted in shorter periods of inundation and connection between productive habitats. Reduced connectivity associated with the WRD scenario was predicted to reduce the algal productivity on the floodplain by up to 26%. Drier years and the development scenario in combination have the potential to cause extreme fragmentation of the floodplain landscape. Karim et al (2018) developed a hydrodynamic model of the Mitchell catchment as part of the CSIRO's Northern Australia Water Resource Assessment (NAWRA). Stewart-Koster et al (2021) applied this model to assess patterns of hydrologic connectivity in the Mitchell catchment. When river flows facilitated floodplain wetland connectivity, up to 58% of floodplain wetland algal productivity was connected to main river channels and available to provide potential energy subsidies to riverine food webs. Stewart-Koster et al (2021) also examined floodplain connectivity over a wet (2009), an average (2001), a dry (2006) year, and under a scenario of three new dams. Substantial variation in floodplain inundation extent occurred between these years, reducing further to between 27% and 41% reduction over these years as the WRD scenario was applied to the model. Stewart-Koster et al (2021) found that the extent of fish movement throughout the Mitchell catchment varied between species and that non-reproductive fish also moved throughout the catchment (i.e., movement was not necessarily related to reproductive requirements). Most individuals captured had made at least one large-scale movement. Similar findings were made by O'Mara et al (2021), who investigated fish movement across the Mitchell catchment by comparing sulphur isotopes in fish and their prey species. Regardless of reproductive life history requirements, O'Mara et al (2021), also found that movement occurred (to varying degrees) across most fish species. Given these scales of movement, reduced connectivity due to potential dams may have an even greater impact than previously thought. For example, most of the fish captured in the upper Palmer and Walsh Rivers had moved there from other parts of the catchment (Stewart-Koster et al 2021; O'Mara et al 2021). In subsequent modelling, O'Mara et al (2021) examined five dam scenarios and found the severity of impact from dam construction on fish movement was influenced by location of the dams, with highest impact predicted to occur if the Pinnacles Dam (Mitchell River) was constructed. This scenario would reduce movement in the Mitchell River and lower Palmer River where important connections to habitat, floodplain and breeding sites exist. Should all five dams be constructed, modelling predicted that potential movement into sites in the Mitchell from elsewhere in the catchment would decrease by about 45% (O'Mara et al 2021; Stewart-Koster et al 2021). The examination of strontium isotope ratios in barramundi otoliths (ear bones) revealed variable use of freshwater habitats by barramundi in the Mitchell, Gilbert, and Flinders Rivers (Robins et al 2021). Highest freshwater residency (i.e., the type of aquatic

(13) Each of the following is a general ecological outcome for water in the plan area -	
Ecological Outcomes	**Summary of Monitoring and Research**
	habitat inhabited during the dry season) occurred in the Mitchell River (~60%), whilst highest estuarine residency (~67%) occurred in the Flinders River, and the Gilbert River had the highest 'intermediate' residency (i.e., brackish, 49%). Results indicated that the geomorphology and inter-annual river flow patterns of these three Gulf rivers provided variable opportunities for the spatial and temporal connectivity of aquatic habitats used by barramundi, including access to seasonal floodplains (Robins et al 2021). Stewart-Koster et al (2021) found that barramundi accessing freshwater habitats displayed faster growth than those staying in the coastal zone. Larger flows in wetter years supported increased growth, biomass and abundance of barramundi (Stewart-Koster et al 2021). Kenyon et al (2020) provided late dry season estimates of banana prawn abundance in the estuaries of the Mitchell, Gilbert and Flinders Rivers in relation to habitat availability. Behaviour and habitat use varied with salinity. During a dry late-dry season when salinities were hypersaline (highly saline) juvenile banana prawns remained in tributaries, whereas in the following year, a wet late-dry season produced brackish conditions and many juveniles moved into the lower estuary in response to the freshwater inflows. Brackish conditions encouraged juvenile banana prawns to utilise the full range of estuarine habitats available. Whilst algal biomass in the water column and on the intertidal mudflats of the Mitchell (and Flinders and Gilbert) were comparable to other tropical estuaries, the organic carbon content of sediments and respiration rates on intertidal flats were low, suggesting that organic carbon availability from sources other than primary production on the mudflats was limited. This indicates that mangrove detritus is not a major contributor to mudflat productivity of these estuaries (Burford et al 2021a). O'Mara et al (2022) examined the trophic transfer of lipids and polyunsaturated fatty acids (PUFA) across habitats in the Mitchell catchment. These are essential dietary components for vertebrates. Fish had similar PUFA composition to aquatic macroinvertebrates. Macroinvertebrates feed on aquatic plants (algae) but have higher lipid and PUFA total content than plants or fish and thus provide a concentrated source of PUFA for fish. However, lipid and PUFA content varies across macroinvertebrate taxa. Therefore, food quality for fish may vary between habitat types due to differences in macroinvertebrate community composition (O'Mara et al 2022). As 94% of algal productivity in the Mitchell catchment occurs on the floodplain as opposed to river channels (Molinari et al 2021a) wetland habitats could thus support high macroinvertebrate biomass and supply high-quality food for fish and other aquatic fauna. The conservation of habitats that are rich in these dietary components is therefore important for the maintenance of healthy fish communities (O'Mara et al 2022). Significant differences in characteristics of aquatic habitats were shown between low connectivity, high connectivity and off-channel sites and these were associated with changes in fish community composition with unique assemblages found in headwater sites. Localised populations may result from reduced movement opportunity as suggested by high species turnover between adjacent sites of low connectivity (O'Mara et al in review). Altered hydrological connectivity in the Mitchell catchment may lead to changes in riverbank shape, water depth, substrate composition and macrophyte cover. Changes would most likely be associated with altered sediment transport and deposition dynamics as these directly influence turbidity, substrate and depth. Dams and reservoirs may cause upstream sediment build-up and downstream channel degradation. Altered substrate composition would likely cause loss of refuge, spawning and foraging habitats which would influence species composition. O'Mara et al (in review) found that coverage of bedrock and sand substrate types were two of the top three environmental variables associated with fish abundance, leading to suggestion that water resource development planning should consider such environmental changes, in addition to direct barrier effects on fish movement. Venarsky et al (2020) combined previously published feeding-guild-specific stable isotope analyses with measures of fish community biomass to determine how wet- and dry-season habitat templates drive the energy sources that support fish biomass in the Mitchell catchment. A habitat template is a combination of physical (flow regime, substrate type and distribution) and chemical (water quality, nutrients) measures which are affected by a hierarchical set of climatic (temperature, rainfall), terrestrial (geology, vegetation) and aquatic (geometry, gradient, discharge) factors. Variations in the habitat template through a stream network influence both the sources

(13) Each of the following is a general ecological outcome for water in the plan area -	
Ecological Outcomes	**Summary of Monitoring and Research**
	of energy supporting productivity of the food web and community composition within that food web (Thorp et al (2006) and Winemiller et al (2010), both cited in Venarsky et al (2020)). Venarsky et al (2020) found the relative contribution of each fish feeding guild was critical to analysis as a single feeding guild (invertivore/piscivore) most influenced the spatial and temporal patterns of energy sources supporting overall fish biomass. In the early dry season, a decreased reliance on autochthonous energy sources (periphyton) was seen moving downstream, which also correlated with increasing floodplain area and wet season inundation times. However, by late dry season in both upper and lower reaches, fish had become increasingly reliant on the autochthonous energy produced in waterholes. Venarsky et al (2020) indicated that wet season energy builds fish biomass (tissue addition through growth) and that dry season energy maintains fish biomass. Autochthonous and allochthonous energy sources combine in unison to support fish community biomass, and seasonal patterns in discharge interact with spatial variability in river geomorphology (channel geometry and floodplain area) to dictate access to these sources of energy (Venarsky et al 2020). A large set of barramundi otoliths (ear bones) collected from the Flinders, Gilbert and Mitchell regions were examined to determine the relationship between river discharge volumes and growth. Total river discharges from January to March each year had a strong positive effect on otolith increment widths (growth rate) of barramundi up to three years of age, across all three regions. However, juvenile growth rates from October to June were most positively affected by river discharge in the Mitchell region, which experiences perennial flow (Leahy and Robins 2021). Burford et al (2021b) found that barramundi recruitment patterns were highly variable across rivers of the region, with significant relationships to river discharge applicable over multiple years and not just in their first year of life. Barramundi are thus a long-term measure of ecosystem health by which inter-annual patterns in estuarine production (in the broadest sense) and river flows in the Gulf catchments may be assessed (Burford et al 2021b). Under a hypothetical severe water extraction scenario modelled for the Mitchell region, Leahy and Robins (2021) predicted that juvenile barramundi growth rates from birth to the formation of the third otolith increment (age 2+) was reduced by 19%. This infers that both smaller and fewer fish would recruit to the fishery, as smaller fish are more vulnerable to predation (Burford et al 2021b; Robins et al 2021). River flows can increase the growth rates of juvenile barramundi with growth enhanced by 25% for those fish accessing freshwater habitats compared with fish in estuarine habitats (Roberts et al 2019). Experimental addition of nutrients to the Mitchell, Flinders and Gilbert estuaries in both dry and wet seasons resulted in increased primary productivity (estuarine mudflat algae) indicating that these estuaries are nutrient-limited (Burford and Faggotter 2021; Burford et al 2021a). This emphasises that regular inputs of nutrients delivered by wet season flows are critical for the maintenance of primary productivity as this has flow-on effects to food chains and consumer animals within the system (Burford et al 2021a). Whilst nutrient exports were highly variable from year-to-year, first flush wet season flows are a key attribute most critical to productivity as these flows will likely deliver the highest nutrient concentrations to estuaries prior to salinity decreasing to the point where primary productivity is adversely affected. Consecutive years of low—medium flows will result in nutrient depletion due to advection, burial and denitrification. Estuarine and nearshore productivity is therefore best achieved by ensuring that first flush flows are protected, and that water extraction is tightly controlled in low—medium flow years (Burford and Faggotter 2021). Venarsky et al (2022) described macrobenthic community dynamics in sandflats and mudflats of the Flinders, Gilbert and Mitchell estuaries. The number of zero flow days in the preceding dry season was the best predicter of community composition. Estuarine salinity regime, interacting with river flows were the likely driver of observed inter-annual patterns in community composition. The frequency (daily to yearly), duration (hours to months) and extent (freshwater to hypersaline) of an estuary's salinity regime thus

(13) Each of the following is a general ecological outcome for water in the plan area -	
Ecological Outcomes	**Summary of Monitoring and Research**
	strongly influence the distribution of taxa. Venarsky et al (2022) indicated that significant alterations in benthic community composition can be driven by relatively subtle fluctuations in dry season flow. **Implications for flow management** Connectivity is an essential component of the ecology of the Mitchell catchment and underpins several ecological processes such as nutrient dynamics and estuarine productivity. Floodplain inundation during the wet season allows fish to access new habitat for feeding and receding floodwaters return nutrients to river channels. Inundation of floodplain wetlands stimulates primary productivity and can provide fish with high quality food. Periods of floodplain inundation may be relatively short and must be maintained if UAW is released in the future. At present connectivity is not adversely impacted within the plan area. The plan has set maximum UAW reserves. UAW releases are accounted for in modelling. Water licences are granted from general reserves with flow thresholds. Kenyon et al (2020) stated that "*Water Resource Plans should legislate trigger levels of flow below which impoundment or extraction cannot occur; both for early-season low-level flows and low-level flows associated with the wet season. Extraction or impoundment should occur from high-level flows only, whereby the bulk of flow volumes continues downstream*". Flows are important for supporting barramundi and banana prawn population dynamics.
(c) minimisation of changes to natural variability in water levels to support natural ecological processes, including the maintenance of refugia associated with waterholes and lakes;	See comments for outcome (a) above. Permanent waterholes occur throughout the plan area and are a major feature of the landscape in the wet-dry tropics. Waterholes in the Mitchell catchment that persist through the dry season are key aquatic refugia and many of these may have cultural significance (Petheram et al 2018). Permanent waterholes are often identified by remote sensing, which means that the minimum waterhole size that can be detected is approximately 25-30 m wide. Narrower waterholes that may be permanent, such as occurring in the upper Mitchell catchment downstream of the Rifle Creek junction, may not be identified by this process. Identification of these smaller (permanent) waterholes is important to ensure water management strategies maintain their refugial values and the ecological processes they support. **Implications for flow management** The water plan provides some protection to waterholes. For example, the plan allows for restrictions to be placed on licences in unsupplemented reaches regarding take of water from waterholes or lakes. Section 37 of the plan also allows restrictions to be placed on new licences regarding the take of water from waterholes and lakes. However, there are several knowledge gaps that should be addressed to enhance management of these features to ensure their persistence. Most of the work on waterholes in the plan area had been completed in the lower Mitchell River and other parts of the plan area (e.g., upper Mitchell River) need to be assessed. Investigation of the ecological values and persistence times of small waterholes in the plan area, such as those in Chillagoe Creek and the upper Mitchell River, will provide information to support future UAW releases and better describe threats to these assets. For example, North Region Aquatic Ecology determined the bathymetry of the waterhole at the Cooktown Crossing gauging station (Mitchell River, 919014A) in July 2022. Gauging station records can be applied to the bathymetry to determine how the volume of this waterhole has changed through time and assess how various water use scenarios may impact waterhole volume.
(d) maintenance of the permanence of water in naturally perennially flowing watercourses and in river bed sands that provide water to support native plants and	Groundwater is likely to contribute to surface flows in several perennial and near-perennial watercourses of the plan area, including Rifle Creek, Mary Creek, Palmer River, McLeod River and parts of the Mitchell River but the extent to which groundwater contributes to surface flows is unknown. Groundwater inputs may contribute to the persistence of permanent (refugial) waterholes in the plan area.

(13) Each of the following is a general ecological outcome for water in the plan area -	
Ecological Outcomes	**Summary of Monitoring and Research**
animals, particularly during dry seasons;	There is little information available to assess this outcome. It is unknown to what extent native plants and animals rely on water in bed sands within the plan area and also the distribution of actual groundwater-dependent ecosystems (GDEs) in the plan area has not been confirmed. Permanent river flows may be associated with groundwater inputs. Groundwater extraction in the Mitchell catchment has potential to reduce stream baseflows, deplete thin aquifers and permit saltwater intrusion (Taylor et al 2018; Taylor et al 2021). The extent to which groundwater contributes to perennial flow regimes is unknown. **Implications for flow management** Perennial systems have unique ecological values (when compared to intermittent systems) so changes to the flow regimes of the perennial waterways in the plan area would have significant ecological consequences. Our knowledge of these is poor. While utilisation of surface water and groundwater resources is low (and the plan provides mechanisms to protect these waterways) further research is required to better understand the ecological characteristics and relationships with hydrology, including groundwater—surface water connectivity.
(e) promotion of improved understanding of the matters affecting flow-related health of ecosystems in the plan area;	See comments for other ecological outcomes in this table. The details of departmental monitoring and other monitoring conducted within the plan area have been summarised in this report and are used as a tool to assess the achievement of the ecological outcomes. There have been a number of studies conducted to determine the potential impact of further allocation of water resources in the area – the information from these and other studies have also been summarised. The department will continue to collaborate with other government agencies and research organisations to enhance management of waterways and associated biota within the plan area. Environmental Values (EVs) and Water Quality Objectives (WQOs) for surface waters of the Mitchell River Basin (Part) and Walsh River sub-basin were released by the Department of Environment and Science (DES 2020). "*EVs and WQOs are used to help set development conditions, influence local government planning schemes, and underpin report card grades for ecosystem health monitoring programs. Aquatic ecosystem water quality objectives have, where possible, been established using local data, and present a truer picture of the values and water quality of local waterways than national and state water quality guidelines. This ensures the values the community holds for its waterways can be maintained and improved, without imposing unrealistic standards from national guidelines that may be inappropriate for local conditions.*" (DES 2020).

Table G-2 General ecological outcomes for groundwater only – Water Plan (Mitchell) 2007

(14) Each of the following is an additional ecological outcome for groundwater in the plan area—	
Ecological Outcomes	**Summary of Monitoring and Research**
(a) maintenance of groundwater contributions to the flow of water in watercourses, lakes and springs;	See comments for outcome 13(d) above. Groundwater is likely to contribute to surface flows in several perennial and near-perennial watercourses of the plan area, including Rifle Creek, Mary Creek, Palmer River, McLeod River and parts of the Mitchell River but the extent to which groundwater contributes to surface flows is unknown. Groundwater inputs may contribute to the persistence of permanent (refugial) waterholes in the plan area. **Implications for flow management** There are significant knowledge gaps associated with this outcome. However, there is limited utilisation of groundwater within the plan area and management strategies have been put in place to manage both surface water and groundwater as a single resource. Production bores not managed under the GABORA Water Plan are registered and the majority are used for stock watering only. No UAW is available from groundwater in the water management areas. Improved understanding of linkages between groundwater and surface water flows across the plan area would provide a more robust framework for impacts of future water take on several ecological outcomes of the plan.
(b) the support of ecosystems dependent on groundwater, including, for example, riparian vegetation, wetlands and waterholes;	See comments for outcomes 13(d) and 14(a) above and 15(a). The contribution of groundwater to wetlands and waterholes is unknown in the plan area. Groundwater may contribute to waterhole permanence in the upper Mitchell River and Chillagoe Creek. GDE mapping by the Queensland Government has not yet been undertaken for this plan area. **Implications for flow management** Monitoring and research into targeted groundwater interaction and ecological studies at these sites, plus groundwater level and usage data would improve certainty for assessment of this outcome.
(c) Allocation and management of groundwater in a way that is compatible with the outcomes of the Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017 to the greatest practicable extent.	The Mitchell Water Plan identifies water that applies to the plan and states in section 10 that the plan does not include water of the Great Artesian Basin. Both plans seek to achieve a sustainable balance between plan outcomes providing for economic, social, cultural and environmental values. The outcomes of both plans are consistent in their protection of flow to support groundwater dependent ecosystems, the continued use of authorisations, and the aspirations of First Nations peoples. Outcomes of both plans also encourage the efficient use of water and the facilitation of efficient water markets.

Table G-3 Specific ecological outcomes – Water Plan (Mitchell) 2007

(15) Each of the following is a specific ecological outcome for water in the plan area—	
Ecological Outcomes	**Summary of Monitoring and Research**
(a) to maintain the cultural, ecological and tourism values of the cave ecosystems of the Chillagoe-Mungana Caves National Park;	The Chillagoe-Mungana Caves National Park has very high cultural, ecological and tourism values (Gillieson 2016; Winn 2016; https://parks.des.qld.gov.au/parks/chillagoe-caves/about/culture). The park includes subterranean wetlands associated with a limestone cave complex, karst towers and spring-fed waterways which drain into the Walsh River. Small waterholes in Chillagoe Creek may rely on groundwater but this is unknown. The ecosystems within the park have a limited distribution in Australia. Karst towers are particularly rare and are globally significant (Gillieson 2016). The vine thickets on the towers are relict communities which have survived due to protection from fire. The Chillagoe-Mungana caves complex has cultural significance as a region supplying a variety of foods, permanent water supplies, resources, and as a shared buffer zone for multiple Traditional Owner groups (the Wakaman, the Wakara, and the Kuku Djungan peoples) (Winn 2016). Rock art associated with the complex is varied and reflects different styles and techniques. The art may also reflect different areas used by different clans and act as “signposts” (Winn 2016). Tourism associated with the caves has been occurring since the 1900s (Winn 2016). A National Park was first gazetted in the 1940s (Winn 2016). As a National Park greater emphasis is placed on the geology of the caves, rather than the cultural values (Winn 2016). **Implications for flow management** There is high uncertainty as to how the current values of the Chillagoe-Mungana Caves system relate to groundwater and potential interactions with surface water. Water present in subterranean caves may indicate intersection with aquifers, and/or percolation of surface water (rainfall). It is unknown to what extent groundwater contributes to the surface flow of adjacent waterways (extent of groundwater—surface water connectivity), although this outcome refers to cave ecosystems. Groundwater-dependent ecosystem (GDE) assessments have not been undertaken and no monitoring bores exist for the area. Threats to Spring Creek and the nearby caves exist from disturbance associated with mining. Mining exploration permits are currently active in the area, and while no large-scale activity is expected prior to the plan review in 2027 it is possible that small-scale operations could cause local de-watering of the aquifer. Water levels dropped markedly in the early 1990s, a trend which was thought may be linked with the dewatering of the limestone aquifer associated with mining in the area. However, there was also a protracted drought during the same period. The matter needs to be reassessed following a higher-than-average wet season.
(b) to maintain flood flows to the estuarine and marine environments of the Gulf of Carpentaria to stimulate breeding, growth and migration of native aquatic animals;	See comments for outcomes 14(a) and 14(b) above. Flood flows are important for supporting the life history requirements of commercially important species such as barramundi and banana prawns. Recent work in the Mitchell River and other Gulf rivers confirmed these links and provided estimates of financial losses that could be expected from reduced flood flows that may arise from UAW releases. Broadley et al (2020) investigated the impacts of flow extractions on banana prawn catch in the Gilbert, Flinders and Mitchell Rivers. Under all modelled flow extraction scenarios, a greater decline in banana prawn catch would be expected in years with low to medium river flows. Results further indicated that managing equitable water extraction during extended low flow or drought periods would be especially challenging for sustaining fishery yields (Broadley et al 2020). The greatest impact of all flow extraction scenarios occurred with a dam on the Mitchell River, leading to a 53% reduction in banana prawn catch predicted to occur in low-flow years. Depending on the scale of water development, adverse effects from water extraction would also be likely in medium- and high-flow years (Burford et al 2020; Burford et al 2021b).

(15) Each of the following is a specific ecological outcome for water in the plan area—	
Ecological Outcomes	**Summary of Monitoring and Research**
	In regard to maintaining a sustainable barramundi fishery, Robins et al (2021) warned that water resource development which reduces or impedes spawner biomass or juvenile survivorship would alter the natural fluctuation of barramundi biomass. This will have consequential impacts on the surplus yield that can be sustainably harvested. **Implications for flow management** If the full uptake of current entitlements and planned water allocations in Gulf catchments were to occur, vessel-level business profit in the Northern Prawn Fishery (NPF) could reduce by 7-12% for at least half of the time and additionally, by around 22% for at least half of the time if major dams were to be constructed in the Mitchell catchment. These reductions due to irrigation development could represent significant financial impacts on the NPF (Smart et al 2021). Demand for UAW in the Mitchell plan area is currently low. Importantly, research by the NESP hub has shown that risk to outcomes and assets will be higher in years with low and medium flows.
(c) to maintain the natural variability of flood flows that inundate, and deliver nutrients, organic matter and sediment to, the wetlands of the areas known as the Mitchell River Fan Aggregation and the Southeast Karumba Plain Aggregation.	See comments for outcomes and 14(a), 14(b) and 15(b) above. The Southeast Karumba Plain Aggregation is listed in the Directory of Important Wetlands of Australia (DIWA). The aggregation includes tidal flats, stream channels, ephemeral and permanent wetlands. The area provides significant waterbird breeding habitat and supports the second largest summer population of wader birds in Australia. It is one of four important bird habitats in the Mitchell catchment, and it also has cultural significance. (Petheram et al 2018; https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/diwa-wetland-southeast-karumba-plain-aggregation/). The Mitchell River fan Aggregation is also listed in DIWA. This aggregation includes mostly freshwater wetlands but also includes estuaries and a large variety of other habitats are present (https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/diwa-wetland-mitchell-river-fan-aggregation/). The apex of the Mitchell River Fan Aggregation is currently located near the Palmer and Mitchell River confluence. Below this apex flood flows spread extensively across numerous deeply incised distributary channels and permanent waterholes of the floodplain. This delta is home to a wide range of waterbirds (Petheram et al 2018). Seasonal flood pulses associated with the wet season are critical for delivering nutrients and stimulating primary and secondary productivity in the estuarine areas where migratory birds feed (Burford and Faggotter 2021). However, concentrations of total nitrogen and phosphorus in these flows only increased in short-term spikes and for most of the time concentrations were not greater than dry season values. It is the large volumes of water discharged from estuaries in medium to high flow years that deliver substantial loads of nutrients to the nearshore zone and drive coastal productivity, both directly and indirectly. Productivity of these habitats is thus directly related to the volume of water discharged (Burford et al 2020; Cramer and Burford 2021). **Implications for flow management** The Southeast Karumba Plains Aggregation and Mitchell River Fan Aggregation include freshwater and estuarine wetlands and require freshwater inflows to support ecological processes and biodiversity. At present freshwater inflows into these significant wetlands are not threatened but future UAW allocations will require that freshwater inflows are maintained, particularly during periods of low annual flow. As shown above, flood flows deliver nutrients to estuaries that support primary and secondary productivity and significant wader bird populations. Flood flows will also facilitate growth and dispersal of barramundi into off stream habitats. Seasonal flooding provides hydrologic connectivity, which is a critical influence on biological and physico-chemical features of floodplain waterholes, including those in the Mitchell.

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