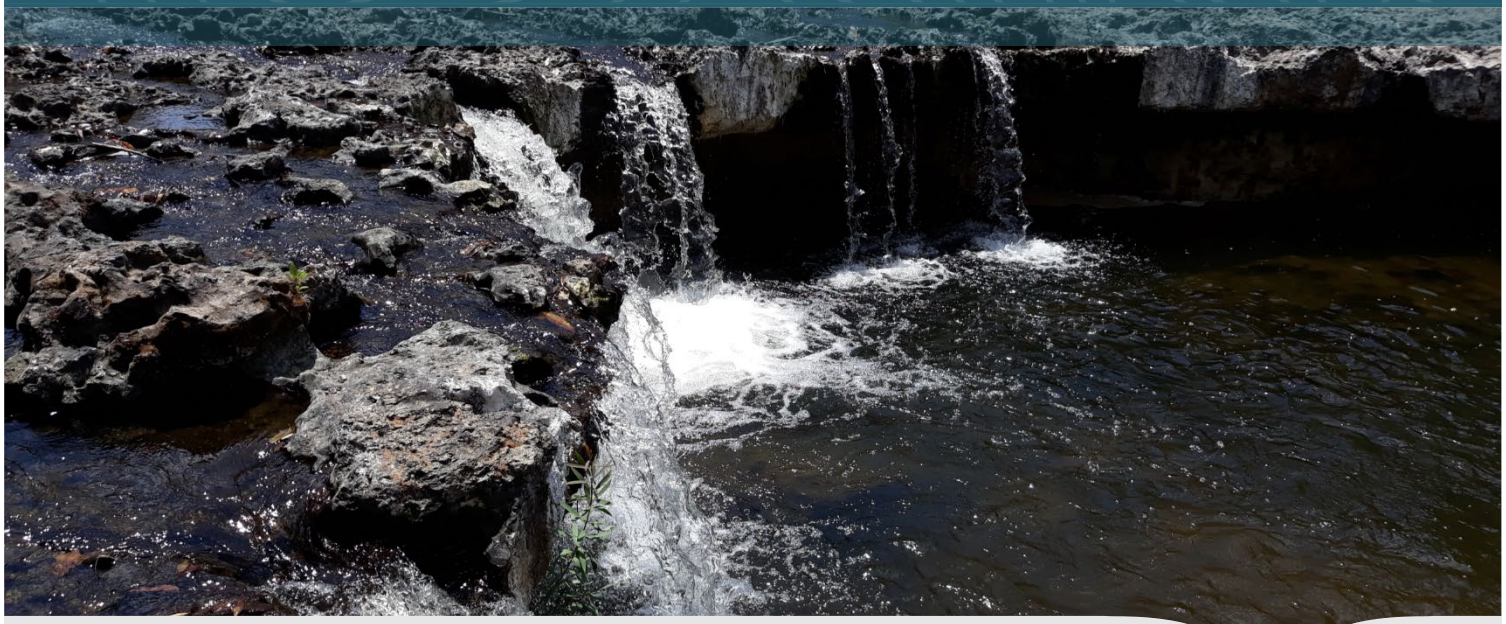
Queensland Government

Department of Regional Development, Manufacturing and Water



Water Plan (Wet Tropics) 2013

Minister's Performance Assessment Report

June 2024

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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, present and emerging.

This publication has been compiled by Water Planning and Science, North Region of Water Resource Management, Department of Regional Development, Manufacturing and Water. Cover photo is Stone River, downstream from Venables Crossing, Lower Herbert catchment.

Interpreter statement:

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Minister’s foreword

I am pleased to publish the second performance assessment report for the Water Plan (Wet Tropics) 2013 (the Wet Tropics water plan). Performance reports are an important part of the water planning process in Queensland for each of the state’s 23 water plans. This report assesses the effectiveness of the Wet Tropics water plan and its implementation since the last report in July 2019. The current Wet Tropics water plan is scheduled to expire on 1 September 2024.

My department has developed the Wet Tropics water plan based on the best available science and continues to update the evidence base through monitoring conducted over the life of the plan. Tourism and agriculture are primary economic drivers for the Wet Tropics catchment; and I recognise the need to balance the consumptive use for agriculture and other economic uses with the need to sustain non-consumptive uses, including tourism, recreation, and environmental and cultural values.

This report confirms that the Wet Tropics water plan and its implementation continue to be effective in advancing the sustainable management of water resources in the water plan area. I intend to postpone its expiry until 2032 to ensure the current sustainable water management arrangements remain in place for the water plan area’s water users. Continuing with the current Wet Tropics water plan until 2032 is expected to have no adverse impacts on water entitlement holders or natural ecosystems in the water plan area.

In the meantime, my department will continue to implement the Wet Tropics water plan. Ongoing monitoring will continue to enable new, emerging, or existing risks that are increasing in threat level, to be identified to ensure the plan continues to effectively allocate the water resources in the water plan area.

Residents in the Wet Tropics water plan area can be assured that water resources in your region are being managed responsibly and sustainably. I encourage anyone with an interest in the management of water resources in the water plan area to read this report.

Hon. Mr Glenn Butcher MP

Minister for Regional Development and Manufacturing

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 in accordance with the 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 (Wet Tropics) 2013 (the Wet Tropics water plan), which is scheduled to expire on 1 September 2024. A summary of the assessment is provided in Table 1: Summary of the performance assessment of the Water Plan (Wet Tropics) 2013.

The assessment shows that the Wet Tropics water plan remains fit for purpose and continues to advance the sustainable management of water resources in the water plan area. It also shows that the implementation of the Wet Tropics water plan has been effective in achieving most of its outcomes.

A risk assessment was undertaken to identify the issues that threaten the Wet Tropics water plan's ability to achieve its intended outcomes. This assessment concluded that the majority of the Wet Tropics water plan's outcomes are being achieved, but that there was insufficient information to fully assess the achievement of outcomes relating to supporting the water-related cultural values of First Nations peoples.

Of the 32 water plan outcomes assessed, three could not be fully assessed due to knowledge gaps, and the rest were ranked as low risk (Appendix A).

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

- Update the plan outcomes following the latest Water Act requirements and contemporary water planning policies.
- Consider climate change impacts on water availability in the water plan area.
- Incorporate the best available science and information, including the latest hydrological modelling and an improved understanding of water requirements for key environmental assets.
- Assess the impacts of the existing and any future water management arrangements across the water plan area using a new hydrologic model incorporating new 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 underground water resources, particularly connectivity to surface water, as well as groundwater-dependent ecosystems.

The learnings gained from implementing the existing plan will be used to improve water management arrangements under the replacement Wet Tropics water plan, as part of an adaptive management cycle based on revised future water needs, improved science knowledge and targeted stakeholder consultation.

Table 1: Summary of the performance assessment of the Water Plan (Wet Tropics) 2013.

	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 plan in advancing the sustainable management of Queensland's water resources	Overall, this assessment indicates that the plan is achieving the purposes of the Water Act. The Wet Tropics water plan continues to advance the sustainable management of water.	Section 3	On track
Effectiveness of the implementation of the plan in achieving the plan outcomes	A risk assessment found that most plan outcomes have been achieved. Of the 32 outcomes, 29 were assessed as low risk, and three outcomes (related to water resources of cultural value) 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 was collected and reported. No issues are identified as water use and demand is low in the water plan area, compared with water availability.	Section 5	On track
Summary of research and monitoring findings	The department prioritises monitoring programs based on risk. Ecological monitoring was undertaken within the water plan area over the past five years. Knowledge gaps associated with underground water 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 plan ecological outcomes.	Section 6	On track
Summary of amendments to the plan since its commencement	Several minor amendments have been made to the plan since its commencement. In 2023, the Resource Operations Plan was converted to a Water Management Protocol.	Section 10	On track
Summary of identified risks to plan outcomes	Of the 32 outcomes, 29 were assessed as low risk, and 3 outcomes (related to water resources of cultural value) could not be fully assessed. Limited information is 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.	Section 11	Some issues
Summary of non-compliances under a water entitlement or other authorisation in the plan area	Over the past five years, there were 167 non-compliance incidents. Most incidents were related to metering, with 147 late and non-supplied meter readings. Appendix E provides details on the number and type of non-compliance and incidents and the type and the outcome of departmental investigations and compliance response that occurred over the 2018/19 – 2022/23 reporting period.	Section 13	On track
Overall status and recommendation for the plan	While overall risks to water users and the environment remain low, the assessment has identified some opportunities and emerging matters to consider.	Section 14	On track

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1. Purpose of the report

The Water Act (s49) requires the Minister to prepare reports for each water plan, to ensure the implementation and effectiveness of each plan is regularly assessed as part of an adaptive management water planning cycle. This cycle involves water plan development, implementation, monitoring, reporting, and reviewing. Section 22(4) of the Water Regulation 2016 requires these reports to be prepared at least every five years and address the following matters:

- Whether the water plan is advancing the sustainable management of Queensland's water resources.
- An assessment of the effectiveness of the implementation of the water plan in achieving the plan's outcomes.
- Information on water use 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 the water plan's outcomes.
- What amendments, if any, have been made to the water plan since its commencement.
- Any non-compliance under a water entitlement or other authorisation in the water plan area.

This report is prepared to assess the performance of the Wet Tropics water plan and its implementation to meet the above statutory requirements, with an emphasis on progress since the previous Minister's report in 2019. It also identifies the potential drivers for change and emerging matters or pressures that a replacement water plan may need to accommodate, as well as issues that should be considered as part of the next performance assessment. Considerations were 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 April 2023 to underpin this report. 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 and that outcomes of the assessment are documented for future reference. The details and outcomes of the risk assessment are provided in Section 11, identification of potential risks to the water plan's outcomes, and Appendix A of this report.

2. Water plan area

The water plan area is located in Far North-Eastern Queensland and covers approximately 19,920km^2. The water plan area comprises seven local government areas: Cairns Regional, Tablelands Regional, Cassowary Coast Regional, Douglas Shire, Hinchinbrook Shire, Wujal Wujal Aboriginal Shire, and Yarrabah Aboriginal Shire Councils. Key urban or regional centres include Cairns, Port Douglas, Innisfail, Tully, and Ingham.

There are seven river catchments including Daintree in the north, Mossman, Mulgrave-Russell, Johnstone, Tully, Murray, and Herbert catchments in the south, all of which flow to the Coral Sea and Great Barrier Reef (Figure 1). The Barron catchment, which flows into the Coral Sea north of Cairns and is not included in the water plan area, divides the southern and northern water plan area catchments. The Barron River catchment is managed under the Water Plan (Barron) 2023.

The only major water storage in the water plan area is Koombooloomba Dam which is owned and operated by CleanCo Queensland Ltd. The dam is located on the headwaters of the Tully River and has a storage capacity of 216,600ML which is used to produce and supply electricity for the local grid. Other water storage infrastructure within the water plan area includes Malanda Weir, Millaa Millaa Weir, Crooks Dam and Eastine Creek Dam.

Figure 1: Water plan area boundary

Some of the highest rainfall in Australia occurs across the water plan area. Monsoonal events and tropical cyclones can result in significant rainfall events, primarily during the wet season (December to March). Average annual rainfall across the water plan area varies from over 8,000mm per annum (mm/a) near Bellenden Ker in the Mulgrave-Russell catchment, to around 800 mm/a in the Upper Herbert catchment to the west.

The main consumptive water users in the water plan area are agricultural industries. Bananas and sugarcane crops are the region's major agricultural outputs with the banana industry being the most reliant on water for irrigation sourced through unsupplemented surface water and underground water. Supplemented water is not available in the water plan area. Various other cropping, grazing and dairy industries are also significant activities in the water plan area.

Non-consumptive water uses with a social, economic, or cultural value include recreation, commercial fisheries, and tourism. The water plan area supports high environmental values, particularly within the Wet Tropics World Heritage Area and the Great Barrier Reef World Heritage Area. Freshwater flows are essential to provide the health and function of the wetlands and estuaries of these world heritage-listed ecosystems.

There are numerous native title determinations across the water plan area and 16 Registered Native Title Body Corporates (RNTBCs). While there are some known culturally significant sites to First Nations peoples, limited information is available to assess the water-related cultural values in the water plan area.

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

The Wet Tropics water plan manages unsupplemented surface water and underground water and is implemented through the Wet Tropics 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 Wet Tropics 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 2 provides a summary of the Wet Tropics water plan's framework and how it advances sustainable management of water. For a more detailed summary of the linkages between Wet Tropics water plan outcomes, strategies and rules see Appendix A.

Table 2: The water plan's framework for advancing the sustainable management of water

Water plan framework	How is this achieved?	Comment
Ecologically sustainable development	The Wet Tropics 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 Wet Tropics water plan to protect environmental flows and maintain the ecological integrity of the river systems to achieve plan outcomes.	The Wet Tropics 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. Ecological sustainable development is achieved through the social, economic, and environmental outcomes prescribed by the Wet Tropics water plan that all development is required to accommodate.
Allocation and use of water resources for economic, physical, and social wellbeing of the	The Wet Tropics 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 the release of unallocated water (UAW) from general,	UAW volumes have been reserved for future development to promote economic development, supporting population and industry growth, and

Water plan framework	How is this achieved?	Comment
people of Queensland	Indigenous, Cape York Indigenous, high flow and strategic reserves available, as well as a water trading framework for permanent and temporary trades. The trading rules and the process for the release of UAW is stated in the protocol. Water in the water 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 Wet Tropics water plan, the Water Act, or the Water Regulation.	aesthetic, recreational and cultural values. Since the plan commencement there have been two releases of UAW, first from the general reserve and the second from the strategic reserve. For detailed information on UAW releases, refer to Section 5 of the report, information on water use and authorisations in the plan area.
Sustain the health of ecosystems	The Wet Tropics water plan contains ecological outcomes, environmental flow objectives and strategies that aim to provide for the long-term viability of aquatic species and ecosystems dependent on flow.	Targeted research and monitoring data helped to inform the current assessment (for details see Section 6, research and monitoring findings). Furthermore, the risk assessment identified the ecological outcomes were being achieved in the reporting period. It ranked the risks to sustaining the health of ecosystems in the water plan area as low (for details see Appendix *A*).
Recognise the interests of First Nations peoples	The Wet Tropics water plan contains economic and social outcomes to support the First Nations peoples water-related social, economic aspirations and cultural values in the water plan area. The plan also includes strategies for minimising the negative impacts of taking or interfering with water under the water entitlements on cultural values. The Wet Tropics water plan provides Indigenous reserves of UAW to help First Nations peoples 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.	The risk assessment identified knowledge gaps in assessing effectiveness of the Wet Tropics water plan's framework in recognising the interests of First Nations peoples in the water plan area (Appendix A). Engagement with First Nations peoples is required to gain an improved understanding of their values and aspirations and the linkages of these to water management.
Enable water resources to be obtained through fair, transparent, and orderly processes	Water in the water plan area can be obtained through trading of water entitlements or through access to the UAW reserved for specific purposes. The Wet Tropics water plan identifies volumes of UAW available across the water plan area and states a framework for establishing and dealing with UAW and limitations on granting UAW from a particular reserve (general, Indigenous, Cape York Indigenous and strategic). Fair and transparent processes for the release of UAW have been established under the protocol and the Water Regulation. The Wet Tropics water plan provides permanent water trading framework trading rules as well as a season water assignment framework, as outlined in the protocol.	The water trading and UAW 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 Wet Tropics 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.	There is concern with the water sharing rule for the Johnstone River which may potentially impact on the water supply for the township of Innisfail.

Water plan framework	How is this achieved?	Comment
	The Wet Tropics 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 Wet Tropics water plan prevents decisions (excluding water permits or the release of the UAW reserve) regarding the allocation or management of water that would increase the average volume of water available to be taken.	DRDMW has information on demand requirements and water shortages and will continue to monitor the water sharing rule and work with the regional council to ensure security for the towns water supply.
Promote efficient use of water through water markets, allocation, risk assessments and community education	The Wet Tropics water plan and the protocol provide for water licences to be permanently traded or seasonally assigned (temporary trading). This allows users to trade water entitlements without selling land, enables users to increase water supplies and improve reliability and provides for new industries to acquire water without jeopardising the environment or affecting other water users. Water use efficiency of proposals is one of the considerations when granting water entitlements from UAW reserves. When the state releases UAW, 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, water trading. Over the years, general community education about water saving practices has helped promote efficient water use. Self-regulation due to factors outside of the Wet Tropics water plan control (i.e., power costs, different crop requirements) also helps to encourage efficient use of water.
Facilitate community involvement in planning for the management and allocation of water	Community involvement is ensured through the consultation and engagement processes in developing and finalising the Wet Tropics water plan and the protocol in line with the requirements of the Water Act.	The Wet Tropics water plan and the protocol were developed in consultation with key stakeholders and all other interested parties. Further community consultation will be undertaken to inform the development of the next water plan.

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

Since the commencement of the Wet Tropics water plan in 2013, the department has monitored its implementation to ensure the outcomes are being achieved. Appendix A provides a comprehensive risk assessment of the effectiveness of the implementation of the plan in achieving the plan's outcomes since the Minister's report in 2019.

Overall, the risk assessment shows that implementation has been effective in achieving the water plan's outcomes. Of the 32 water plan outcomes assessed, three could not be fully assessed due to knowledge gaps, and the rest were ranked as low risk. See Appendix A

Three outcomes which could not be fully assessed relate to making water available to First Nations peoples 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 Wet Tropics 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. This will aim to fill the 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 Wet Tropics water plan include:

- Establishment of volumetric water entitlements.
- Metering of active licences in the Mulgrave-Russell catchment.
- A framework for UAW reserves.
- A permanent and seasonal water trading framework.
- The conversion of water licences to water allocations.

5. Information on water use and authorisations in the water plan area

Water users in the water plan area have access to water taken under a water entitlement (e.g. water allocation or water licence) or under a statutory authorisation through the Water Act. An entitlement is not needed for low-risk activities such as stock and domestic, or prescribed activities such as filling spray units, washing produce and washing down equipment, plant or vehicles to prevent the spread of weed seeds. UAW is reserved and can be made available for future use with consideration to protecting existing entitlements and flows for cultural and environmental values.

5.1 Water entitlements

Water entitlements in the water plan area include:

- Water allocations to take unsupplemented surface water.
- Water allocations to take unsupplemented underground water.
- Water licences to take unsupplemented surface water.
- Water licences to take underground water in the Wet Topics groundwater management areas.

Appendix B-1 provides data on the number of specific entitlements and the values of water allocated under these entitlements. In summary:

- Out of the 242,191.1ML allocated under all entitlements, approximately 88.8% (215,133.8ML) has been allocated as unsupplemented surface water. Approximately 11.2% (27,057.3ML) has been allocated as water licences for underground water.

5.2 Water use

In accordance with section 107 of the Water Regulation, all water entitlements in the Mulgrave-Russell catchment of the water plan area, other than licences for stock or domestic purposes, or for water entitlements for which the annual volumetric limit is not more than 2ML, are metered entitlements. Of the 390 entitlements prescribed as metered entitlements in the water plan area, 154 had a water meter installed and the remainder have not yet activated their water take for purposes other than stock or domestic.

In the reporting period (2018/2019 – 2022/2023), the total metered water usage in the Mulgrave-Russell catchment ranged from approximately 30.61 to 36.80 per cent of the total allocated volumes (Appendix B-2). This level of use indicates that the demand for water was not high across the water plan area and there was opportunity to meet any potential growth in demand for additional water through the existing underutilised entitlements.

5.3 Water trading

There are three water markets currently in the plan area:

1. Water allocation market (permanent trades) - trading of registered water allocation titles associated with unsupplemented water allocations in trading zones within the Mulgrave, Lower Johnston, Liverpool Creek, and Tully water management areas.
2. Seasonal water assignment market (temporary trades) - seasonal assignment of water licences associated with:
    - surface water licence zone
    - underground water licence zone.
1. Relocatable water licence market (permanent trades) - transferring of water licences from one parcel of land to another associated with:
    - surface water licence zone
    - underground water licence zone.

The establishment of these water markets provides certainty for the water users and creates a more secure business environment. Trading water entitlements can stimulate better decision making about usage and requirements. Over time, this promotes efficiency and can make businesses more profitable.

The overall benefits of trading water:

- Helps water users see the value of their water as a secure asset, and obtain finance against its value.
- Encourages water-use efficiency by saving water to enable entitlement holders to sell or seasonally assign spare water.
- Enables business owners to sell their water without selling their land.
- Enables users to increase water supplies and improve the reliability of current allocations, and to switch to an alternative use of the water that may generate higher returns.
- Enables new industries to acquire water without jeopardising the environment or affecting other water users.

Over the last five water years, there have been 15 trades of unsupplemented water allocations water management area.

There have been 25 seasonal water assignments of surface water since 14 August 2020 (data for seasonal assignments before this date is not available) across all subcatchment areas totalling 1,829ML (Table 3). There have been 7 seasonal water assignments of underground water since 14 August 2020 in the Mulgrave-Russell groundwater management area totalling 181.5ML (Table 4).

The water management protocol sets out rules for seasonal water assignments. Permanent unsupplemented surface water allocation trades are available on the Market information Business Queensland website or via the following link: Market information | Business Queensland. Monthly reports from July 2019 indicate low market activity and present weighted average price information relating to water allocation transfers undertaken during the reporting period.

Table 3: Seasonal water assignments for surface water, 2020 - 2023 water years

Issue Date	Volume (ML)	Management Group	Location
06/11/2020	4.00	Wet Tropics Subcatchment Areas (Surface Water)	Murray Subcatchment B
22/02/2021	12.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment E
13/04/2021	30.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
14/07/2021	30.00	Wet Tropics Subcatchment Areas (Surface Water)	Daintree Subcatchment
21/07/2021	10.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment A
30/07/2021	300.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
10/08/2021	6.00	Wet Tropics Subcatchment Areas (Surface Water)	Herbert Subcatchment A
13/09/2021	153.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
27/09/2021	10.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
10/11/2021	12.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment E
29/11/2021	50.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment E
28/06/2022	36.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
28/07/2022	30.00	Wet Tropics Subcatchment Areas (Surface Water)	Daintree Subcatchment
28/07/2022	300.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
09/08/2022	10.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment A
22/08/2022	6.00	Wet Tropics Subcatchment Areas (Surface Water)	Herbert Subcatchment A
23/08/2022	50.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment E
03/04/2023	36.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment E
08/06/2023	47.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
29/06/2023	153.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D

03/08/2023	300.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
22/08/2023	153.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
15/09/2023	10.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment A
13/10/2023	47.00	Wet Tropics Subcatchment Areas (Surface Water)	Mulgrave-Russell Subcatchment D
09/11/2023	50.00	Wet Tropics Subcatchment Areas (Surface Water)	Johnstone Subcatchment E

Table 4: Seasonal water assignments for underground water, 2020 - 2023 water years

Issue Date	Volume (ML)	Management Group	Location
19/10/2020	25.00	Mulgrave-Russell Ground Water Management Area	Mulgrave-Russell Zone 111G1D
23/04/2021	35.00	Mulgrave-Russell Ground Water Management Area	Mulgrave-Russell Zone 111G1D
18/08/2021	35.00	Mulgrave-Russell Ground Water Management Area	Mulgrave-Russell Zone 111G1D
03/09/2021	25.00	Mulgrave-Russell Ground Water Management Area	Mulgrave-Russell Zone 111G1D
28/01/2022	1.50	Mulgrave-Russell Ground Water Management Area	Mulgrave-Russell Zone 111G1A
21/02/2023	25.00	Mulgrave-Russell Ground Water Management Area	Mulgrave-Russell Zone 111G1D
21/08/2023	35.00	Mulgrave-Russell Ground Water Management Area	Mulgrave-Russell Zone 111G1D

5.4 Entitlements granted from the unallocated water reserve

The Wet Tropics water plan provides for 57,850ML of UAW held in general, strategic (Indigenous), strategic (State Purpose) and a Cape York Indigenous reserve, to meet demands for additional water across the water plan area. There is an additional 870,000ML available from a high flow reserve. The details of each UAW reserve are provided in Table 5 below and Appendix B-3.

Table 5: Total amounts of UAW currently held in a reserve

Type of reserve	Total volumes (ML)
General	15,400
Cape York Indigenous	400
Strategic (Indigenous)	5,200
Strategic (State Purpose)	34,900
High flow	870,000

During the reporting period, there have been two releases of UAW in the water plan area, one in Tully Subcatchment B from the strategic reserve and the other in the Mulgrave-Russell from the general reserve (Table 6). Of the granted release from the Mulgrave-Russell general reserve, six successful bidders purchased 950ML at an average price of $652 per megalitre.

Table 6: Completed UAW release processes for the water plan area[1]

Year of Release	Reserve	Area	Volume available	Volume granted (ML)

			for release (ML)	
2017	Strategic	Tully Subcatchment B	35,900	1,000
2018	General	Mulgrave-Russell, Zone 1D	16,350	950

1. Volume available for release' refers to the amount of volume released during the process. 'Volume granted' refers to the amount of water granted during the release, which was less than the volume available due to either there being insufficient interest or applicants were unable to meet the criteria for purchase of the water.

Interested parties can register their interest in UAW at any time. For information on unallocated water in your area, contact your local water management office or email UAW.North@rdmw.qld.gov.au.

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 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.

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 water plan area.

6. Research and monitoring findings for the water plan

The water planning framework is supported by water monitoring activities, including monitoring of the quantity and quality of surface water and underground water systems across Queensland. Together with targeted ecological monitoring for water plans, this information is vital for continued improvement of water planning.

The Environmental Flows Assessment Program (EFAP) is a departmental monitoring program involving targeted ecological monitoring projects to assess the effectiveness of each water plan in achieving its stated ecological outcomes. Ecological assets with critical links to flow, that are representative of the plan ecological outcomes and the various aspects of the flow regime, are selected as indicators of the broader ecosystem for monitoring. Information collected under this program is used by the Department of Environment, Science and Innovation (DESI) to assess the effectiveness of the plan in achieving ecological outcomes, using a risk assessment approach (Marshall and McGregor 2006).

6.1 Summary of ecological monitoring

Ecological monitoring relevant to water plan outcomes has been conducted by the department, other government agencies and external researchers. Appendix G summarises monitoring conducted within the water plan area from 2019-2023.

A feature of the water plan area is that there are few large flow-regulating structures present. Connectivity between freshwater and marine habitats is therefore still maintained, although there are numerous small barriers to movement of biota, such as road crossings, culverts and bunds. The importance of connectivity between freshwater and estuarine habitats has been shown for lagoons on the Tully-Murray floodplain. A variety of fish species move between freshwater and estuarine habitats on the floodplain and maintenance of connectivity allows successful completion of life cycles. In contrast, hydrologic connectivity has been disrupted in the upper Tully catchment by Tully Falls Weir. The department has proposed a pass flow to enhance hydrological connectivity downstream of Tully Falls Weir, and further studies are being undertaken to inform implementation of a passing flow rule.

Perennial (continuously flowing) waterways are common in the water plan area and these systems support unique and species-rich aquatic communities. These include cling gobies, which live in high-flow habitats in short coastal streams of the water plan area. Maintaining perennial flow regimes is critical for maintaining populations of these unique species.

The water plan area supports populations of the freshwater crocodile, particularly in the upper Herbert River. There is limited information available on the life history requirements of this species and its distribution in the water plan area.

Water quality is a major area of concern in the Wet Tropics due to sediment and nutrient runoff from sugar cane and banana farms potentially impacting coastal and marine communities associated with the Great Barrier Reef. Previous studies have suggested frameworks and approaches to manage water quality in Wet Tropics streams, as well as monitoring of sediment and nutrient loads being exported from different land use types. Reclamation of marginal sugar cane land to reduce nutrient exports to the reef have also been proposed. However, while the transport of sediments and nutrients to the reef is related to discharge, the plan has little impact on sediment and nutrient runoff. Programs such as the Marine Monitoring Program and Reef Report Card continue to monitor loads and water quality in the water plan area with the goal of achieving end of basin water quality objectives by 2025 (DES 2019).

The Wet Tropics Water Quality Improvement Plan 2015-2020 (Terrain and Australian Government 2015) identified research priorities for ecosystem condition and trend monitoring. It emphasised the need for targeted surveys of fishes and turtles in impacted catchments to better understand their distribution and ecology. The plan also suggested refining monitoring protocols to include indicator species sensitive to flow and water quality changes. Additionally, it highlighted the importance of assessing remnant palustrine wetlands, updating knowledge on aquatic invasive species, and monitoring estuarine, near-shore, and marine habitats.

Despite the volume of research conducted in the water plan area several significant knowledge gaps remain. The distribution of aquatic plants and animals within the water plan area, and their flow requirements, are still poorly known. In previous assessments, an eco-hydraulic approach was used to quantitatively assess the risk to ecological assets from water resource development. However, these assessments lacked detailed knowledge of flow ecology requirements and relevant habitat data, which affected the confidence in risk analyses. Local (plan-specific) research to define eco-hydraulic rules for specific fish species would improve confidence levels as locally relevant life history and catch data could be incorporated into future risk assessments.

A further significant knowledge gap is the groundwater-dependence of ecosystems and associated biota, which remains poorly understood. Quantifying underground water extraction, particularly from aquifers linked to dependent ecosystems, would enhance risk assessment associated with water resource development. Further method development is also needed to better assess surface water-groundwater interactions and connections between groundwater, dependent ecosystems, and biota.

6.2 Summary of water monitoring

The department manages, operates, and maintains 33 stream gauging stations in the water plan area (see Appendix F). 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 derivation accurate streamflow volumes.

The Wet Tropics water plan manages underground water in eight groundwater management areas (GMAs). In total, there are 27 monitoring bores across catchments within the water plan area. These bores provide data that assist in improving hydrological understanding for the water plan area, including the understanding of surface water and underground water interaction. All water monitoring data can be accessed online at the water monitoring portal.

7. Social and economic assessment

The Wet Tropics water plan supports growth in population and industries and aims to maintain flows that support water-related social and economic values in the water plan area. The water plan area has a significant regional population and includes the urban centres of Cairns, Port Douglas, Innisfail and Ingham. Data from the 2021 census was sourced from the Australian Bureau of Statistics and Queensland Government Statistician's Office to assess whether there were any significant changes in population rate or industry as fluctuations in these variables could indicate a change in water demand. The data was grouped using the Statistical Area, Level 2 (SA2) spatial extents of local government areas within in the water plan area. It is important to note that these SA2 boundaries are not consistent with the Wet Tropics water plan boundaries and overlaps between the two exist however this socio-economic assessment is still expected to reflect the socio-economic status of the water plan area.

7.1 Population trends

The total estimated population for the water plan area based on 2021 census data was approximately 176,000 people with approximately 18.4% of the population being First Nations peoples. Since 2011, the total population of the water plan area has increased by 4.5%. Over the next 25 years, the population is projected to increase at a rate of 1% per annum (ABS, 2021).

7.2 Economic profile

Agriculture and tourism are the primary economic drivers in the water plan area. Agriculture, including farming and fishing, is a significant economic driver, contributing millions to the local economy. The primary agricultural products of the region are sugarcane, bananas and livestock production (Balmoral Group Australia, 2023).

The Cairns Regional Council and Douglas Shire Council local government areas are key tourist destinations within the water plan area, attracting many visitors and generating 91% of the region's total spending in all LGA's. The Cairns LGA attracts over 3,000,000 tourists annually (Balmoral Group Australia, 2023).

Mining exists in the region but occupies a small portion of the land. Mining, healthcare, and social assistance have experienced notable employment growth, with social assistance contributing the most significantly to overall employment in the water plan area. Employment in the area faces some challenges, with a lower labour participation rate and a higher unemployment rate than the Queensland average (Balmoral Group Australia, 2023).

7.3 Land use

Land use trends in the water plan area have shifted over 2009 and 2021, with decreases in dryland plantation forestry (36%) and irrigated perennial horticulture (15%). There has been a 36% increase in irrigated cropping, particularly in crops such as bananas and sugarcane. Mulgrave-Russell catchment recorded growth of over 270%, while the Johnstone catchment saw a 216% increase, and the Mossman catchment experienced a 95% rise. (Balmoral Group Australia, 2023).

Other noteworthy changes include the expansion of seasonal horticulture, which has grown by 474% in the Murray catchment and 188% in the Johnstone catchment. There was a significant increase in the intensive use of land for animal production and mining, increasing by 17% and 29%, respectively (Balmoral Group Australia, 2023).

8. Cultural values assessment

While the Wet Tropics water plan includes a framework for the maintenance of water-related cultural values and supporting the economic and spiritual aspirations of First Nations peoples, there was insufficient information to assess the effectiveness of the plan's implementation in achieving its relevant outcomes under sections 12(c)(ii), 13(b)(ii) and 13(c).

A cultural values assessment and engagement with 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 and provides an outlook of the anticipated future climate change patterns (climate change projections).

9.1 Recent climate variation in the water plan area

The climate events of most concern are those that reduce the availability and reliability of water supplies, including the occurrence of prolonged dry periods (droughts). The key climate variables are rainfall, temperature, and evaporation, and their daily, monthly, seasonal, and annual timescale variability.

Figures 2 through 4 show the average daily temperature, annual potential evapotranspiration, and annual rainfall for the Wet Tropics catchments (Vitkovsky, 2023). Notably, the temperature has exhibited a significant rise since the start of the Wet Tropics water plan, while evapotranspiration has shown a slight decrease during this period, and rainfall has become slightly higher in recent years.

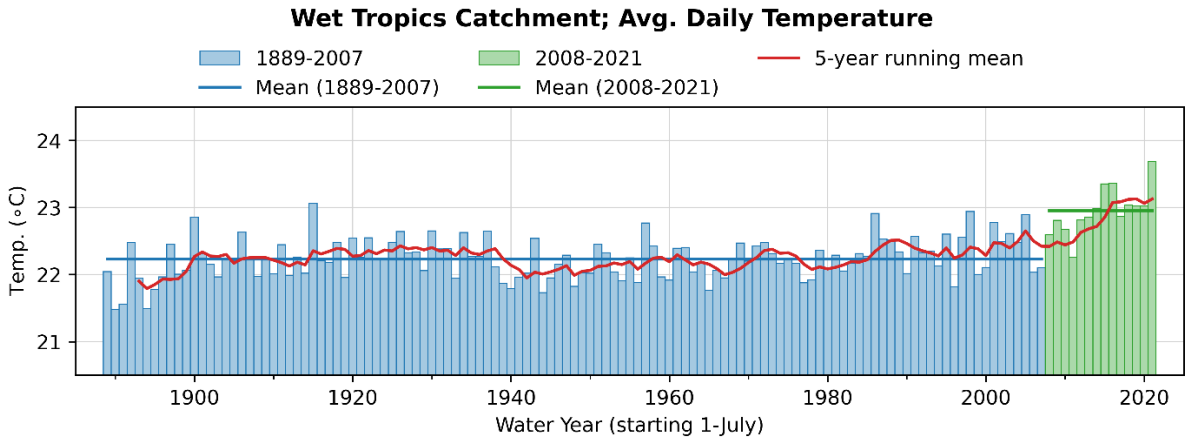

Figure 2: Wet Tropics average daily temperature

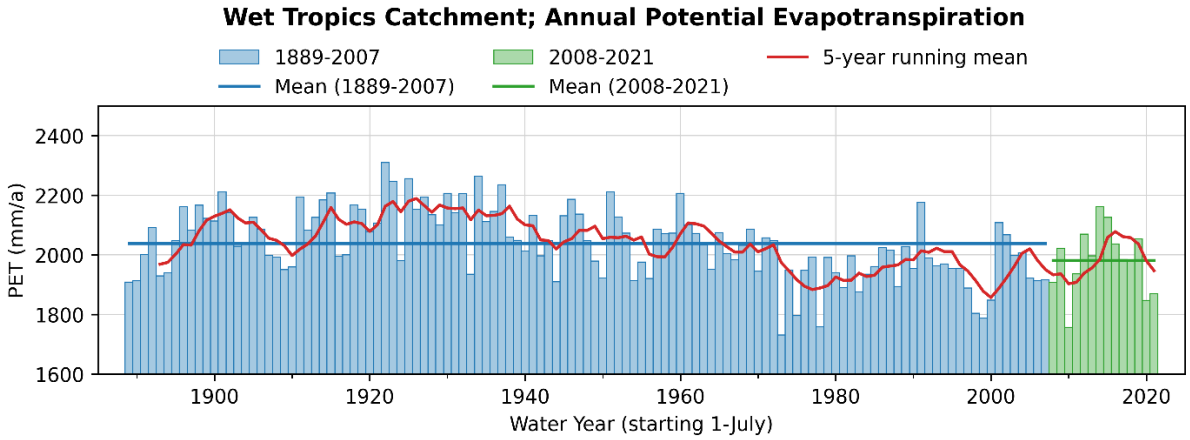

Figure 3: Wet Tropics annual potential evapotranspiration

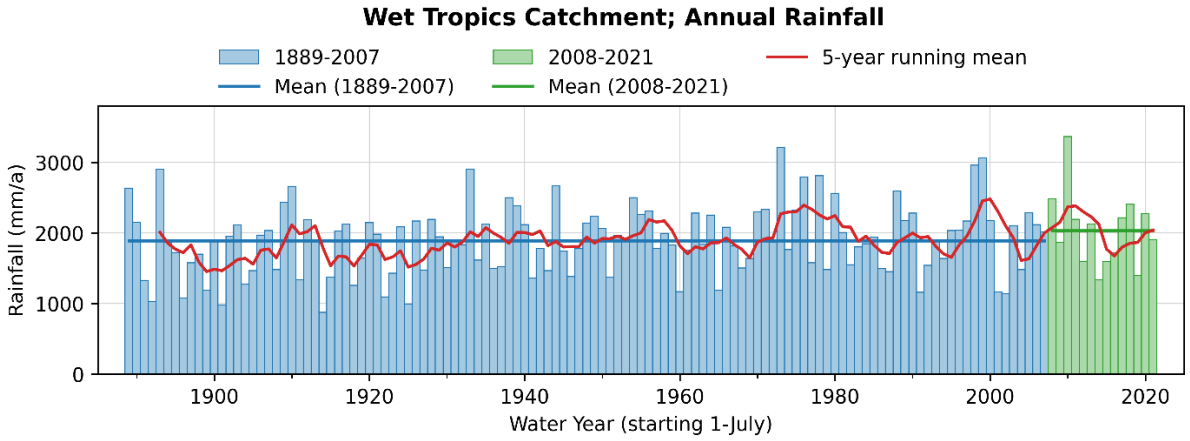

Figure 4: Wet Tropics annual rainfall

9.2 Climate change projections for the water plan area

The climate is changing primarily because increasing amounts of greenhouse gases (GHG) in the atmosphere are trapping heat, warming the air and oceans. An assessment of the climate change projections for the Wet Tropics water plan catchments was undertaken by Department of Environment, Science and Innovation (DESI) to inform this report (Vitkovsky, 2023). To determine the potential climate changes in the water plan area, DESI used global climate models to simulate the Earth's climate system.

9.2.1 Overview of assessment approach

General Circulation Models (GCM) were used to produce projections of climate variables such as average daily temperatures, annual potential evapotranspiration and annual rainfall. The GCMs were sourced from the Coupled Model Intercomparison Project, phase 5 of the Intergovernmental Panel on Climate Change (IPCC), Assessment Report 5 (WCRP, 2022). The GCMs consider a trajectory of GHG 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 review historical climate data to understand what has occurred climatically in the past, especially since the plan was first implemented. A time-of-emergence analysis is used on climate variable (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 water plan area indicate that a temperature increase emerges around the mid-1990s (Figure 5). The historical temperature range in the Wet Tropics is relatively narrow, making the temperature increase easily identifiable. There was no emergence for annual evapotranspiration (Figure 6) or annual rainfall (Figure 7).

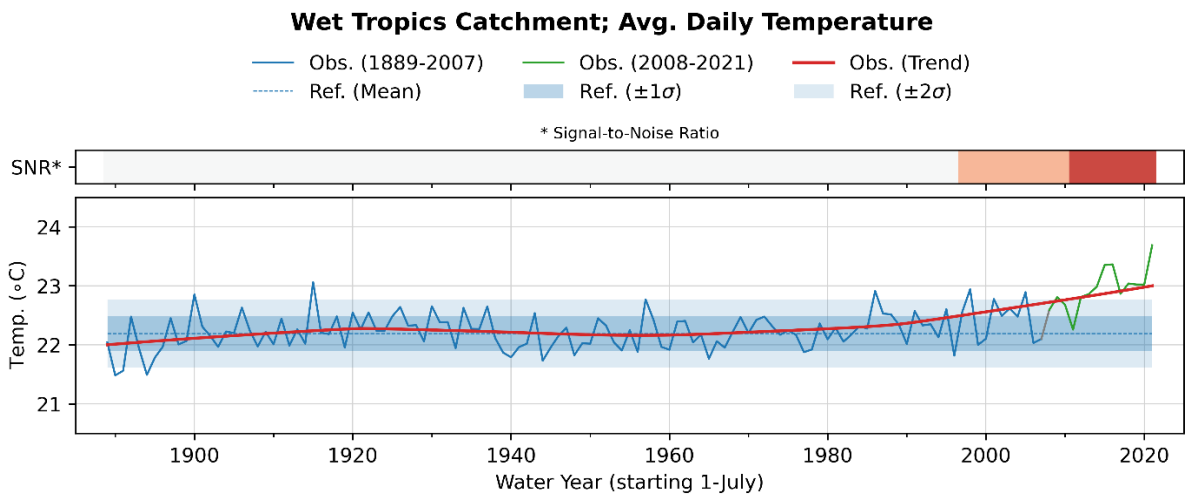

Figure 5: Time of emergence analyses: average daily temperature

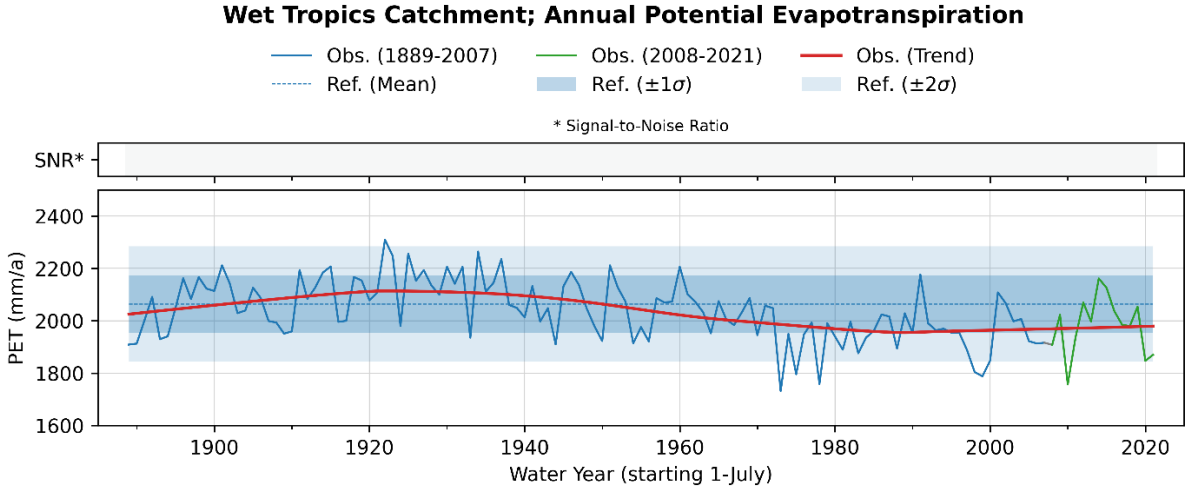

Figure 6: Time of emergence analyses: potential evapotranspiration

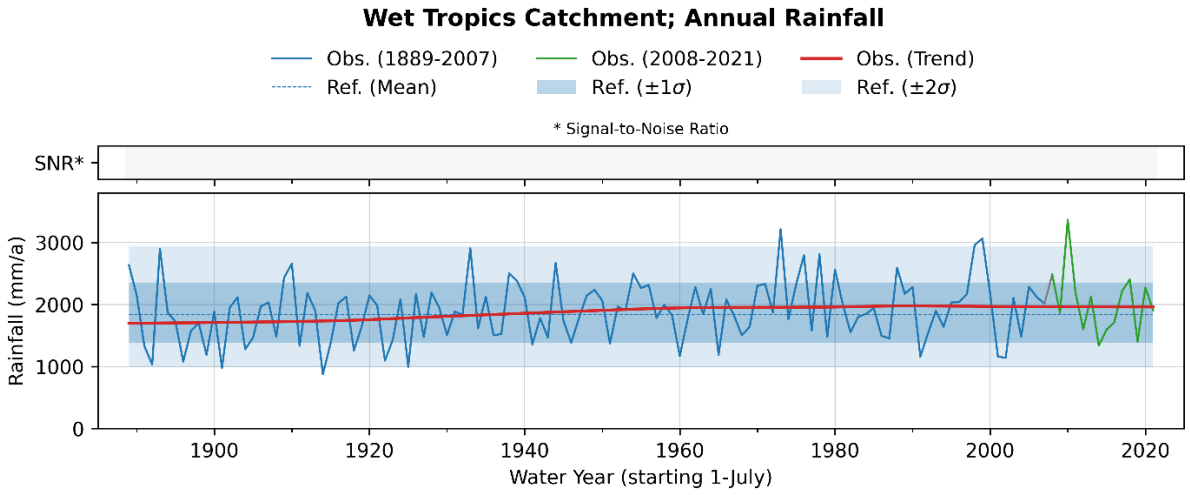

Figure 7: Time of emergence analyses: annual rainfall

Climate projections at the catchment scale using the GCMs are presented below. Temperature projections show a consistent increase with the scenarios beginning to diverge around 2030, suggesting an inevitable temperature rise (Figure 8). This temperature rise is accompanied by a corresponding increase in potential evapotranspiration throughout the catchment (Figure 9). In terms of annual rainfall, there is a slight downward trend amidst considerable uncertainty (Figure 10). The shaded coloured bands represent the uncertainties in the model structures. Notably, the observed climate in recent years aligns with the projected data. Furthermore, the projected rainfall in Queensland is uncertain as is common throughout the state..

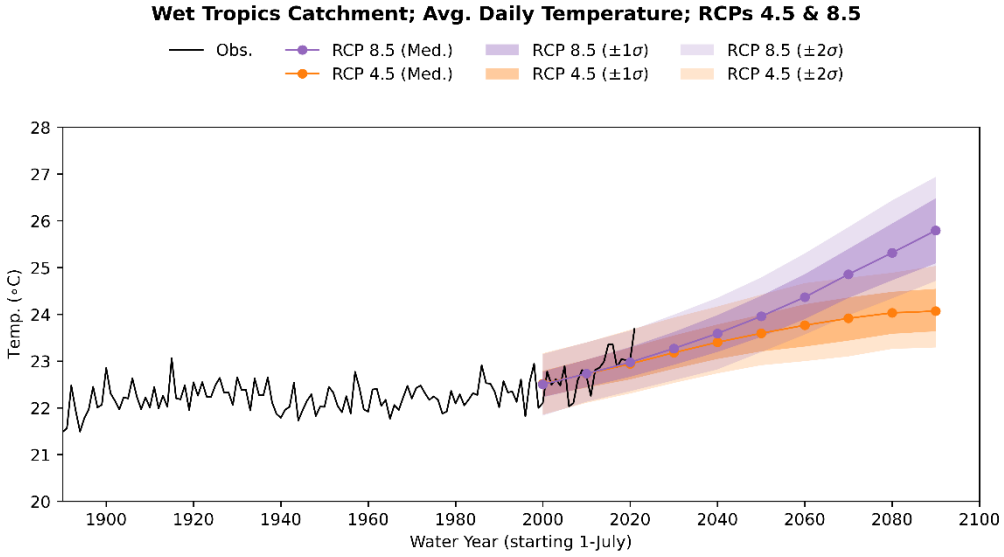

Figure 8: Observed and projected catchment average annual climate: average daily temperature

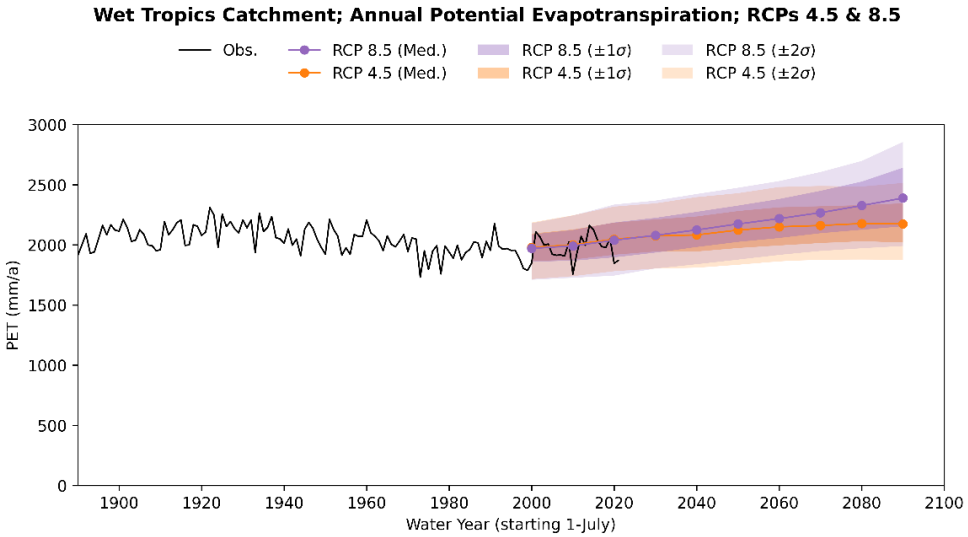

Figure 9: Observed and projected catchment average annual climate: annual potential evapotranspiration

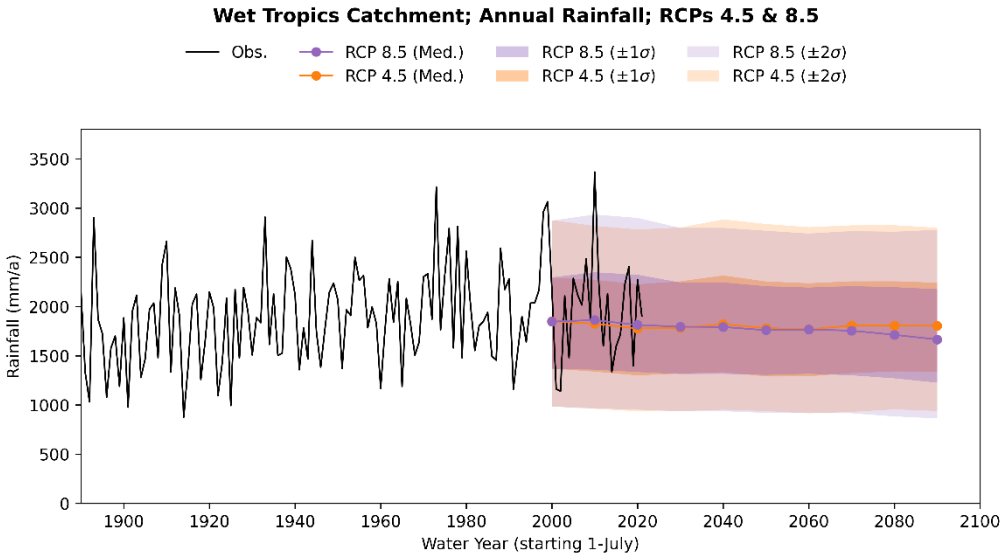

Figure 10: Observed and projected catchment average annual climate: annual rainfall

Projections were also undertaken to investigate seasonal changes in climate variables. Projections indicate a general increase in both temperature and potential evapotranspiration across all months. The monthly rainfall has more variability, but it is trending towards a small increase in dry season months for both projections and a decrease in the summer month. These anticipated changes are expected to lead to lower annual rainfall totals in the water plan area, thereby impacting the generation of streamflow from the catchment. It's worth noting that the water plan area historically experiences high levels of rainfall.

Finally, climate change analysis is an evolving field with new understandings, models and syntheses published regularly. The information presented in this brief 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 Wet Tropics water plan since it commenced, including consequential amendments to reflect administrative changes relating to the Water Act.

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

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

In April 2023, a risk assessment was undertaken to identify potential risks to the water plan's outcomes that could emerge within the lifetime of the Wet Tropics water 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, 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 32 water plan outcomes assessed, three[1] could not be fully assessed due to limited information available and the rest were ranked as low risk (Appendix A).

One outcome which could not be assessed relates to maintaining flows which support water related aesthetic, cultural and recreational values in the water plan area, including cultural values of First Nations peoples.

Two outcomes which could not be assessed relate to making water available to First Nations peoples to achieve their economic aspirations, and to support the water-related cultural values in the water plan area.

These outcomes are partly met through:

- Unallocated water reserves.
- Environmental flow provisions, where key ecosystems protected by the water plan area 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 these outcomes as there is insufficient information on First Nations peoples cultural values and uses of water in the water plan area. Hence, engagement with First Nations peoples will be undertaken to support 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.

[1] The outcomes under s12(c)(ii) and 13(b)(ii) relating to making water available to First Nations peoples to achieve their social and economic aspirations, 13(c) relating to providing for the maintenance of flows to support cultural values.

12. Opportunities and emerging matters

The risk assessment underpinning this report identified knowledge gaps that could be addressed through further research and/or monitoring and decision-making. It also identified matters potentially emerging over or beyond the lifetime of the current Wet Tropics water plan that should be considered under the water plan's framework. These include:

- The need to update water plan outcomes to align with the latest Water Act requirements and contemporary water planning policies and emerging issues.
- The need to better understand cultural water values of First Nations peoples, as well as their economic and social aspirations and associated water needs.
- The need to review water availability and UAW volumes across the planning area to address growing demands for additional water to support economic growth, town water supplies, and the economic, social and cultural aspirations of First Nations peoples.
- Consideration of climate change impacts on water availability in the water plan area.

It is proposed that these matters be considered as part of the next water plan review, noting that the Wet Tropics water plan can be replaced earlier if required. The learnings gained from implementing the existing plan to date will be used to make improvements as part of an adaptive management cycle based on revised future water needs, enhanced scientific information, and targeted stakeholder engagement.

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

Over the past five years, there were 167 non-compliance incidents. Most incidents were related to metering, with 147 late and non-supplied meter readings. Appendix E provides details on the number and type of non-compliance and incidents and the type and the outcome of departmental investigations and compliance response that occurred over the 2018/19 – 2022/23 reporting period.

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 2022-24 (rdmw.qld.gov.au) 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 Water Resource Management Annual Compliance Plan (rdmw.qld.gov.au) identifies activities that support the 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 | Department of Regional Development, Manufacturing and Water (rdmw.qld.gov.au) will support improved compliance outcomes. Further information on the Rural Water Futures program and its initiatives can be found on the department's website.

14. Way forward

This assessment shows the Wet Tropics water plan continues to be fit for purpose and there are no high risks to the achievement of the outcomes within its scheduled timeframe. The Wet Tropics 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 water plan area.

The identified risks and emerging issues in the preceding sections highlight the need for enhanced measurement and monitoring to ensure the plan continues to meet its outcomes. Further engagement to understand First Nations peoples' aspirations and values is also an ongoing priority to ensure these values are being met through the implementation of the plan.

The Wet Tropics water plan is due to expire on 1 September 2024. Based on the assessment presented in this report, it is considered that the Wet Tropics water plan remains effective and fit for purpose, and it is recommended that the Wet Tropics water plan expiry be postponed to 2032. In the interim, water plan implementation and monitoring will continue, and the Wet Tropics water plan will undergo a re-evaluation before its expiration.

15. How to make a submission

Everyone interested in water management in the Wet Tropics is welcome to provide a submission about the proposal to postpone the expiry of the plan. Submissions must:

a) be in writing and signed by each person who made the submission or an authorised officer (such as the executive officer or secretary of a committee), unless the submission is electronic, in which case no signature is required.

b) state the name and address of each person who made the submission

c) state the grounds of the submission and the facts and circumstances relied on in support of the grounds

d) be received on or before **5pm, 15 July 2024.**

To make a written submission, you are encouraged to use the submission form in **Appendix H: Submission** form and complete the steps in the checklist below to ensure your submission is properly made.

Submissions can be made by:

Online: visit www.rdmw.qld.gov.au/water/consultations-initiatives and search for 'Wet Tropics water plan expiry'

Email: northwps@rdmw.qld.gov.au

Post: Department of Regional Development, Manufacturing and Water
Chief Executive
Water Planning and Science North Region
Attention: Wet Tropics water planning coordinator
PO Box 20
South Johnstone QLD 4859

Further Information:

For further information on lodging a submission, enquires should be directed to:

- Phone: 1800 822 100
- Email: northwps@rdmw.qld.gov.au

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Appendix A Assessment of water plan outcomes

Table A-1: Risk assessment for general and social outcomes in the plan

Plan outcome	Water Plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative risk ranking and assessment of outcomes
12 Each of the following is a general outcome for water in the plan area —			
a) provision for— (i) the use of water entitlements and other authorisations in the plan area; and	The plan itself does not limit or restrict existing users, or the taking of water under statutory authorisations.	The protocol provides for water allocation trading, water licence trading, seasonal assignment and 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.
(ii) the continued use of existing underground water works	The plan established eight groundwater management areas. Underground water users that notify the department of the existing underground water works may continue to take water.	Underground water trading is available in the Mulgrave-Russell and Mossman groundwater management areas.	**Low risk** This outcome is being achieved.
(b) protection the probability of being able to take water under a water entitlement;	The plan provides performance indicators, such as environmental flow objectives and water allocation security objectives.	The protocol provides for, water allocation trading, water licence trading, and seasonal assignment.	**Low risk** This outcome is being achieved.
(c) availability of water for the following— (i) growth in industries dependent on water resources in the plan area;	The plan provides for water trading, relocatable water licences and has general reserves of unallocated water.	The protocol provides a process for dealing with unallocated water, water trading and seasonal assignment.	**Low risk** This outcome is being achieved. The Wet Tropics water plan provides ongoing access to water under existing and new water entitlements.
(ii) Indigenous communities dependent on water resources in the plan area to achieve their economic aspirations;	The plan establishes 'Indigenous reserves' and 'Cape York Indigenous Reserve' of unallocated water.	The protocol provides a process for dealing with unallocated water.	**Unable to be assessed** This outcome is partially met through UAW reserves and environmental flow provisions where key ecological values provided for by the Wet Tropics water plan are likely to overlap with the economic and social aspirations of First Nations peoples.

Plan outcome	Water Plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative risk ranking and assessment of outcomes
			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 aspirations of 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 the evaluation of this outcome and inform the review of the Wet Tropics water plan is required.
(iii) stock purposes in the plan area	Stock and domestic take, in any way, is authorised under the Water Act and recognised in the water plan.	N/A	**Low risk** This outcome is being achieved. Sufficient water is available to support stock purposes.
(d) the support of flexible and diverse water supply arrangements for water users;	The plan provides a process for water trading and for converting area based water entitlements to volumes.	The protocol provides for, water allocation trading, water licence trading, and seasonal assignment.	**Low risk** This outcome is being achieved.
(e) the support of activities stated in the Water Regulation 2016, schedule 3;	The take for prescribed activities authorised under the Water Act and regulated under Water Regulations 2016 are recognised under the water plan up to 20ML/a.	The protocol supports the activities stated with the Water Regulation 2016, schedule 3.	**Low risk** This outcome is being achieved.
(f) maintenance of flows that support water-related economic activities in the plan area, including, for example, tourism	The plan provides volumes of UAW that may be accessed. The water plan also limits the level of interference to water flow. Underground water is managed within established groundwater management areas.	The protocol provides a process for dealing with UAW. The protocol also provides water sharing rules to ensure water flow.	**Low risk** This outcome is being achieved. Flows are largely provided for across the water plan area, with the exception of some localised issues.

Plan outcome	Water Plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative risk ranking and assessment of outcomes
(g) encouragement of continual improvement in the efficient use of water	The plan provides a framework for amending water licences to volume, including consideration for efficient use of water in the water plan area.	The protocol provides for water trading and seasonal assignment rules. Water sharing rules limit the taking of water in times of low flow in locations that have historically been subject to restrictions.	**Low risk** This outcome is being achieved.
(h) maintenance, to the extent practicable, of the quality of underground water for consumptive purposes.	The plan established eight groundwater management areas.	Specifies the maximum total nominal entitlement of underground water licences by GMA. Capped use in GMAs.	**Low risk** Existing management arrangements for underground water are managing the risk of seawater intrusion. This outcome is being achieved.
(i) ensuring a reliable and secure supply of water, including for the Kareeya and the Koombooloomba hydro-electric power stations	The plan provides for replacing authorities and granting water licences for industrial purpose or amenities purposes at Kareeya HydroPower Station.	N/A	**Low risk** This outcome is being achieved. Water licences have been granted to CleanCo for the operation of the hydro plant and amenities.
a) increased security for town water supplies that rely on surface water and underground water	The plan provides for strategic water reserves.	The protocol provides a process for dealing with UAW.	**Low risk** This outcome is partially achieved. The Wet Tropics water plan provides ongoing access to water under existing and new water entitlements. Even though there are council areas which are looking for options in alternative water resources, the department is undertaking urban water security assessments to ensure continued town water supply.
(b) availability of water for the following— (i) population growth in towns and communities dependent on water resources 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.
(ii) Indigenous communities dependent on water resources in the plan area to achieve their social aspirations	The plan establishes 'Indigenous reserves' and 'Cape York Indigenous Reserve' of UAW.	The protocol provides a process for dealing with UAW.	**Unable to be assessed.** This outcome is partially met through UAW reserves and environmental flow

Plan outcome	Water Plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative risk ranking and assessment of outcomes
			provisions where key ecological values provided for by the Wet Tropics water plan are likely to overlap with the economic and social aspirations of 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 aspirations of 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 Wet Tropics water plan is required.
(iii) domestic purposes in the plan area	Stock and domestic take, in any way, is authorised under the Water Act and recognised in the water plan.	N/A	**Low risk** This outcome is being achieved.
(iv) alternative options for town water supply in the Mulgrave-Russell catchment area	The plan provides for strategic water reserves.	The protocol provides options for surface water and underground water access and a process for releasing with UAW.	**Low risk** This outcome is being achieved.
(c) maintenance of flows that support water-related aesthetic, cultural and recreational values in the plan area, including the cultural values of the traditional owners in the plan area	The plan provides performance indicators, such as environmental flow objectives.	The protocol provides for water sharing rules.	**Unable to be assessed** This outcome is being partially achieved. However, there is insufficient information on the cultural values of First Nations peoples to properly assess this outcome. Further engagement with First Nations peoples, to identify the cultural values and uses of water and associated water requirements to support evaluation of

Plan outcome	Water Plan strategies that provide for outcomes	Water Management Protocol (WMP) rules that provide for outcomes	Qualitative risk ranking and assessment of outcomes
			this outcome and inform the review of the Wet Tropics water plan is required.
(d) maintenance, to the extent practicable, of the quality of water for human use.	The plan provides volumes of UAW. The plan established eight groundwater management areas.	The protocol provides a process for dealing with UAW. The protocol provides for water trading and seasonal assignment rules and provides for water sharing rules to limit the take of water in times of low flow in locations that have historically been subject to restrictions.	**Low risk** This outcome is being achieved. Existing management arrangements for underground water are managing the risk of seawater intrusion. Reserves of UAW allow for future growth and how this is assessed. Water trading encourages the efficient use of water. Groundwater management areas limit any further take of underground water to minimise seawater intrusion.

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

Plan outcome	Plan strategies and water management protocol (WMP) rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative risk ranking and preliminary assessment of outcomes
14 Each of the following is ecological outcome for water in the plan area				
14(a)(i) to provide for the continued capability of a part of the river system to be connected to another, including by maintaining flows that — allow for the movement of native aquatic fauna between riverine, floodplain, wetland, estuarine and marine environments; and	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. **The WMP:** The WMP includes WSRs that: • outline minimum stream flows for a number of sites • provides a process to determine Daily Volumetric Limit (DVL) percentages	Migratory Fish Turtles Floodplains Wetlands	Longitudinal (upstream-downstream) and lateral (between rivers and floodplains) connectivity is critical for the completion of life history for several migratory fish species, as well as for other large-bodied fauna such as platypus and turtles. The water plan area has large numbers of barriers to movement, such as bunds and road crossings, but few structures associated with water management. The lack of passflows from Tully Falls Weir has impeded connectivity in a 4 km reach from downstream of the weir through to the tail race of Kareeya hydropower station and through Tully Gorge. Floodplain wetlands on the Tully-Murray floodplain are important nursery habitats for a variety of fish species. Several of these species require connectivity with estuaries to complete life cycles. Although these wetlands have been impacted by agricultural land uses, migratory fish species still complete critical migrations due to continued connectivity of these wetlands with estuaries. Many of the major waterways in the water plan area are perennial and would have naturally high levels of connectivity through the dry season, as a result of consistent base flows. Baseflows also provide freshwater inflows to estuaries, maintaining salinity gradients and supporting a variety of estuarine habitats. At present, there is little large-scale water take in the water plan area and connectivity is not adversely affected.	**Low risk** This outcome is being achieved. Flows are largely provided for across the water plan area, with the exception of some localised issues. Current water use is low and the plan contains performance indicators and environmental flow objectives to protect flows.
(ii) to provide for the continued capability of a part of the river system to be connected to another, including by maintaining flows that — support	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs.	All assets	See comments for 14(a)(i) above. Water-related ecosystems in the water plan area include rivers, streams, waterholes, wetlands, floodplains and estuaries. The assets associated with these habitats require a variety of flows to complete life cycles or provide suitable habitats.	**Low risk** This outcome is being achieved. Current water use is low and the plan contains performance

Plan outcome	Plan strategies and water management protocol (WMP) rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative risk ranking and preliminary assessment of outcomes
water-related ecosystems; and	**The WMP:** The WMP includes WSRs that: • outline minimum stream flows for a number of sites • provides a process to determine DVL percentages		Agricultural development in the Tully-Murry floodplain has harmed freshwater floodplain lagoons due to increased nutrient pollution from agriculture, posing a threat to Wet Tropics biodiversity. Understanding stream ecology is crucial for conservation efforts, as perennial stream flows play a vital role in supporting the high biodiversity of the region. Water-related ecosystems in the water plan area are threatened by a range of non-flow related factors. These include poor water quality, weeds, feral animals and land use changes. These factors are outside the scope of the plan but may interact with flow to influence the distribution of assets and habitat quality.	indicators and environmental flow objectives to protect flows.
(iii) to provide for the continued capability of a part of the river system to be connected to another, including by maintaining flows that — support river-forming processes;	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. **The WMP:** The WMP includes WSRs that: • outline minimum stream flows for a number of sites • provides a process to determine DVL percentages	Bank full discharge	The intent of this outcome is to ensure large flows that maintain channel form and deliver sediment throughout the water plan area are maintained. River-forming process are often associated with bankfull flows. Limited changes to high flow regimes and bank full flows have occurred in the water plan area, due to the lack of infrastructure that can influence these flows. Monitoring under the Reef Plan 2050 continues to record information on sediments being delivered to the GBR lagoon. Land use is an important factor in the volume and source of sediments delivered to the reef. In addition, recent work has shown that infrequent, large floods, such as those associated with cyclones, can strip large volumes of sediment from floodplains. This research improves our understanding of sediment dynamics in the water plan area.	**Low risk** This outcome is being achieved.
14(b)(i) to provide for a flow regime that ensures — maintenance of fresh water to the estuaries of watercourses and the Great Barrier Reef; and	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs.		The delivery of freshwater to estuaries of the water plan area is critical to maintain salinity gradients and brackish water habitats. The Reef Report Card 2020 indicated that through the life of this Wet Tropics water plan, overall discharge from rivers in the Wet Tropics was the lowest for 15 years. However, the Water Monitoring Information Portal indicates that some of the highest discharges recorded also occurred during this period for several rivers in the water plan area (i.e., Mossman in 2013, Herbert in 2017-18, Daintree and Bloomfield in 2018).	**Low risk** This outcome is being achieved.

Plan outcome	Plan strategies and water management protocol (WMP) rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative risk ranking and preliminary assessment of outcomes
	The WMP: Includes criteria for releasing unallocated water that is mindful of the receiving waters of the Great Barrier Reef and inshore lagoons.		Freshwater flows to estuaries have not been impacted to any extent in the water plan area due to the absence of large storages, except for Koombooloomba Dam on the Tully River. However, water take associated with this structure is for hydropower generation and it is returned to the river, less negligible losses.	
(ii) to provide a flow regime that ensures – productivity in the receiving waters of the Great Barrier Reef and inshore reefs;	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. **The WMP:** Includes criteria for releasing unallocated water that is mindful of the receiving waters of the Great Barrier Reef and inshore lagoons.	Estuarine productivity represented by banana prawn catch and barramundi year class strength	The department has not conducted monitoring relevant to this outcome. The QFISH database contains commercial and recreational fisheries catch data. Information in the database will be used to assess this outcome when the plan is reviewed. Modelling associated with the GBR Water Quality Report Card 2020 indicated that across all GBR catchments, progress towards reduced sediment export was over half way to the target value and reduction in dissolved inorganic nitrogen (DIN) export was almost half way towards the target value. Reductions were attributed to better fertiliser management, the application of mill mud to cane fields and new or improved fencing to exclude cattle from waterways. At a finer scale, water quality exported to inshore marine habitats collectively from the Wet Tropics catchments alone is summarised in the Reef Report Card 2020 as *Moderate* and improving, although water clarity (Secchi depth) is graded *Poor*. Coral condition (cover, composition, juvenile, algae) surveyed across 12 reefs in the region was graded *Moderate*, with indicators remaining relatively stable, although reefs at Bedarra, Dunk South and Snapper North islands have persistently recorded very poor scores due to a high coverage of macroalgae. Seagrass condition (abundance, nutrient status, reproductive effort) varied across the region and was graded *Poor* overall, with abundance and reproductive effort having decreased from *Moderate* to *Poor* condition.	**Low risk** This outcome is being achieved.
14(c) to provide for the support of ecosystems dependent on	**The plan:** The plan identifies performance indicators and	Waterhole persistence Baseflow GDEs	The department has not conducted monitoring relevant to this outcome.	**Low risk** This outcome is being achieved.

Plan outcome	Plan strategies and water management protocol (WMP) rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative risk ranking and preliminary assessment of outcomes
underground water, including, for example, ecosystems dependent on surface water and underground water interactions;	provides for the maintenance of flows through EFOs. The plan identifies Groundwater Management Areas (GMAs) **The WMP:** Contains strategies relating to trading or seasonally assigning underground water licences which aim to protect underground water for groundwater-dependent ecosystems.		Underground water is critical to sustaining the dry season baseflows of perennial streams in the water plan area. Groundwater-dependent ecosystems (GDEs) in the water plan area include baseflow GDEs and Terrestrial GDEs. The department developed minimum flow rules for water sharing rules in Behana and Theresa Creeks – these streams are likely to be baseflow GDEs. The minimum flow rule for Theresa Creek is also intended to ensure flows over Millaa Millaa Falls, a popular tourist attraction on the Atherton Tablelands. GDEs within the water plan area have been mapped but require ground-truthing. The extent of surface water – underground water connectivity within the water plan area is not well characterised.	
14(d) to provide for maintenance of a daily flow at each node of at least 1 megalitre per day to perennial surface water flow;	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. **The WMP:** Includes water sharing rules that stipulate minimum stream flows for a number of sites. Provides a process to determine DVL percentages.	Baseflow GDEs Riffles	The plan includes seven nodes and 33 gauging stations. For the data available, all nodes and gauging stations recorded mean daily flows greater than 1ML/day. While the outcome is likely to be achieved, a minimum flow of 1ML/day in the larger rivers of the water plan area would effectively equal zero flow. This would have serious implications for rivers with perennial flow regimes.	**Low risk** This outcome is being achieved.

Plan outcome	Plan strategies and water management protocol (WMP) rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative risk ranking and preliminary assessment of outcomes
14(e) to provide for flows and hydraulic habitat for flow-spawning fish and endemic species, including, for example, the Pacific blue-eye (*Pseudomugil signifer*);	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. **The WMP:** Includes water sharing rules that stipulate minimum stream flows for a number of sites. Provides a process to determine DVL percentages. Imposes conditions on water licences for the Kareeya hydroelectric power station.	Riffles Pacific blue-eyes Aponogeton	Little monitoring or research has been conducted in the plan since 2019 to address this outcome. The minimum flow rules for Theresa and Behana Creeks, specified in the Water Management Protocol, will maintain hydraulic habitats such as riffles in these systems during periods of low flow. Confirmation monitoring is required to determine whether the flow thresholds specified in the Water management protocol are supporting ecological outcomes of the plan. More work is needed in the water plan area to determine the distribution and population viability of the Pacific blue-eye. Fast-flowing habitats are favoured by cling gobies, a unique group of freshwater fish. The distribution of these species within the water plan area is unknown, although they favour short coastal streams.	**Low risk** This outcome is being achieved.
14(f) to minimise the impacts of taking water on water-related ecosystems;	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. **The WMP:** Includes water sharing rules that stipulate minimum stream flows for a number of sites. Provides a process to determine DVL percentages. Imposes conditions on water licences for the Kareeya hydroelectric power station.	All assets	Water-related ecosystems in the water plan area include rivers, streams, waterholes, wetlands, floodplains and estuaries. The assets associated with these habitats require a variety of flows to complete life cycles or provide suitable habitats. Water take in the water plan area has not impacted medium to large flows so assets dependent upon these flows are assumed to be unimpacted.	**Low risk** This outcome is being achieved.

Plan outcome	Plan strategies and water management protocol (WMP) rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative risk ranking and preliminary assessment of outcomes
	Contains strategies relating to trading or seasonally assigning underground water licences which aim to protect underground water for groundwater dependent ecosystems.			
14(g) protection and maintenance of refugia associated with waterholes, lakes and wetlands	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. The plan allows conditions to be attached to licences taking water from waterholes, lakes and springs. **The WMP:** Includes water sharing rules that stipulate minimum stream flows for a number of sites. Provides a process to determine DVL percentages. Outlines limitations for taking water from Mandalee waterhole.	Waterholes Floodplain wetlands Floodplain vegetation communities	Waterholes, as a feature of intermittent systems, are not common in the perennial systems of the water plan area. Mandalee waterhole is a prominent waterhole on the upper Herbert River. Water take from the waterhole is under the control of a self-managed water sharing group. Wetlands on the Tully-Murray floodplain are important habitats for a variety of migratory fish species, despite threats from adjacent agricultural land uses.	**Low risk** This outcome is being achieved.
14(h) minimisation of changes to the natural variability of flows that support – (i) water-related ecosystems	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. The plan allows conditions to be attached to licences	All assets Waterfalls	See comments for 14(a)(ii) and 14(f) above. The department has not conducted monitoring relevant to this outcome since the previous Ministers Performance report.	**Low risk** This outcome is being achieved.

Plan outcome	Plan strategies and water management protocol (WMP) rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative risk ranking and preliminary assessment of outcomes
	taking water from waterholes, lakes and springs. **The WMP:** Includes water sharing rules that stipulate minimum stream flows for a number of sites. Provides a process to determine DVL percentages. Outlines limitations for taking water from Mandalee waterhole.			
(ii) riffle habitats	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs. **The WMP:** Includes water sharing rules that stipulate minimum stream flows for a number of sites. Provides a process to determine DVL percentages. Outlines limitations for taking water from Mandalee waterhole.	Riffle habitat	See comments for outcome 14© above. The department has not conducted monitoring relevant to this outcome. Riffles are critical habitats for maintaining local and regional biodiversity in the Wet Tropics. Riffles occur throughout the water plan area. However, there is limited information on the environmental values supported by riffles in the water plan area. Minimum flow rules for Behana and Theresa Creeks will protect riffles during the dry season. Implementation of the passflow condition from Tully Falls Weir will support riffle habitat downstream of the weir.	**Low risk** This outcome is being achieved.
(iii) the reproduction and nesting habitats of the Australian freshwater crocodile (*Crocodylus johnstoni*)	**The plan:** The plan identifies performance indicators and provides for the maintenance of flows through EFOs.	Freshwater crocodile	The department has not conducted monitoring relevant to this outcome. There is little information available for freshwater crocodiles in the water plan area. Previous work on crocodiles, including freshwater crocodiles, has indicated that vegetation is important	**Low risk** This outcome is being achieved.

Plan outcome	Plan strategies and water management protocol (WMP) rules that provide for outcome	Related ecological assets	Summary of monitoring and assessment	Qualitative risk ranking and preliminary assessment of outcomes
	The plan allows conditions to be attached to licences taking water from waterholes, lakes and springs. **The WMP:** Includes water sharing rules that stipulate minimum stream flows for a number of sites. Provides a process to determine DVL percentages. Outlines limitations for taking water from Mandalee waterhole.		for nesting and to protect hatchlings from predation. Terrestrial weeds however can interfere with selection of nesting locations and success. Mandalee waterhole, on the upper Herbert River, is thought to have a population of freshwater crocodiles. This waterhole has a self-managed water sharing rule arrangement and the success of this strategy ensures that a water regime is maintained to support freshwater crocodiles. More information is needed on the distribution and habitat use of freshwater crocodiles in the water plan area.	

Appendix B Water entitlements and use

B-1 Water Entitlements

Table B-1-1: Summary of water allocations licences in the water plan area

Water classification	Volume based water allocations		Area based water allocations		Other
	Total Number	Total nominal volume (ML)	Total Number	Total nominal volume (Ha)	Total Number
Surface water	199	112,857.7	-	-	-
Underground water	-	-	-	-	-

Table B-1-2: Summary of water licences to take water in the water plan area

Water classification	Volume based water licences		Area based water licences		Other
	Total Number	Total nominal entitlement (ML)	Total Number	Total nominal entitlement (Ha)	Total Number
Surface water	1,489	215,133.8	3	55	2
Underground water	207	27,057.3	-	-	-

Table B-1-3: Summary of all water licences to take water per purpose type

Total nominal entitlement (ML)			Number of water licences		
Any	Rural	Stock	Any	Rural	Stock
89,928.2	151,625.53	0	181	1,354	119

B-2 Water use

Table B-2-1: Metered water use in the 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 (%)
Mulgrave-Russell catchment	2018-2019	155	38,613	12,544.17	32.49
	2019-2020	151	37,011.8	13,623.32	36.80
	2020-2021	149	37,067.3	13,297.23	35.87
	2021-2022	149	37,323.3	11,717.1	31.39
	2022-2023	154	37,306.6	11,420.73	30.61

B-3 Unallocated water

Table B-3-1: UAW reserves in the water plan area

Reserve name	Purpose	Area	Initial reserve (ML)	Remaining reserve (ML)
General	Any	Plan area	16,350	15,400
Indigenous	To support economic and social aspirations of First Nations peoples	Plan area	5,200	5,200
Indigenous	To support economic and social aspirations of First Nations peoples	Cape York Peninsula Region	400	400
Strategic	State	Plan area	35,900	34,900
High flow	Any	Plan area	870,000	870,000

Appendix C Water taken or interfered with under statutory authorisations

Table C-1: Information on water authorisations in the 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. No known stock routes exist in the water plan area.
S94 General authorisations to interfere with overland flow water or interfere by impoundment for structures used for collecting monitoring data	There was no significant increase in works taking overland flow water in the water plan area. The majority of the water plan area has high reliable annual rainfall producing naturally large volumes of overland flow water, so there is little need for water users to store water. 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.
S95 Aboriginal and Torres Strait Islander 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.
S97 Environmental authorities to take or interfere with overland flow	No identified change in water taken under this general authorisation. Overland flow water is currently not regulated under the water plan.
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 are required for road and rail construction and maintenance and public amenities. No significant increase in infrastructure and/or 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: Prescribed activities that would be most utilised are washing down equipment, plant or vehicles, filling spray units to apply herbicides or pesticides. The water plan has set a limit of 20ML for prescribed activities. s101(1)(b) Overland flow water is not regulated under the water plan. s101(1)(c) Take of underground water: Only permitted under a water licence or water permit within a groundwater management area, for stock or domestic purposes or for a prescribed activity. Additional water licences may only be granted from UAW. 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 water plan area.
s102 Authorisations under water plans or regulation	No identified change in water taken under these authorities. The water plan has set a limit of 20ML for taking or interfering with water for activities prescribed under a regulation.
s103 Authorisations to take water for stock or domestic purposes may be limited	No identified change in water taken under these authorities. An owner of land may take water, in any way, from a watercourse, lake or spring in the water plan area for stock or domestic purposes.

Appendix D Water plan amendments and milestones

Table D-1: Summary of water planning milestones

Effective date	Milestone
December 2013	The Wet Tropics water plan commenced in December 2013 and provides for the allocation and sustainable management of water by: defining the availability of water in the water plan area providing a framework for sustainably managing water and the taking of water identifying priorities and mechanisms or dealing with future water requirements providing a framework for establishing water allocations providing a framework for reversing, where practical, degradation in natural ecosystems regulating the taking of underground water.
May 2014	The *Land and Other Legislation Amendment Act 2014* and the Water Resource Plans Amendment Plan (No. 1) 2014 amended the Wet Tropics water plan to align with underground water provisions in the *Sustainable Planning Act 2009.*
June 2014	The Water Resource Plans Amendment Plan (No.1) 2014: amended the plan to enhance transparency and effectiveness of the environmental flow objectives made minor amendment to increase clarity and reduce regulatory burden.
November 2015	The Wet Tropics Resource Operation Plan commenced.
December 2016	The *Water Reform and Other Legislation Amendment Act 2014* amended the water resource plan to become a water plan. The Water Resource Plans Amendment Plan (No.1) 2014: amended plans to enhance transparency and effectiveness of the environmental flow objectives made minor amendment to increase clarity and reduce regulatory burden.
October 2018	The *Mineral, Water and Other Legislation Amendment Act 2018* changed the requirements for new water plans. The Minister must now consider outcomes relating to cultural values and climate change for any new plans.
May 2023	Wet Tropics Water Management Protocol commenced. Under transitional arrangements in the Water Act, some functions of the resource operations plan are now given effect by resource operations licences, operations manuals, a water management protocol, and certain provisions taken to be included in the water plan.
September 2024	The Wet Tropics water plan is due to expire.

Appendix E Overview of non-compliance by entitlement holders

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

Type of alleged non-compliances	Number of alleged non-compliances	Outcome
Contravene licence conditions	1	One advisory letter was sent
Excess take under entitlement	11	Seven advisory letters were sent Two formal warnings were issued Two penalty infringement notices were issued
Late and non-supplied meter readings	147	20 advisory letters were sent 14 formal warnings were issued One penalty infringement notice was issued 112 incidents achieved compliance without any formal administrative action
Take of water without an approved meter	2	Two incidents were responded to with verbal education
Unauthorised take	3	Two advisory letters were sent One formal warning was issued
Unauthorised interference	3	Two advisory letters were sent One incident was responded to with verbal education

Appendix F RDMW gauging stations in the water plan area

Table F-1: List of current RDMW gauging stations in the water plan area.

Catchment	Gauging Station Number	Gauging Station
Daintree	108002A	Daintree River at Bairds
Daintree	108003A	Bloomfield River at China Camp
Daintree	108008A	Whyanbeel Creek at Upstream Little Falls Creek
Herbert	116017A	Stone River at Running Creek
Herbert	116010A	Blencoe Creek at Blencoe Falls
Herbert	116011A	Millstream at Ravenshoe
Herbert	116012A	Cameron Creek at 8.7km AMTD
Herbert	116013A	Millstream at Archer Creek
Herbert	116014A	Wild River at Silver Valley
Herbert	116015A	Blunder Creek at Wooroora
Herbert	116016A	Rudd Creek at Gunnawarra
Herbert	116008B	Gowrie Creek at Abergowrie
Herbert	116001F	Herbert River at Ingham
Herbert	116004C	Herbert River at Glen Eagle
Herbert	116006B	Herbert River at Abergowrie
Herbert	116021A	Stone River at Venables Crossing
Johnstone	112102A	Liverpool Creek at Upper Japoonvale
Johnstone	112103B	Liverpool Creek at Silkwood
Johnstone	112002A	Fisher Creek at Nerada
Johnstone	112003A	North Johnstone River at Glen Allyn
Johnstone	112004A	North Johnstone River at Tung Oil
Johnstone	112006B	Rankin Creek at Ross's
Johnstone	112101B	South Johnstone River at Upstream Central Mill
Mossman	109001A	Mossman River at Mossman
Mulgrave-Russell	111105A	Babinda Creek at The Boulders
Mulgrave-Russell	111005A	Mulgrave River at The Fisheries
Mulgrave-Russell	111007A	Mulgrave River at Peets Bridge
Mulgrave-Russell	111101D	Russell River at Bucklands
Murray	114001A	Murray River at Upper Murray
Murray	114002B	Meunga Creek at Sing's
Tully	113004A	Cochable Creek at Powerline
Tully	113006A	Tully River at Euramo
Tully	113015A	Tully River at Tully Gorge National Park

Appendix G Summary of ecological monitoring

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

Ecological outcomes	Asset(s)	Summary of monitoring and research
14(a) The continued capability of a part of the river system to be connected to another, including by maintaining flows that – (i) allow for the movement of native aquatic fauna between riverine, floodplain, wetland, estuarine and marine environments	Migratory fish Turtles Floodplain wetlands	The intent of part (i) of this outcome is to protect the flow regime to ensure that migratory biota can move through the critical chains of habitat that support their life history requirements. This includes movement between freshwater and marine environments, floodplain, wetland and riverine habitats. Connectivity throughout the entire stream profile is required for species such as eels and shrimps (Pearson et al 2015). Water Monitoring (2022) determined a passflow to be released from Tully Falls Weir to maintain hydrologic connectivity between Tully Falls Weir and the Kareeya hydropower station, located downstream of Tully Falls. Abbott et al (2020) found the fish species richness of Boolgooroo Lagoon, Mungalla wetlands (Lower Herbert catchment) increased from three to nine following removal of a bund wall that prevented seawater intrusion. Bund removal was considered an efficient, sustainable, cost-effective and passive remediation method to reinstate tidal ingress as some freshwater weeds and ponded pastures are removed relatively effectively. Removal of the bund allowed diadromous species such as barramundi and estuarine species (e.g. tarpon) to enter the wetland. Moore et al (2021) identified 3,341 potential barriers to fish movement in the Murray and lower Herbert River catchments, occurring at a density of 1.27 barriers per km^2. Based on criteria including stream order, distance to other barriers and habitat condition, 51 potential barriers were prioritised for remediation. The three highest priority barriers for remediation were located on Dallachy (Murray Basin), Cattle and Trebonne Creeks (Herbert Basin). An additional project concluding in 2023 has identified over 1,600 potential barriers across the lower Barron, Mossman and Daintree Rivers. These catchments are considered to be diversity hotspots for diadromous fish (adults spawn in estuaries and juveniles mature in wetlands after migrating upstream) (https://terrain.org.au/what-we-do/biodiversity/identifying-fish-barriers/). This compares with the 3,748 barriers identified by Kroon and Phillips (2016) across the Wet Tropics region. **Implications for flow management** • Little monitoring or research relevant to this outcome has been carried out in the water plan area since the previous Minister's Report in 2017. Studies have indicated that temporal variability in connectivity occurs in association with freshwater flows and tidal events. There is also potential for connectivity to be disrupted by water take occurring during periods of low flow. However, this outcome can be achieved by maintaining flow objectives, and restrictions on water allocations and future developments that interfere with waterways. • Migratory fauna require connectivity between riverine reaches, floodplain wetlands, estuarine and marine environments to fulfill their reproductive life history obligations. Previous research in the water plan area has shown the importance of connectivity for maintaining the biodiversity of species assemblages over a range of aquatic habitats.

		• Whilst there are few large water storage structures in the water plan area that would impede movement, thousands of potential barriers to migration have been identified, with dozens of these prioritised for urgent remediation to benefit migratory fauna. In addition, floodplain levees are present in some catchments, and these can limit the extent of floodplain inundation and connectivity between river channels and floodplains (Godfrey et al 2021). • Previous work in the water plan area has demonstrated the importance of maintaining wetland connectivity and natural seasonal flow patterns for sustaining freshwater fish diversity in the Wet Tropics (Godfrey et al 2017).
(ii) support water-related ecosystems	All assets	Part (ii) of this outcome pertains to the long-term sustainability of aquatic ecosystems, associated habitats and water resources. This involves protecting and mimicking flow bands of the natural hydrograph to maintain the diverse range of flow-dependent ecosystems in the water plan area. This can be achieved through maintaining flow objectives and restrictions on water allocations and future developments that interfere with waterways. Pearson et al (2018) investigated the influence of land-use disturbance on invertebrate assemblages of the Wet Tropics bioregion. Land use had a substantial impact on assemblage structure and landscape and habitat descriptors were also important in describing these patterns. Local impacts (disturbances) were also important in the patterns observed. As all streams were flowing at the time of sampling and sampling was limited to the dry season, flow would not be expected to be critical in delineating patterns in invertebrate assemblages - however, dry-season baseflows were thought to ameliorate some of the impacts of poor water quality derived from cropping land uses. Adame et al (2019a) examined the denitrification potential of tropical floodplain wetlands of the Herbert and the Tully–Murray Rivers, forested with *Melaleuca* spp. Average potential denitrification rates (D_t) were comparable to other tropical and temperate wetlands. Background water concentrations of nitrate-N was the factor most significantly associated with denitrification. Denitrification capacity is dependent upon size, location in the catchment and inundation frequency. Maintaining the hydrological regimes of these wetlands is therefore important for maintaining the ecosystem services they provide. Given the importance of ecosystem services provided by wetlands in the Wet Tropics area, investigations have been undertaken to determine feasibility of constructed wetlands to reduce sediment and nutrient runoff to the Great Barrier Reef and converting marginal sugarcane paddocks to constructed wetlands (e.g. Adame et al 2019b; Wallace et al 2020; Wallace and Waltham 2021; Canning et al 2022). Environmental values and water quality objectives for the Daintree and Mossman Basins, the Johnstone River basin, the Mulgrave-Russell basin and the Tully River, Murray River and Hinchinbrook Island Basins have been updated by DES (2020a,b,c,d). These objectives were refined from national and state water quality guidelines to represent the values of local waterways and underpin the report card grades of ecosystem health monitoring programs. The structure of zooplankton communities in the Mulgrave River is influenced by channel morphology, flow perenniality, water velocity, wet season flooding and salinity (Godfrey et al 2021). Maintenance of flow perenniality, dry season hydrologic connectivity and freshwater inputs to estuaries are critical for maintaining habitats for zooplankton and primary and secondary production (Godfrey et al 2021).

		Implications for flow management • Water requirements of many of water-related ecosystems in the water plan area are poorly understood. • The plan has flow objectives in place to protect flows across the hydrograph. These are effective in maintaining a flow regime to support water-related ecosystems.
(iii) support river-forming processes	River geomorphology	The intent of part (iii) of this outcome is to ensure the continuation of flows that maintain channel morphology and geomorphological processes, as the alteration of these flows can impact natural rates of erosion, deposition and bank undercutting. River-forming processes are generally associated with bank full flows. Sediment monitoring has been an integral component of the Reef Plan. Suspended sediments are sampled along transects extending from freshwater, estuary, flood plume, inshore reef and seagrass (Bainbridge et al 2021). Bahadori et al (2020) traced the sources of bed and suspended sediments and particulate nitrogen (PN) in the Johnstone River and its estuary originating from different land uses (rainforest, grazing, sugar cane and banana farming). Rainforest was the largest contributor of both suspended and bed sediments exported to all river reaches investigated (i.e. upper Johnstone, lower Johnstone, South Johnstone and estuary). However, when delivery rates were considered per unit of area covered by the above land uses, highest rates occurred from intensive agricultural farms (sugar cane and banana farms) located in the lower catchment Bahadori et al (2020) reiterated that the bulk of suspended sediment transported in tropical river systems occurs in within a short time of high rainfall during the wet season. Bainbridge et al (2021) developed a new protocol for measuring sediment grain sizes and applied this to sediments exported from the Tully and Burdekin Rivers. This revealed that the ecologically relevant <20 µm fraction makes up a larger proportion of exported sediment than existing models had indicated. This terrigenous, organic-rich, fine sediment presents the greatest ecological risk to corals and seagrass as it has a disproportionate influence on light attenuation, and it settles as fine and often sticky particles which are difficult to disperse. Bainbridge et al (2021) believed that standardised reporting of sediment grain sizes from freshwater, flood plumes and marine areas was required to better inform estimation of catchment loads for specific grain sizes. **Implications for flow management** • Reduction in the export of fine-grained sediment from catchments will likely reduce ecological risk to near shore and marine habitats. • The absence of large flow regulating structures means that sediment transport during high flow events is not impacted in the water plan area.
14(b) provision of a flow regime that ensures – (i) maintenance of fresh water to the estuaries of watercourses and the GBR		The intent of part (i) of this outcome is to maintain estuarine salinity regimes, connectivity for fish passage and fisheries productivity. The Reef Report Card 2020 indicated that through the life of this Wet Tropics water plan, overall discharge from rivers in the Wet Tropics was the lowest for 15 years. However, the Water Monitoring Information Portal indicates that some of the highest discharges recorded for several rivers in the water plan area (i.e., Mossman in 2013, Herbert in 2017-18, Daintree and Bloomfield in 2018) also occurred during this period. Freshwater

		flows to estuaries have not been impacted to any extent in the water plan area due to the absence of large storages, except for Koombooloomba Dam on the Tully River. However, water take associated with this structure is for hydropower generation and it is returned to the river, less negligible losses. Whilst freshwater flows to estuaries are important for the delivery of nutrients and the maintenance of connectivity and salinity gradients, the reduction of nutrient exports specifically derived from agriculture is critical to the water quality of estuaries and the receiving GBR lagoon. Masters et al (2017) trialled a range of nitrogen (N) application rates and measured N export rates from a sugarcane crop located near Silkwood in the South Johnstone sub-basin. The critical elements driving off-site N loss are the rate, timing and form of N that is applied (i.e., standard N fertiliser – primarily urea; or controlled release fertiliser - polymer coated). However, a clear challenge lies in determining the optimum N rate to apply, whilst simultaneously maintaining good productivity and reducing N loss to the environment. For the grower, a higher application rate of 134-158 kg N/ha was favoured for economic return, over a rate of 94-112 kg N/ha, which better matches plant requirements, resulting in lowered N loss and improved N use efficiency. The structure of zooplankton communities in the Mulgrave River is influenced by channel morphology, flow perenniality, water velocity, wet season flooding and salinity (Godfrey et al 2021). Maintenance of flow perenniality, dry season hydrologic connectivity and freshwater inputs to estuaries are critical for maintaining hydraulic habitats for zooplankton and primary and secondary production (Godfrey et al 2021). **Implications for flow management** • Freshwater flows are essential for the maintenance of estuaries and salinity gradients, protection of the GBR, connectivity for fish passage, and the delivery of nutrients to estuaries and the GBR lagoon.
(ii) productivity in the receiving waters of the GBR and inshore reefs		The intent of part (ii) of this outcome concerns the export of nutrients (particularly nitrogen), toxins, sediment, loss pathways, and the effects of these on biota in the GBR lagoon and on inshore reefs. Modelling associated with the GBR Water Quality Report Card 2020 indicated that across all GBR catchments, progress towards reduced sediment export was over half way to the target value and reduction in dissolved inorganic nitrogen (DIN) export was almost half way towards the target value. Reductions were attributed to better fertiliser management; the application of mill mud to cane fields and new or improved fencing to exclude cattle from waterways. At a finer scale, water quality exported to inshore marine habitats collectively from the Wet Tropics catchments alone is summarised in the Reef Report Card 2020 as *Moderate* and improving, although water clarity (secchi depth) is graded *Poor*. Coral condition (cover, composition, juvenile, algae) surveyed across 12 reefs in the region was graded *Moderate*, with indicators remaining relatively stable, although reefs at Bedarra, Dunk South and Snapper North islands have persistently recorded very poor scores due to a high coverage of macroalgae. Seagrass condition (abundance, nutrient status, reproductive effort) varied across the region and was graded *Poor* overall, with abundance and reproductive effort having decreased from *Moderate* to *Poor* condition. The 2020 report card results for individual Wet Tropics catchments and for the Wet Tropics region overall are summarised in Appendix B. A large proportion (31%) of total nitrogen loads exported to the GBR originate from the Wet Tropics region, despite the area comprising only 5.1% of the total GBR catchment area (Hateley et al 2014a; 2014b; McCloskey et al 2017; Bahadori et al 2020).

		Seagrasses within the Great Barrier Reef World Heritage Area (GBRWHA) are prone to threats from freshwater discharge laden with sediments, nutrients, pesticides, and turbidity issues associated with coastal developments or dredging which causes the resuspension of fine sediments. Collier et al (2016) presented species-dependent acute and long-term light thresholds for seagrasses of the GBRWHA which ranged from 2-6 mol m^{-2} d^{-1}. Integration times (average time in days used to describe light history and as first signal to trigger management plan), time to (expected) impact and confidence scores were also tabulated. This information may provide a useful water quality guideline for estuarine exports. Lewis et al (2023) presented values for sediment and nutrient loads (represented by seven parameters) for pristine and near-pristine sites in the Wet Tropics bioregion (including sites in the Barron water plan area). Pristine sites were defined as those with a land use of 100% conservation; near-pristine sites included 83- 99% conservation land use and some non-intensive land uses. Recommended values were presented for dry weather concentrations and event mean concentrations. **Implications for flow management** • Targeted reductions in nutrients, sediment and pesticide exports are required to better protect the GBR and inshore reefs. The high coverage of macroalgae on reefs described above is likely due to elevated nutrient exports.
14(c) the support of ecosystems dependent on groundwater, including, for example, ecosystems dependent on surface water and groundwater interactions	Waterholes Baseflow GDEs	This outcome is intended to protect groundwater dependent ecosystems (GDEs) from the impact of water entitlements. This can be achieved through imposing volumetric limits and limiting the allocation of new licences. The Bureau of Meteorology has mapped potential GDEs nationally, but complete GDE mapping by the Queensland Government for the water plan area is not yet available on WetlandMaps. GDEs within the water plan area include baseflow streams and the ecology of these stream is highly dependent on predictable baseflow (Donaldson et al 2013; Pearson et al 2015). Stanley and Reading (2020) investigated nitrate dynamics in underground water under sugarcane in the Liverpool Creek catchment (South Johnstone River basin). Stanley and Reading (2020) observed distinct spatial variability in underground water chemistry, concurring with the findings of Rasiah et al (2013) that nitrate dynamics are site-specific and should not be extrapolated to other areas. Aquifers with very low NO_3^- and dissolved oxygen had consistently higher sulphate, sulphur and ferrous iron concentrations, with low concentrations of dissolved organic carbon. When examined with averaged measured redox potential considered, this indicated that some underground water areas provided favourable conditions for the removal of NO_3^- via autotrophic denitrification, whilst other aquifer regions retained NO_3^- concentrations higher than trigger values defined in regional water quality guidelines. The distinct variability in NO_3^- concentrations observed over small distances was attributed to the naturally heterogeneous structure of coastal alluvium, in combination with processes of denitrification, shallow lateral drainage and adsorption to clay particles within alluvial sediments. Wallace and Waltham (2021) found information relating to the potential of tropical wetlands to filter contaminants from agricultural runoff to be scarce, and so developed a water balance and denitrification model to run with field data collected from a 10 Ha wetland constructed over a previous sugarcane plot in a Babinda sub-catchment area of the Mulgrave-Russell catchment. Over a 12-month period, mean denitrification properties were 51 kg N ha^{-1} $year^{-1}$, but estimates were highly variable. The authors attributed variation in

		denitrification rates to 'hot spots'—where wetland conditions favour the rapid conversion of dissolved nitrogen into nitrogen gas, and 'cold spots' —where hydrological conditions do not allow much denitrification to occur for most of the year. To identify wetlands with significant filtering capacity, dissolved nitrogen (DIN, organic nitrogen and ammonium) should be measured periodically. Low dissolved oxygen (DO) should also be identified through the water column and diurnally as denitrification will not occur when DO is below critical thresholds. Canning et al (2022) used a hybrid approach to assess the benefits achieved by the construction of lagoons on cane farms in the Tully catchment by combining fish biodiversity assessments with farm financial cost-benefit analysis. The constructed lagoons provided vegetated margins, moderate depth and water quality, connectivity to Tully River riverine habitats and enhanced fish biodiversity, with 36 native freshwater species recorded. The study also estimated that surrounding cane farms would financially benefit from the elevation of low-lying croplands (using the excavation spoil) to reduced flooding. Better drainage and flow regulation enhanced crop yield and the elevated land increased gross margins by extending crop production cycles or permitting a transition from cattle grazing to cropping. **Implications for flow management** • Further research is required to quantify GDE water requirements, as well as the impact of increased underground water use, and future climate change. For example, in the lower Herbert there are gaps concerning risks to GDEs from increased take, and risks associated with seawater intrusion. Determining the degree of surface water-underground water interactions in high pressure areas of the water plan area will also be vital for determining increasing water demand impacts on GDEs. • The water requirements of underground water dependent vegetation are poorly understood. • Wet season rainfall recharges aquifers and allows for the maintenance of connectivity between underground water and surface water during the dry season, but flow thresholds to fill floodplain wetlands and the contribution of underground water to wetland persistence is currently unknown and requires quantification.
14(d) maintenance of a daily flow at each node of at least 1 megalitre per day to perennial surface flow;		The intent of this outcome is to ensure that perennially flowing waterways are at least meeting the minimum daily flow requirement for the purpose of maintaining long term ecological function. The stream gauging network operated by the department has 33 gauges in the water plan area (Queensland Government WMIP). The Wet Tropics plan has seven nodes – all of which are expected to have perennial flows. Appendix C shows that the minimum mean daily flow recorded during the life of the plan at any node/gauge was 111.28ML/day. Therefore, during the life of the plan, flows at all nodes exceeded 1 ML/day. **Implications for flow management** • The threshold of 1ML/day should be re-considered during the next plan review, based on water monitoring data collected over the life of the plan.

		• A higher flow threshold is likely to be required to maintain current water levels and protect ecosystems from future impacts of water take.
14(e) provision of flows and hydraulic habitat for flow-spawning fish and endemic species, including for example Pacific blue-eye (*Pseudomugil signifer*)	Riffles Pacific blue-eyes	The intent of this outcome is to maintain environmental conditions that sustain hydraulic habitats for flow-spawning fish, and other ecological assets dependent on these conditions (e.g. Pearson et al 2015). Pacific blue-eyes (*Pseudomugil signifer*) tolerate fresh, brackish and fully marine conditions and are found in tidal mangrove creeks, estuaries, saltmarshes, rainforest streams, riverine habitats and freshwater swamps, but they do not usually penetrate far inland (Allen et al 2003). They can spawn in fresh or salt water and eggs are deposited in aquatic or marginal vegetation, or occasionally onto the substrate (Pusey et al 2004). Eco-hydraulic rules applied by DSITIA (2013a) for blue-eyes to achieve reproductive success were low flow (daily discharge ≤ median flow); stable flow (water level fluctuation ≤ 5 cm for a 19 day period); and daily mean water temperature ≥ 22ºC. Confirmation of these requirements in the water plan area is required. Water velocity is a major determinant of the microdistribution of invertebrates in Wet Tropics streams (Donaldson et al 2013; Pearson et al 2015; Godfrey et al 2021). Keller et al (2019) found that water velocity and depth were the two major determinants of fish habitat use in a wet-dry tropics stream for the 20 common fish taxa assessed. Four distinct habitat guilds were identified based on the water velocity, water depth, and habitat structural complexity the species were associated with. Ontogenetic shifts in habitat use were observed in three species. The study highlighted the need to maintain dry season flows that support a diversity of riverine mesohabitats for freshwater fishes. Particularly riffle habitats which provide nursey and refuge habitat for some species but are vulnerable to desiccation due to water resource development. **Implications for flow management** • Effective flow management can provide habitat and conditions suited to diadromous species, which include wetted riffles, stream, and estuarine connectivity, as well as heterogenic flow velocities and variation in substratum provided by habitat complexity. • The hydraulic habitat requirements of endemic flora and fauna not well understood.
14(f) minimisation of the impacts of taking water on water-related ecosystems	All assets	This intent of this outcome is to mimic the different flow bands of the hydrograph to protect the long-term sustainability of aquatic ecosystems and water resources, particularly during low flow periods. The department conducted cross-sectional surveys in the Tully River to estimate a pass flow from Tully Falls Weir that would maintain downstream hydrologic connectivity and ensure ecological outcomes of the plan are being achieved. The approach used in this investigation was to determine a minimum water surface elevation that should be maintained to ensure hydrologic connectivity downstream of the weir. Maintenance of a water surface elevation of 659.830 m AHD was recommended. This elevation would require a mean daily flow of approximately 13ML/day^{-1} (Water Monitoring 2022). **Implications for flow management** • Maintaining flow objectives and restrictions on water allocations will reduce risk from water resource use on the diverse range of ecosystems in the water plan area.

14(g) protection and maintenance of refugia associated with waterholes, lakes and wetlands	Waterholes Floodplain wetlands Floodplain vegetation communities	The intent of this outcome is to maintain waterholes, lakes and floodplain wetlands as they provide significant refugia for aquatic species. These assets are at greatest risk during times of low or no flow and may also require flooding to establish connectivity for movement of aquatic fauna. The Reef Water Quality Report Card assessed freshwater wetland condition for the entire GBR coastline, where overall, freshwater wetlands were rated *Moderate* (C), but wetland areas managed for conservation received a *Good* (B) rating, whereas non-conservation areas received a *Moderate* (C) score. These same results were echoed by grades for pressures on wetland condition (water regime change, pollutant input, habitat modification, pest introduction) with no net change recorded from the previous assessment. The latter two of these assessed variables were graded *Poor* (D) in non-conservation wetlands. It was noted that weed control and the re-establishment of native vegetation in riparian buffer areas would assist in improving the biotic integrity of wetlands and connectivity between wetlands. Additionally, the physical integrity of freshwater wetlands would be improved by greater control of pest animals. Associated with findings reported above (in Abbott et al (2020); section 14(a)), Waltham et al (2019a) found that removal of a bund wall at Mungalla Station did not fully achieve the desired level of wetland restoration due to seasonal oscillation between freshwater and more saline states, and temporal effects this had on vegetation (e.g. Aleman grass) dominance. Adame et al (2019b) reported wetlands in GBR catchments to presently have low rates of loss, and to be generally well protected. However, it was further stated that wetlands have been primarily considered in their capacity to improve water quality from terrestrial runoff to the GBR, whilst their intrinsic values and other ecosystem services have received little attention. Suggestions followed that nitrogen markets, water pollution offsets and payments for ecosystem services offer financial opportunities for wetland restoration. Waltham et al (2021a) sought to outline a potential payment for an ecosystem services (PES) scheme to drive large-scale wetland restoration across the GBR catchment and looked to learnings from the evaluations of overseas schemes as well as the Riversdale-Murray Valley Water Management Scheme, to benefit from over 15 years of local stakeholder hindsight. The Riversdale-Murray scheme carried out several projects across the Tully-Murray floodplain, aiming to reduce floodplain inundation across cane land and increase cane production through the creation of arterial drainage and lagoon wetland networks. Whilst summarising some of the challenges toward achieving a viable scheme, they also outlined financial incentives and other considerations aimed at achieving positive outcomes. Suggestions included: early and clear identification of objectives and values across the landscape; strong engagement with community and indigenous groups; aggregated contributions to a central fund and bundled payments via a reverse-auction process; a transaction database and robust environmental accounting framework; and legal protection of restored projects from destruction. Similar to a conventional managed investment fund, Waltham et al (2021a) presented the GBR Catchment Wetland Investment Fund, as a highly collaborative platform to be operated as a common asset trust, with flexibility, well-established legal mechanisms, conflict resolution processes, administrative and transaction efficiency, and which enables investment and support in multiple ecosystem services. In examining the success of other restoration attempts occurring over a number of decades at several wetland complexes across GBR catchments, Waltham et al (2019b) indicated that ‘success’ must firstly be defined, through clear understanding of complex cause and effect pathways, with focus on the management and values of these wetlands.

		Key reasons for the failure of many restoration projects are numerous and include: a lack of clear project objectives; shortfalls in a whole-of-catchment approach (i.e., inadequate project scale – both spatial and temporal); costs for on-going maintenance in relation to funding cycles; change in stakeholder involvement; and the prioritisation of inappropriate sites (i.e., upstream sites should be restored before downstream sites). Waltham et al (2021b) indicated that even if the Reef Regulations (December 2019) nutrient load mandate were combined with best practice on-farm nutrient management practices, it is unlikely the end-of-catchment DIN targeted load reduction of 60% (from the 2012–2013 anthropogenic load level) for Wet Tropics catchments (as specified in the Reef 2050 Water Quality Improvement Plan (2017–2022)) could be achieved. In searching for ways to improve water quality exiting these catchments, Waltham et al (2021b) conducted a multi-criteria analysis to identify low-lying, marginal sugarcane land potentially suitable for transitioning to alternative land uses. Cost-effectiveness of DIN reductions were considered, accounting for land conversion costs and reductions in annuity gross margins. Treatment wetlands and no-input cattle grazing offered cost-effective solutions in some areas (i.e., where conversion costs were low and high DIN reductions possible) of 20-26 $/kg DIN, comparing favourably with $50/kg DIN reduction for existing agricultural extension-based approaches. However, when appropriately situated, ecosystem service wetlands (i.e., wetlands restored for fish production) offered the most cost-effective performance of all for DIN reduction at 11–14 $/kg DIN. Keller et al (2019) found that 15 fish taxa surveyed in a tropical river were associated with moderately deep and low velocity habitats or waterholes during the dry season. This was likely due to the complexity of habitat structures (submerged wood, undercut banks, root masses etc.) for feeding and shelter, the buffering capacity of waterholes to changes in water level and water quality, and the greater surface area of waterholes relative to other habitats such as riffles and runs. **Implications for flow management** • Flows required to maintain many coastal wetlands are impeded by barriers such as bunds. Only high flood events facilitate overbank flows to flush/fill these wetlands. Increasing climate variability and water resource development may significantly change the periodicity of these events. Flow thresholds to fill floodplain wetlands and the contribution of underground water to wetland persistence is currently unknown and requires more research. • Due to perennial stream flow across much of the water plan area, waterholes are limited to the upper Herbert River.
14(h) minimisation of changes to the natural variability of flows that support – (i) water-related ecosystems	All assets Waterfalls	The intent of this outcome is to maintain all flow bands of the hydrograph to promote the long-term sustainability of ecological assets and water resources. This includes flow frequency, seasonality, duration, perenniality and the spells between events. By comparing barramundi sampled from two catchments with differing upstream land uses (the Daintree and Tully Rivers), Hook et al (2017) investigated the potential impacts of declining water quality on fish liver physiology. The two rivers also differed in sediment, nutrient, and pesticide loads, with contaminant loads and the area of agricultural land use being lower in the Daintree. Patterns similar to those observed in previous laboratory-based studies of fish and amphibians exposed to the agricultural herbicide atrazine were detected. If the patterns observed here in liver physiology were to present at the whole organism level, differences in water quality between these two rivers may alter fish growth and fitness.

		Godfrey et al (2021) examined the drivers of zooplankton dynamics in the lower Mulgrave River, finding greater abundance in slack water habitats. Maximum proliferation of zooplankton occurred in the late dry season, with the assemblage most influenced by wet season floods, estuarine incursion, perennial flows, the presence of slack waters and the incised nature of the river through its floodplain. **Implications for flow management** • This outcome is achieved through restricting water take and maintaining flow regimes.
(ii) riffle habitats	Riffle habitat	Riffles are critical habitats for maintaining local and regional biodiversity in the Wet Tropics (Pearson et al 2015). The intent of this outcome is to ensure that riffle habitats do not become a) dewatered by reduced flow as this would result in barriers to fish migration and loss of important habitat or b) drowned out by flow supplementation. Modelling of riffle inundation conducted by DSITIA (2013a) defined the frequency and duration measurement end points for effective riffle function as a depth range of 0.1 - 0.4 m above the riffle substrate. **Implications for flow management** • Riffles are important stream habitats that support communities of aquatic plants and animals that differ from standing water habitats. Maintaining these habitats is critical for maintaining local and regional biodiversity in the Wet Tropics. • Stream cross-section surveys are required through each node of the water plan area to characterise habitat variety and additional surveys may also be required after significant flow events that are large enough to alter stream morphology (DSITIA 2013b). • The features of riffle habitats that aquatic fauna and flora rely upon are not well understood. • It is recommended that the minimum flow thresholds determined for Behana and Theresa Creeks, as specified in the Wet Tropics ROP, be maintained.
(iii) the reproduction and nesting habitats of the Australian freshwater crocodile (*Crocodylus johnstoni*)	Freshwater crocodile	The intent of this outcome is to provide a flow regime that supports the life cycle requirements of freshwater crocodiles, including through their reproductive, nesting and juvenile recruitment seasons. Freshwater crocodiles occupy a limited range within the Wet Tropics and the upper Herbert may be the only catchment within the water plan area where they occur naturally (the Millstream, Dry River and Mandalee Waterhole). However, they have been translocated to several waterways, including Lake Barrine, Lake Eacham, Mena Creek and the Barron River. It appears that localised populations have established in these waterways (WTMA 2013). DSITIA (2013a) defined the eco-hydraulic rule applicable to freshwater crocodiles for modelling as persistence of permanent waterholes ≥ 2 m total depth. Research cited below also indicates that water level stability is important. Individual freshwater crocodiles appear to maintain a consistent home range across years, but little information is available on the extent of movements made during the wet season. The majority of individuals appeared to remain at the water's edge and their spread moves with this edge as pools expand and coalesce (DSITIA 2013b).

No further information on freshwater crocodiles specific to the Wet Tropics was found, but some information on reproduction and habitat requirements is available. Somaweera et al (2019a) examined interactions between vegetation and freshwater crocodilian ecology and noted that hatchling or juvenile crocodilians, including those of *C. johnstoni*, display a preference for vegetated sites, with lower survivorship recorded in non-vegetated sites due to higher rates of predation. Negative correlations were also observed between hatchling survivorship, distance between nest sites and suitability of nursery habitat. Seasonal floodwater fluctuations also affect available vegetative cover. Association of *C. johnstoni* with tree root masses and suspended fibrous root mat habitats was also reported, as these provide ideal resting and hiding places (Walsh 1989, cited in Somaweera et al 2019a). The presence of grasses and weeds can prevent female *C. johnstoni* from digging nesting holes (see Somaweera et al 2019a). Sex determination is temperature-dependent in crocodilians, thus shading by vegetation, or the lack of it, can cause skewed sex ratios, potentially threatening long-term population viability (Berec et al 2001, cited in in Somaweera et al 2019a). For example, temperature profiles of *C. johnstoni* nests in northern Australia were 2—3ºC cooler where the invasive alien stinking passionflower vine (*Passiflora foaetida*) had overgrown nests, compared to nests remaining in the open. Compared to unvegetated banks, *C. johnstoni* hatchling density was significantly higher amongst riparian and floating vegetation. Hatchling density was also positively correlated with the total number of food items and the total mass of food ingested by hatchlings. As early hatchlings do not travel far, they had selected vegetated habitats close to the nest to maximise their feeding rates (Somaweera et al 2011, cited in Somaweera al 2019a).

C. johnstoni have slow growth rates, with males and females taking about 31 and 26 years, respectively, to reach a length of 1.8 m. They can ultimately reach over 3 m in length, attain weight of 90 kg, and are long-lived with a mean lifespan of ~50 years. Sexual maturity is reached after 17 years and only about 1 % eggs laid survive to maturity (see Somaweera et al 2019b). Altered flow regimes such as raised water levels reduce the shallow water habitats favoured by hatchlings and juvenile crocodiles. Rapid fluctuations in water levels may flood nests leading to mortality. Infrastructure such as dams and barrages can fragment populations, alter prey guilds and cause changes in thermal profiles. Major threats to freshwater crocodiles include invasive alien species: the cane toad *Rhinella marina* (toxic prey); cattle (nest trampling); introduced feral nest predators: pigs *Sus scrofa*, feral dogs *Canis familiaris* (as well as dingoes); and invasive plants: stinking passionflower vine *Passiflora foaetida*. This weed occurs over 80% of the estimated range of freshwater crocodiles. Further, where suitable nesting space is limited because of weed invasion, females may nest in sub-optimal locations, leading to embryonic mortality caused by flooding, desiccation, predation and skewed sex ratios. Male C. johnstoni are only produced over a very narrow range of incubation temperature (31-32oC) and the long egg incubation time of 75-90 days provides ample time for weeds to overtop nests (Somaweera et al 2019b).

Implications for flow management

- There is presently insufficient information available on linkages between the provision of refugial waterholes (≥ 2 m deep) and *C. johnstoni* population viability to set a threshold of concern for modelling (DSITIA 2013a).
- Eco-hydraulic rules for this species will need to be developed from information as it becomes available. This will assist in developing specific environmental management rules for specific locations so that water use can better be managed in relation to the survival of this species.

	• In the interim, effective flow management for the preservation of *C. johnstoni* populations should maintain stream baseflows, avoid fluctuations of water level due to water take or supplementation and ensure the maintenance of riparian vegetation to enhance juvenile survivorship. • Information on species distribution and the location and persistence times of waterholes at least 2 m deep is required.

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Appendix H Submission form

Office Use Only

Submission No:.....

Surname (Mr/Mrs/Ms/Dr/Other)

First Name

Address

Postcode

Organisation

Position

Phone No. Mobile

Email

Signature 1 Date

Signature 2* Date

*if necessary, e.g. for an organisation

Which interest group do you primarily represent? (You may tick more than one box)

☐ Irrigator (surface water)
☐ Irrigator (underground water)
☐ Dryland farmer
☐ Grazier
☐ Mining industry
☐ Water service provider
☐ Community group (please specify) .....
☐ Riparian landholder
☐ Horticultural interests
☐ Local government
☐ Stock and domestic water user
☐ Environmental interests
☐ Commerce/development
☐ Aboriginal peoples
☐ Torres Strait Islanders
☐ Research/academic
☐ Tourism industry
☐ Commercial fisher
☐ Recreational fisher
☐ Small business
☐ NRM Board/Catchment
☐ Industry group (please specify) .....
☐ Other (please specify) …….....

What are your thoughts on the proposed extension?

Are there any risks you feel need to be considered?

Do you think the proposed recommendations are adequate for the sustainable management of water resources in the water plan area?

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