



Australian Government

Commonwealth Environmental Water Office

Commonwealth Environmental Water Portfolio Management Plan

Border Rivers

2019–20

Acknowledgement of the traditional owners of the Murray-Darling Basin

The Commonwealth Environmental Water Office respectfully acknowledges the traditional owners, their Elders past and present, their Nations of the Murray-Darling Basin, and their cultural, social, environmental, spiritual and economic connection to their lands and waters.

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Commonwealth environmental water portfolio management planning

Commonwealth Environmental Water Holder

The Commonwealth Environmental Water Holder is a statutory position established under the *Water Act 2007* and is responsible for managing the Commonwealth's environmental water holdings. This water must be managed to protect and restore the rivers, wetlands and floodplains (and the native animals and plants they support) of the Murray–Darling Basin. Ms Jody Swirepik is the current Commonwealth Environmental Water Holder. She is supported by staff of the Commonwealth Environmental Water Office, which employs six local engagement officers who live and work in regional centres across the Murray–Darling Basin.

Commonwealth environmental water

Commonwealth environmental water holdings are water entitlements that have been acquired by the Australian Government through investments in water-saving infrastructure and purchases on the water market. The holdings are a mix of entitlement types held across 19 catchments. The rules governing the entitlements vary across states and across catchments. Commonwealth environmental water entitlements are subject to the same fees, allocations, carryover and other rules as equivalent entitlements held by other water users.

There are broadly three options for managing Commonwealth environmental water:

- delivering water to a river or wetland to meet an identified environmental demand
- leaving water in storage and carrying it over for use in the next water year (referred to as 'carryover')
- trading water, that is, selling water and using the proceeds to buy water in another catchment or in a future year, or investing in complementary 'environmental activities'.

Purpose of the document

This document sets out the plans for managing the Commonwealth environmental water portfolio in the Border Rivers catchment for 2019–20. Efficient and effective management of Commonwealth environmental water requires the utilisation of all portfolio management options. By taking a multi-year approach to planning, portfolio management tools such as use, carryover and trade can be managed for maximising environmental outcomes.

The portfolio management plans support transparent, coordinated and adaptive management of Commonwealth environmental water, consistent with the Basin-wide environmental watering strategy and having regard to the Basin annual environmental watering priorities.

To learn more about the planning approach see *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2019–20* (available at: <http://www.environment.gov.au/water/cewo/publications> under 'Planning approach').

Delivery partners

Commonwealth environmental water is managed in conjunction with and delivered by a range of partners. This portfolio management plan has been developed in consultation with our delivery partners, including in Queensland the Department of Natural Resources, Mines and Energy (DNRME); Department of Agriculture and Fisheries (DAF); Department of Environment and Science (DES); and the Queensland Murray-Darling Committee Inc (QMDC). In NSW they include the Office of Environment and Heritage (OEH); Department of Primary Industries – Fisheries (DPI Fisheries); Department of Industry – Water (DoI Water); WaterNSW and Local Land Services (LLS) groups. Advice on the use of Commonwealth environmental water in the Border Rivers is also provided by individual landholders and Border Rivers Food and Fibre (BRFF).

Your input

The management of Commonwealth environmental water relies on considerable advice and assistance from others. Individuals and groups within the Murray–Darling Basin community are encouraged to submit suggestions for the management of Commonwealth environmental water. Please contact the Commonwealth Environmental Water Office via: ewater@environment.gov.au.

Table of contents

Commonwealth environmental water portfolio management planning	2
Commonwealth Environmental Water Holder	2
Commonwealth environmental water	2
Purpose of the document	2
Delivery partners	2
Your input	3
Table of contents	4
Environmental watering in the Border Rivers catchment	5
1.1. The Border Rivers catchment	5
1.2. Environmental objectives in the Border Rivers catchment	5
1.2. The Border Rivers catchment	6
1.3. Environmental flow requirements	7
2. Portfolio management in 2019–20	8
2.1. Lessons from previous years	8
2.2. Antecedent and current catchment conditions and the demand for environmental water in 2019–20	10
2.3. Water availability in 2019–20	15
2.4. Overall purpose of managing environmental water based on supply and demand	16
2.5. Water Delivery in 2019–20	17
2.6. Trading water in 2019–20	18
2.7. Carrying over water for use in 2020-21	19
2.8. Identifying Investment Opportunities	19
3. Next steps	26
3.1. From planning to decision making	26
3.2. Monitoring	26
3.3. Further information	27
Bibliography	28
Attachment A – Expected outcomes from the Basin-wide environmental watering strategy	32
Attachment B – Operational details for watering	35
Operational considerations in the Border Rivers catchment	35
Potential watering actions under different levels of water resource availability	37
Potential watering actions – standard operating arrangements	40
Attachment C – Long-term water availability	45
Commonwealth environmental water holdings	45
Other sources of environmental water	45
Planned environmental water	45

Environmental watering in the Border Rivers catchment

1.1. The Border Rivers catchment

The Border Rivers catchment covers around 49 500 km² in southern Queensland and north eastern NSW, with roughly an equal area in each state. The system is based around the Macintyre and Dumaresq rivers, which merge upstream of Boggabilla and continue as the Macintyre River (Figure 1). The Dumaresq River, Macintyre River and the part of the Barwon River downstream of the junction of the Weir River to Mungindi (the end of the Border Rivers system) forms the border between NSW and Queensland for approximately 470 kilometres. The Weir River, wholly in Queensland, is the only significant tributary of the lower Macintyre River.

The headwaters of the Macintyre River are in the Great Dividing Range near Inverell from where it flows in a north-westerly direction. Its main tributary, the NSW Severn River, on which Pindari Dam is located, rises in the elevated region north of Glen Innes. Otleys Creek is the last significant tributary before the Macintyre and Dumaresq rivers merge. To the north east, the Severn River and Pike Creek in Queensland and Tenterfield Creek and the Mole River in NSW join to form the Dumaresq River. The main tributaries of the Dumaresq below this are the Beardy River in NSW and Macintyre Brook in Queensland (Figure 1).

Rainfall in the Border Rivers catchment is summer-dominant and highly variable, resulting in high variable stream flows (refer section 2.1) and timing and pattern of flow events between years.

The major public storages are Pindari Dam on the Severn River in NSW (312 gigalitres (GL)), Glenlyon Dam on Pike Creek in Queensland (254 GL), and Coolmunda Dam on Macintyre Brook in Queensland (69 GL). The volume of on-farm storage is comparable to public storage, reflecting the importance of unregulated flows (opportunistic diversion of river and overland flows) to irrigation supplies in the catchment. On a long term average basis unregulated entitlement (supplementary water licences in NSW and unsupplemented water allocations in Queensland) and diversions in the Border Rivers catchment exceed regulated water entitlements and use.

The lands of the Border Rivers catchment have been important to Aboriginal people for more than 25,000 years. Aboriginal nations retain a connection with the region and their history, culture and livelihoods are closely intertwined with its river systems. Aboriginal nations of the region include the Bigambul, Euahlayi, Githabul, Kambuwai, Gomeroi/Kamilaroi, Kwiambul, and Ngarabal (MDBA 2019a).

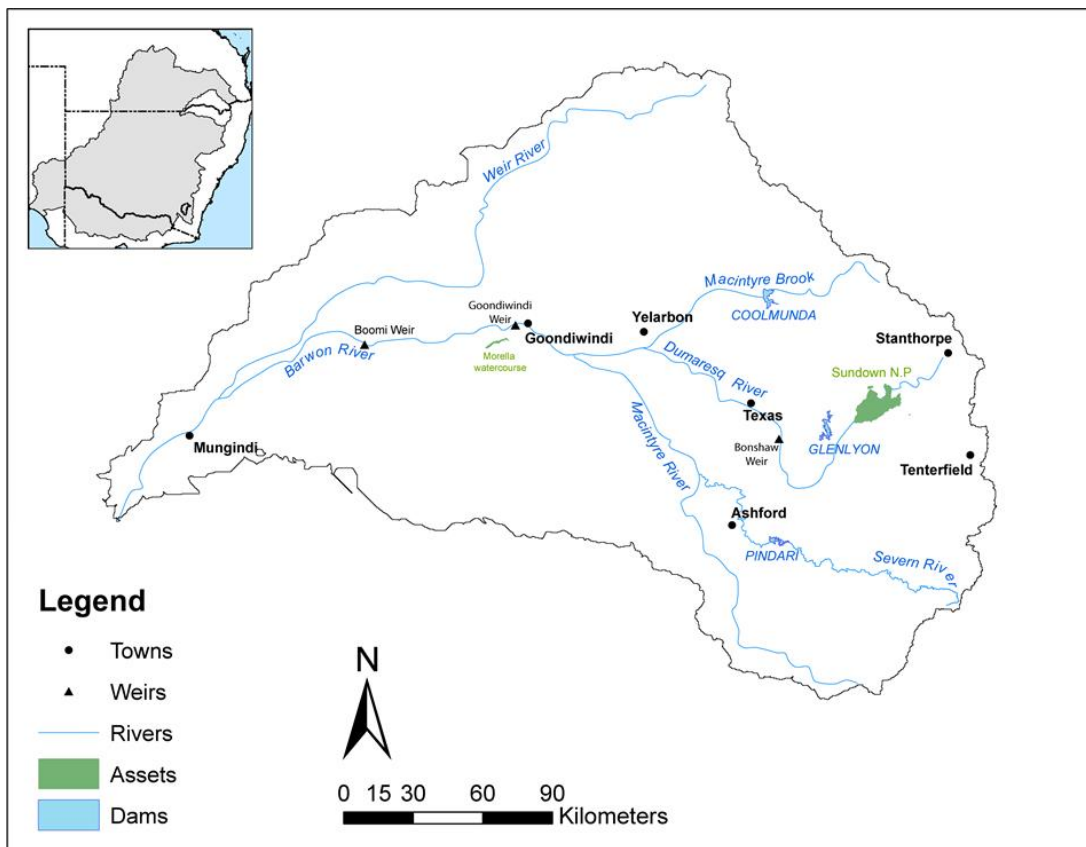


Figure 1: Map of the Border Rivers catchment

1.2. The Border Rivers catchment

The long-term environmental objectives for the Murray–Darling Basin are described in the Basin Plan's environmental watering plan and the Basin-wide environmental watering strategy, which includes 'quantified environmental expected outcomes' at both a Basin-scale and for each catchment. The expected outcomes relevant for the Border Rivers are summarised in Table 1 and described in detail in Attachment A. Parts of the Border Rivers (including natural waterways, lagoons, billabongs, anabranches and floodplains) including the Macintyre River below Graman Weir, Severn River below Pindari Dam and the Dumaresq River below the junction with the Mole River and their associated aquatic biota are included in the 'Endangered Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River' under NSW fisheries legislation (NSW DPI 2007).

The NSW state government is developing a long-term watering plan for the Border Rivers catchment. This plan will identify the priority environmental assets and ecosystem functions in the catchment, the objectives and targets for these assets and functions, and their watering requirements. Once finalised, the plan will provide the key information on the long-term environmental water demands in the catchment. Prior to the development of long-term watering plans and water resource plans, the Commonwealth Environmental Water Office will continue to draw on existing documentation on environmental water demands developed by state governments, local natural resource management agencies and the Murray–Darling Basin Authority.

The Queensland state government has developed a long-term watering plan for the Queensland Border Rivers and Moonie catchments (QDNRME 2019a). The plan identifies the priority environmental assets and ecosystem functions in the catchment, the objectives and targets for these assets and functions, and their watering requirements. The plan is available here:

<https://www.mdba.gov.au/sites/default/files/pubs/Queensland-long-term-watering-plan-border-rivers-moonie-2019.pdf>.

Both the NSW and Queensland long-term watering plans in the Border Rivers form part of draft state catchment based water resource plans (required under the Basin Plan). Each water resource plan sets out the rules for how water is used at a local or catchment level, including new limits on how much water can be taken from the system, how much water will be made available to the environment, and how water quality standards can be met. Basin state governments are responsible for complying with water resource plans and accounting for water taken from the river system (MDBA 2019b). Water resource plans outline how each region aims to achieve community, environmental, economic and cultural outcomes and ensure that state water management rules meet the Basin Plan objectives. The plans reflect current arrangements that are working and include new arrangements that strengthen water management at a local level (MDBA 2019b).

Based on these strategies and plans, and in response to best available knowledge drawing on the results of environmental watering monitoring programs, the objectives for environmental watering in the Border Rivers catchment are summarised in Table 1 below. The objectives for water-dependent ecosystems will continue to be revised as part of the Commonwealth Environmental Water Office's commitment to adaptive management.

Table 1: Summary of objectives being targeted by environmental watering in the Border Rivers catchment

BASIN-WIDE MATTERS (Matters in red link to the Basin-wide Environmental Watering Strategy)	OBJECTIVES FOR BORDER RIVERS ASSETS		
	IN-CHANNEL ASSETS	OFF-CHANNEL ASSETS	
	Severn (NSW and Queensland), Dumaresq, Macintyre and Barwon River	Wetlands, lagoons and billabongs	Anabranches and effluent creeks
VEGETATION	Maintain riparian and in-channel vegetation condition, growth and survival	Maintain and improve wetland vegetation condition, growth and survival in targeted sites. Maintain floodplain vegetation (with use of unregulated holdings and flows).	
WATERBIRDS		Maintain foraging, roosting and breeding habitats at targeted sites on the floodplain to support waterbirds.	
FISH	Provide flows that improve habitat conditions and support different life stages (migration, spawning, recruitment, refuge)	Support natural flow variability and connectivity between the river channel, wetlands anabranches and floodplains	
INVERTEBRATES	Provide habitat (e.g. pools and riffles) and conditions (low flows, pulses, scouring flows) to maintain /improve micro and macroinvertebrate condition and diversity.		
OTHER VERTEBRATES	Provide habitat and conditions to support survival and recruitment of native aquatic fauna (e.g. platypus, native water rat, frogs, turtles)		
CONNECTIVITY	Support longitudinal connectivity in the major streams of the Border, including end of system flows to the Barwon River	Support lateral and longitudinal (anabranches) connectivity between the river and wetlands and floodplains	
PROCESSES	Support primary production, nutrient and carbon cycling and biotic dispersal and movement		
WATER QUALITY	Maintain water quality within channels and pools	Support more natural water temperature, flow regimes and connectivity to support nutrient cycling and water quality benefits	
RESILIENCE	Provide refuge habitat for fish and other aquatic fauna		

Information sourced from: Australian Wetlands (2009), CEWO (2014), Davie and Mitrovic (2014), Kingsford (1999), McGinness and Arthur (2011), MDBA (2012), NSW DPI (2018), NSW DWE (2009a, b), Reid et al. (2015), SKM (2009, 2012), Thoms et al. (2005).

1.3. Environmental flow requirements

Not all environmental demands can and will be met through the use of held environmental water. Some demands are met by regulated water deliveries for consumptive purposes, while others are met by large unregulated/natural flows events or are beyond what can be delivered within operational constraints. Figure shows the broad environmental demands that are in scope for Commonwealth environmental water. Importantly, these are broad, indicative demands and individual watering events may contribute to particular opportunities, such as using infrastructure to deliver water to individual wetlands that would otherwise not be possible due to constraints.

There may be opportunities for Basin State governments to remove or modify constraints, which will improve the efficiency and/or effectiveness of environmental watering. Further information on operational delivery including constraints is described in [Attachment B](#).

Border Rivers – Regulated and unregulated

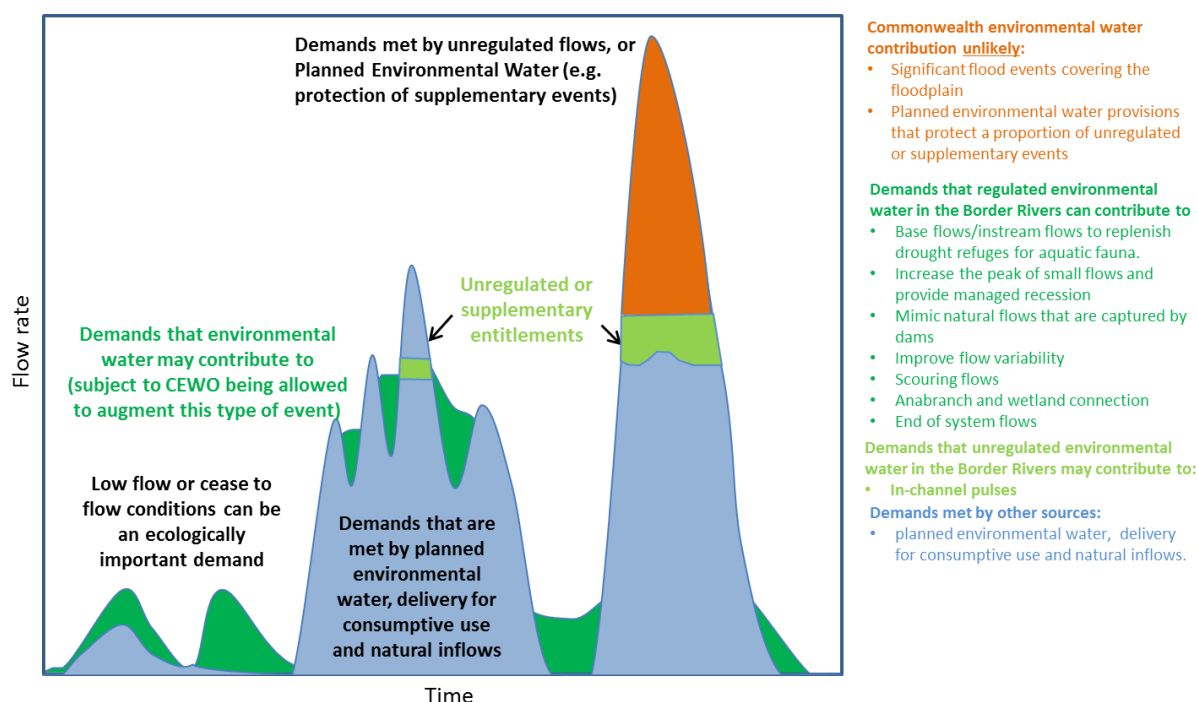


Figure 2: Scope of demands that environmental water may contribute to in the Border Rivers catchment

Based on the above objectives and delivery constraints, specific watering requirements (flow magnitude, duration, timing and frequency) have been identified as being in scope for Commonwealth environmental water. These water requirements are described in Table 3. As with the objectives, the environmental water requirements will continue to be reviewed and revised in response to new knowledge. Through implementation of the their Water Reform Action Plan, the NSW Government is committed to improving the way in which environmental water in the NSW northern Murray–Darling Basin is managed. Consistent with this, current policies relating to the management of environmental flows may change. As with the objectives, the environmental water requirements will continue to be reviewed and revised in response to new knowledge.

2. Portfolio management in 2019–20

In planning for the management of Commonwealth environmental water, the Commonwealth Environmental Water Office aims to maximise the outcomes achieved from the available water. This includes consideration of the urgency of demands (based on targeted objectives and watering requirements, watering history and asset condition) and the available supply under different resource scenarios. Plans for water delivery, trade and carryover are then made in a multi-year context, with an assessment also undertaken of need for water in future years.

This planning process is outlined in full in Table 3 and summarised in the sections below.

2.1. Lessons from previous years

Outcomes from monitoring and lessons learned in previous years is a critical component for the effective and efficient use of Commonwealth environmental water. These learnings are incorporated into the way environmental water is managed.

The Commonwealth Environmental Water Office works with the Murray-Darling Basin Authority, state agencies, research organisations, regional organisations, local groups and others, such as landholders to collect and collate relevant monitoring information and evaluation results that facilitates adaptive management and changing our practices where needed.

This continual review of information and outcomes is helping to build knowledge about the best way to get positive outcomes on a larger scale, based on what works and what doesn't work. Key findings and recommendations from the 2018-19 watering year (and previous years) and the latest monitoring results in the Border Rivers catchment are described below.

A moderately healthy and diverse native fish population exists in the Border Rivers (Dumaresq, Macintyre and NSW Severn river reaches) and is comprised of all Basin Wide Strategy (BWS) listed species, including the threatened Murray cod and silver perch (NSW DPI and QDAF 2019; NSW OEH 2018). The Border Rivers native fish assemblage is considered one of the healthiest native fish populations in the Northern Murray-Darling Basin, particularly for Murray Cod and freshwater catfish (e.g. NSW DPI 2015a, b, c; MDBA 2017; NSW DPI and QDAF 2019).

The release of water for the environment appears to have improved the native fish community in the Border Rivers, including a positive effect on recruitment and the maintenance of habitat and fish communities, with no notably negative impacts apparent (NSW DPI and QDAF 2019). These flows provided increased inundation of key features in all regulated systems of the Border Rivers, whilst also providing greater localised connectivity and movement opportunities for fish (NSW DPI and QDAF 2019). Timing for delivery of these flows needs to consider any potential negative impacts, such as potentially disrupting early spawning seasons for species like Murray cod or affecting water quality through thermal pollution (NSW DPI and QDAF 2019).

Low flow events in the Dumaresq, including water for the environment released in late 2017 inundated a large proportion of key habitat features in the system and contributed to improving overall fish condition in the Dumaresq and Macintyre rivers in early 2018 (NSW DPI and QDAF 2019). Similarly, the release of water for the environment in the Severn in late winter 2017 to prime the system and support movement, habitat inundation, productivity, and recruitment helped lead to an improvement in overall fish condition in late 2017 and early 2018 (NSW DPI and QDAF 2019).

The release of water for the environment in the Severn and Dumaresq rivers during late winter/early spring in 2017 also contributed to specific responses from target species, including:

- Increased numbers of Murray cod young-of-year in both the Macintyre and Dumaresq systems.
- Increased freshwater catfish nests and recruits in both the Dumaresq and Severn rivers, with larval trapping in the Severn River confirming successful breeding with freshwater catfish larvae caught.
- The abundance of unspotted hardyhead and Murray-Darling rainbowfish increased in seasons following the release of water for the environment.
- The release of water for the environment during the sampling period also benefited carp gudgeon, and although populations for this species were highly variable, improved spawning and recruitment responses were observed following flow events.
- There was also an absence of carp recruits over the four years of monitoring; suggesting conditions were not suitable for the breeding and/or recruitment of this species during the sampling period (NSW DPI and QDAF 2019).

While the Macintyre and Dumaresq fish communities are relatively similar, the NSW Severn has a distinct fish assemblage including silver perch (absent from the Dumaresq and Macintyre) and some Murray cod, but a lack of small-bodied fish species. The Severn also has a lack of recruitment among all species, although spawning aggregations of silver perch may have occurred in 2017 (NSW DPI and QDAF 2019).

The unregulated Weir River in the Border Rivers catchment also has relatively healthy spawning and recruitment of golden perch largely absent from other areas in the Border Rivers (QDERM 2010, QDNRME 2018). The Dumaresq also supports populations of threatened small-bodied species including olive perchlet and purple-spotted gudgeon, however suitable sites for spawning and recruitment of these species in the Dumaresq may be limited (Kerr et al. 2017; Kerr and Prior 2018).

Release of held environmental water outside of peak spawning and recruitment periods can still have important environmental outcomes for native fish in the Border Rivers during extreme dry periods, including better water quality, access to in-channel habitats, food sources and providing some opportunity to escape from isolated waterholes. Recent learnings from water management in the Border Rivers and connection with the downstream Barwon-Darling also suggest that:

- The water needed to replenish waterholes and allow for seepage is much greater if a river has ceased-to-flow and antecedent conditions are dry, compared to when a river is still flowing.
- Within-catchment water requirements need to be balanced with broader system needs when environmental water availability is low.
- Travel times for regulated releases from storage need to be considered when coordinating flows between systems.
- Any future operational protocols and systems to better manage environmental flows should be practical and workable. The Northern Connected Event in 2017-18 and the Northern Fish Flow in 2018-19 have highlighted the importance of coordinated flow delivery and protection of environmental flows. The NSW and Commonwealth governments are addressing this through implementation of the NSW Water Reform Action Plan, including recent (2018) amendments to the NSW Water Management Act Section 324 provisions. These amendments clarify that 'managing water for environmental purposes' is within the scope of the existing public interest test in relation to making temporary water restriction orders. Improvements to metering and hydrometric systems are also likely, which would underpin the implementation of sound operational protocols.

There are also some opportunities arising through recent and current monitoring and management activities in the Border Rivers, including:

- Opportunities to better understand refuge pool persistence and their function, water quality and supported fish communities/assemblages in the Dumaresq, Severn and Macintyre under different climate scenarios (building on habitat mapping projects in the Dumaresq and Severn completed by DPI Fisheries in NSW (NSW DPI and NTLLS 2015, 2018). DNRME (Queensland) has done some work on waterhole persistence in Queensland MDB catchments (e.g. the Moonie) (QDES 2018).
- An opportunity to investigate whether infrastructure-assisted delivery into Morella Pungbougul and Boobera Lagoon systems (if agreed with landholders and under a wetter scenario/ higher water availability) is feasible and possible environmental/cultural outcomes.

The outcomes from these monitoring activities are used to inform portfolio management planning and adaptive management decision-making.

2.2. Antecedent and current catchment conditions and the demand for environmental water in 2019–20

In 2018-19, the Border Rivers experienced below average rainfall with some areas in the Queensland catchment experiencing the lowest rainfall on record (BOM 2019a; Figure 3). The Border Rivers also experienced mean above average daily temperatures and in some areas the highest temperature on record (BOM 2019b, c, d; Figures 4 and 5). The most significant rainfall periods were in October and November 2018 and March 2019 (BOM 2019e, f). The soil moisture in the Border Rivers at the end of 2018-19 is very low, with some regions in the lowest 1% on record, very much below average or below average (Figure 6).

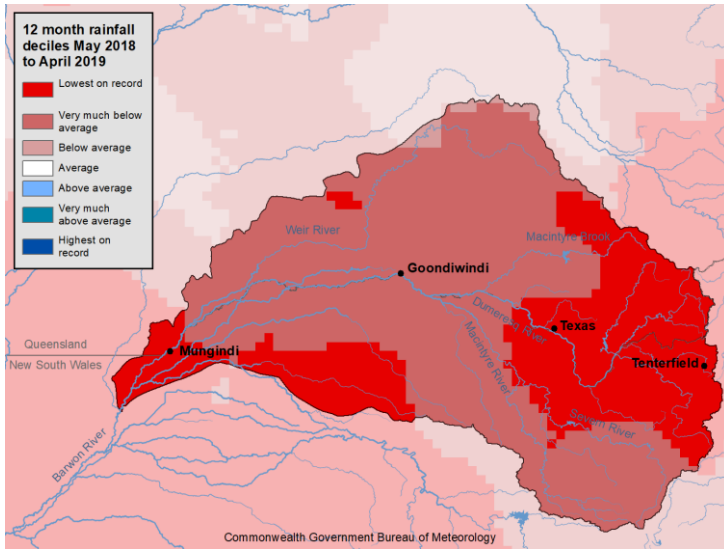


Figure 3: 12 month rainfall deciles for the Border Rivers (May 2018-April 2019) (source Commonwealth Government Bureau of Meteorology)

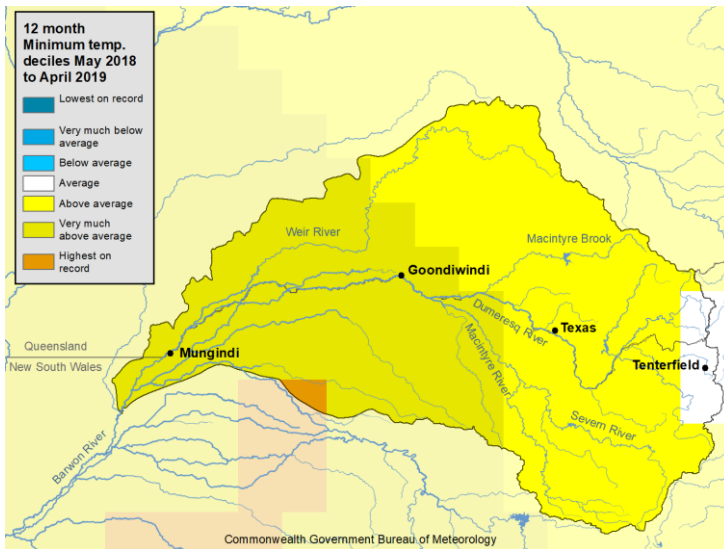


Figure 4: 12 month minimum temperature deciles for the Border Rivers (May 2018 to April 2019) (source Commonwealth Government Bureau of Meteorology)

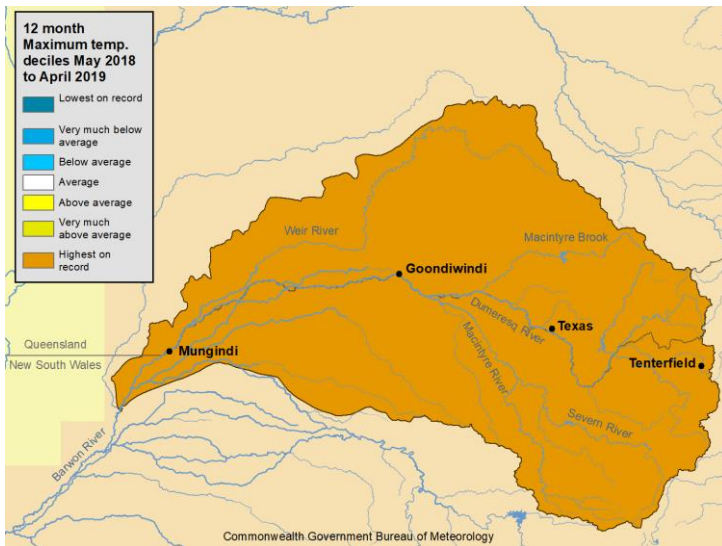


Figure 5: 12 month maximum temperature deciles for the Border Rivers (May 2018 to April 2019) (source Commonwealth Government Bureau of Meteorology)

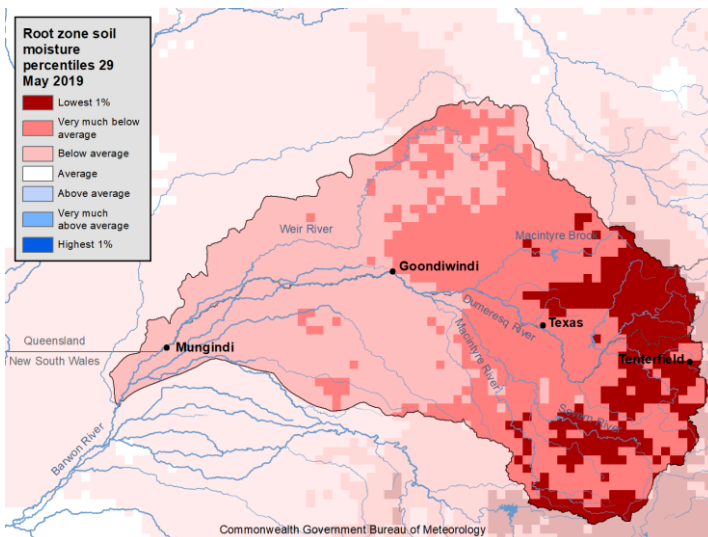


Figure 6: Root zone soil moisture profiles for the Border Rivers (29 May 2019) (source Commonwealth Government Bureau of Meteorology)

The Dumaresq River had a series of small in-channel pulses early in the water year, largely base flow conditions from September to November and small pulses through the summer. There was another small pulse created by the Northern Fish Flow (peaking at around 600 ML/day at Roseneath for around seven days and 520 ML/day at Glenarbo for around three days) in May 2019 but flows have now returned to very low flow conditions.

The NSW Severn (gauged at Ducca Marrin) was largely at very low flow or base flow conditions for July before small pulses and large pulses in Spring and early summer, dropping to small pulse and base flows and very low flow levels in late summer and autumn/winter.

The Macintyre River at Goondiwindi had small pulses in late winter and spring, large pulses in early summer and small pulses in late summer/early March. There was another small pulse in early May 2019 (peaking at round 335 ML/day for one to two days) due to the Northern Fish Flow). The Weir River had small flow events in October and November, with a larger event in late March and early April. End of system flows at Mungindi have been at low flow/very low levels for much of the water year. The Northern Fish Flow arrived at Mungindi on 23 May (peaking at around 181 ML/day on 24 May 2019).

In 2018-19 Commonwealth environmental water has been used to support important environmental assets, including threatened and BWS listed fish species, in-stream aquatic habitat and drought refugia in reaches of the Border Rivers downstream of Glenlyon Dam. Deliveries in late April and May 2019 as part of the Northern Fish Flow contributed to partially meeting downstream environmental demands (base flows) at Mungindi and also provided maintenance and conditioning flows for native fish populations in the Dumaresq River reach and downstream NSW Macintyre (CEWO 2019a-f). There were no deliveries of Commonwealth environmental water to the Severn in 2018-19, however flows in Spring 2017 supported reproduction success in the NSW Severn and Dumaresq river reaches. The catchment as a whole is still recovering from prolonged periods of restricted flows over the last 15 years, with the majority of asset demands needing further protection in 2019-20 and in future years.

The Murray-Darling Basin Authority's 2019-20 environmental watering outlook and annual watering priorities have assessed the Border Rivers water resource availability scenario as 'very dry' (MDBA 2019a,b).

Environmental water demands for environmental assets in the Border Rivers catchment in 2019-20 are represented in Table 3 and are summarised below:

River channel: High demand for replenishment flows in the Dumaresq, NSW Severn and lower Macintyre river reaches to maintain in-stream habitat during low to no flow conditions. New low flow/flow variability environmental demands have been developed for the Glenarvon gauge on the Dumaresq and Ducca Marin on the Severn. The low flow end of system target at Mungindi has also been amended (triggers: cease to flow (<20ML/d) for more than 25 days at Glenarvon or Ducca Marin and for more than 30 days at Mungindi). These changes are based on experiences in 2018-19 under extreme dry conditions and discussions with state partner agencies. If insufficient water is available to meet this demand once triggered, other 'complementary actions' may be required such as enhanced water quality and/or aquatic biota monitoring.

Moderate demand for small in-channel pulses in the Dumaresq and Macintyre systems to support spawning and recruitment of in-channel specialists (Murray cod and freshwater catfish) including a winter priming flow and spring spawning event. Moderate demands for small in-channel pulses in the Dumaresq and Macintyre to promote spawning and recruitment of flow-dependent specialists (golden and silver perch) in October to April. This demand is moderate to high in the NSW Severn due to populations of the threatened silver perch being present. Moderate to high demand for a large pulse in the lower Macintyre River to provide access for juvenile fish to a range of habitats, including connectivity to low level wetlands to bring nutrients and carbon into the main river channel. Moderate need for stable low flows in the Dumaresq (Oct-December) to support stable low spawning fish (including the endangered olive perchlet and purple-spotted gudgeon), and high to critical need for stable low flows during spring in the NSW Severn and Macintyre systems. Moderate demand for large pulses in the Dumaresq and Macintyre systems to provide for scouring, connection of riparian areas and longitudinal connectivity. Moderate to high demand for a large in-channel pulse in the Macintyre through to the end of the system (4,000 ML/day at Mungindi for minimum 5-11 days) Inundate key habitat (large woody debris), support key ecosystem functions (nutrient, sediment and carbon cycling) and support recruitment opportunities for a range of native aquatic species (fish, frogs, turtles and invertebrates). Meeting most of these demands requires other flows in the system. The higher flow demands in the Dumaresq and Macintyre will only be met if there are suitable unregulated flows as there is insufficient regulated environmental water to drive these. Demand in the lower Macintyre are high as the required frequency for a large in channel pulse (biennial) has not occurred for over six years.

Anabranches: Moderate / high to high demand. Anabranch connection would support floodplain vegetation and to improve wetland health and exchange of nutrients and carbon to support productivity in the system. Lower Macintyre River anabranches have had limited connection since 2013 due to flows in the main river being limited to low magnitude, short duration events. However, there is unlikely to be sufficient environmental water to uniformly support anabranches through river channel flows, and there is uncertainty about required frequency and protection of in-stream flows through these watercourses. Therefore, should it be possible to contribute to these demands in 2019-20, watering is likely to be limited to infrastructure assisted delivery to targeted anabranch(es) with known high demand where multiple environmental benefits, such as fish and riparian/wetland vegetation, can be achieved.

Wetlands: Low to high demand. High for wetlands that are isolated from natural flows as a result of resource development, such as certain Morella watercourse lagoons south of Goondiwindi. These demands have become critical as not met in 2017-18. Requirements could potentially be met through targeted infrastructure assisted delivery in 2019-20 or coming years as a pilot following consultation. Moderate for other wetlands between Goondiwindi and Boomi, as these areas have been inundated after three years without in-flows. Some wetlands require filling and reconnection with the main river on a regular basis to support wetland health and resilience, exchange of nutrients, carbon and biota (particularly lateral movement of fish) and wetland vegetation. Low to moderate demand is also likely for near channel wetlands on the lower Dumaresq River, given that demands were partially met with Commonwealth environmental water delivery in autumn 2018 and flows inundating >30% of wetlands were also received early 2018 (>1,040 ML/day) and early 2019. A contribution to meet demands in the lower Macintyre River is likely to require using available holdings and temporary water to increase the protection of a flow event in the target reach of the river. Wetlands in the NSW Severn River have low demand as these have been watered for the last six years through unregulated flows, irrigation deliveries and stimulus flows.

Barwon-Darling: There is a growing awareness of the importance of connecting flows across the northern Basin, to support habitat, water quality, native fish and other aquatic species in the Barwon-Darling and its tributary systems, including the Border Rivers. Subject to antecedent conditions, water availability, and urgency of environmental demands, there may be opportunities to coordinate releases across multiple rivers in the northern Basin to meet broader environmental demands. The environmental demands in the Barwon-Darling are described in the *Commonwealth Environmental Water Portfolio Management Plan: Barwon-Darling 2019–20*.

Murray–Darling Basin-wide environmental watering strategy and 2019–20 annual priorities

The Murray-Darling Basin Authority publish the Basin annual environmental watering priorities each year and have published multi-year priorities since 2017-18. Commonwealth environmental water in the Border Rivers catchment will contribute to the following multi-year environmental watering priorities and the 2019-20 Basin annual environmental watering priorities.

Rolling, multi-year priorities

The rolling, multi-year priorities for river flows and connectivity are to:

- Support lateral and longitudinal connectivity along the river systems.

The rolling, multi-year priorities for native vegetation are to:

- Maintain the extent, improve the condition and promote recruitment of forests and woodlands.
- Maintain the extent and improve the condition of lignum shrublands.

The rolling, multi-year priorities for waterbirds are to:

- Improve the abundance and maintain the diversity of the Basin's waterbird populations.

The rolling, multi-year priorities for native fish are to:

- Improve flow regimes and connectivity in northern Basin rivers to support native fish populations across local, regional and system scales.
- Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations.

2019-20 Annual Priorities

There are no specific 2019-20 Basin annual environmental watering priorities relevant to the Border Rivers catchment, however proposed watering activities are consistent with Queensland DRNME's draft 2019-20 watering priorities for the Border Rivers and Moonie areas, including:

- River flows and connectivity with the Barwon-Darling (in the event of rainfall and subsequent flows in tributaries flowing into the Barwon).
- Macintyre River Billabongs downstream of Goondiwindi which support vulnerable bird species including brolgas, black-necked storks and magpie geese (in the event of natural flows in the Macintyre River and/or waterways upstream)
- Native fish – small flows in the Dumaresq River providing fish opportunities to move longitudinally, stable low flows in warmer months to benefit small-bodied fish spawning and recruitment, flows large enough to enter off-stream wetlands (e.g. Macintyre River Billabongs) benefiting specialist fish that use these areas for breeding purposes.
- Vegetation – low flows in the Dumaresq to benefit instream vegetation used by small-bodied fish for breeding purposes. Higher flows that can enter the Macintyre River Billabongs to benefit instream and fringing wetland vegetation (QDNRME 2019b).

2.3. Water availability in 2019–20

Forecasts of Commonwealth water allocations

The volume of Commonwealth environmental water likely to be carried over in the Border Rivers catchment for use in 2019–20 is estimated to be 2,193 ML.

Allocations against Commonwealth water entitlements in the Border Rivers are determined by state governments and will vary depending on inflows. The following forecasts in Table 2 are based on the best available information including State forecasts and historical inflow scenarios.

Table 2: Forecasts of Commonwealth water allocations (including carryover) in 2019–20 in the Border Rivers as at 31 May 2019.

Entitlement type	Forecasts of Commonwealth water allocations (including carryover) in 2019–20 (GL)					
	Very dry ← → Very wet					
	95 percentile	90 percentile	75 percentile	50 percentile	25 percentile	10 Percentile
Supplemented (Queensland) – medium	2	2	2	2	2	3
General Security (NSW)	0.9	0.9	1.0	1.0	1.1	1.2
Total – Border Rivers	2.9	2.9	3.0	3.0	3.1	3.2
Unsupplemented (Queensland)	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL
Supplementary(NSW)	Up to 1.4 GL	Up to 1.4 GL	Up to 1.4 GL	Up to 1.4 GL	Up to 1.4 GL	Up to 1.4 GL

Information on allocations to Commonwealth environmental water holdings can be found at <http://www.environment.gov.au/water/cewo/portfolio-mgt/holdings-catchment> and is updated monthly.

Water resource availability scenarios

Commonwealth environmental water is not managed in isolation. When considering the available resource to meet environmental demands, it is necessary to also factor in the resources managed by other entities and available to contribute to environmental objectives. Relevant resources include planned environmental water, natural and unregulated flows, conveyance water and consumptive water. Further detail on sources of environmental water in the Border Rivers Catchment is provided in Attachment C.

By combining the forecasts of water held by the Commonwealth with streamflow forecasts, as well as taking into account operational considerations, water resource availability scenarios can be developed ranging from very low to very high. Based on available information moderate to low resource availability scenarios are in scope for 2019-20. Moderate resource availability would require at least median rainfall and inflows. The Border Rivers carryover is moderate. Catchment has been experiencing dry conditions. Allocations are not predicted to improve without median rainfall and inflows. If dry conditions continue, water resource availability is likely to trend towards low. No reliable seasonal streamflow data available from Bureau of Meteorology.

The Border Rivers catchment in both NSW and Queensland is facing significant water shortages for all water types. (As of May 2019) Glenlyon Dam was at 9% capacity and Pindari Dam at 6% (NSW DOI 2019). The Border Rivers (and a number of other catchments in the Murray-Darling Basin) are being managed according to the drought stages in the NSW Extreme Events Policy (NSW DOI 2018). The NSW Border Rivers catchment is currently in Stage 3 drought conditions (severe water shortages) under the Extreme Events Policy (NSW DOI 2019). Should conditions worsen to Stage 4 drought conditions, there may be partial or full suspension of water sharing rules. The Extreme Events Policy and NSW Border Rivers draft Incident Response Guide identify critical human water needs as the highest priority under extreme conditions, with water for the environment as the second priority and a number of critical environmental values also identified. Further consideration is needed on how to maximise environmental outcomes from any water releases to meet critical human water needs; and which environmental assets should be prioritised if the catchment moves to Stage 4 water shortages in 2019-20 or beyond.

2.4. Overall purpose of managing environmental water based on supply and demand

Environmental water needs (demand) and water availability (supply) both influence the overall purpose of Commonwealth environmental water management. Under different combinations, the management purpose can range from 'avoiding damage' to the environment to 'improving' ecological health. This in turn informs the mix of portfolio management options that are suitable for maximising outcomes. Figure 7 shows how current demands and forecasted supply are considered together.

The overall 'purpose' for managing the Commonwealth's water portfolio in the Border Rivers catchment for 2019-20 is to **avoid damage** to environmental assets including in-channel habitats, drought refugia and fish condition and resilience in the Dumaresq and Lower Macintyre (downstream of Glenlyon to Boggabilla) and NSW Severn (downstream of Pindari Dam). If resource availability becomes very high there may be scope to **protect and ensure ecological capacity for recovery** of these assets. A secondary aim is to maintain the health and resilience of selected key wetlands and anabranches.

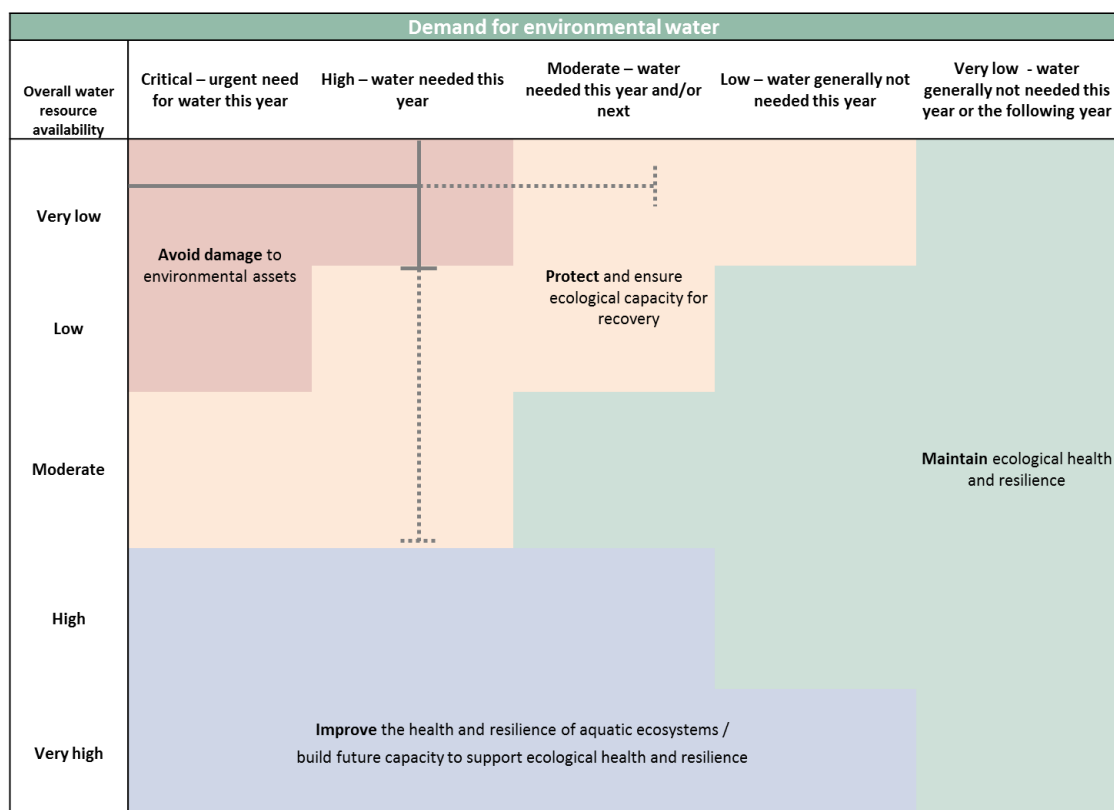


Figure 7: Determining a broad purpose for portfolio management in the Border Rivers catchment for 2019–20. Note: grey lines represent potential range in demand and water resource availability.

Further detail on how the overall purpose for portfolio management changes under different supply and demand scenarios is provided in *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2019–20* (available at: <http://www.environment.gov.au/water/cewo/publications>).

2.5. Water Delivery in 2019–20

Consistent with the demands and purpose described above, the Commonwealth Environmental Water Office is considering supplying environmental water to the following watering actions for 2019–20 (see also Table 3 for supporting information regarding the basis for determining these watering intentions).

Under a very low resource availability scenario, the focus of environmental watering in the Border Rivers in 2019–10 is to maintain in-channel habitat in reaches immediately below Glenlyon and/or Pindari dams. A watering action to replenish refuge pools and improve water quality in reaches immediately downstream of Glenlyon and Pindari dams. If there are no inflows to either Glenlyon or Pindari over the coming months this will likely be constrained to delivery with town water supply (e.g. Texas/Goondiwindi). The likely downstream extent of these replenishment flows would be to Boggabilla given expected high losses under dry conditions.

Going into 2019–20, the following options are priorities based on antecedent conditions; if there is a sufficient increase in water availability and in some cases flow events that can be added to:

- A peak priming pulse in the NSW Severn River to support reproduction opportunities for silver perch.
- Stable flows in the Dumaresq and Severn rivers to support reproduction, conditioning and movement opportunities for other native fish communities, including Murray cod, freshwater catfish, purple-spotted gudgeon and olive perchlet.
- Anabranch connectivity to improve inflows into key anabranches to protect environmental assets and functions in these watercourses and the benefits of anabranch connectivity to the main river system (nutrient and carbon transfer, movement, spawning and reproduction of fish and other aquatic species).

- In the event that conditions become much wetter with improved resource availability, larger unregulated flow events in the system could provide opportunity to support additional outcomes:
- Contribute to a large in-channel pulse through to the end of the system to improve the health and resilience of in and near channel flora and fauna. The flow would aim to improve availability of habitat for fish and other aquatic organisms, initiate significant transfer of nutrients and carbon and provide movement, spawning and recruitment opportunities for fish.
- Contribute to a large in-channel pulse to improve the health and resilience of riparian and near channel wetlands and in-stream processes in the Dumaresq River. The flow would connect to and support vegetation and primary productivity in these areas. In the channel, flows would scour algae and reset biofilm processes to stimulate the aquatic food chain and provide movement, spawning and recruitment cues to native fish.

Stakeholder Feedback.

Feedback on environmental demands and priorities in 2019-20 for the Border Rivers were sought from partner agencies including NSW OEH, DPI Fisheries, NSW DOI Water and Queensland DRNME. There was general support for the actions proposed in the Portfolio Management Plan, with recommendations including greater consideration of assets, risks and management strategies identified in water resource plans and long-term watering plans (to be addressed once these are finalised in 2020-21), more explicit consideration of extreme events and environmental water coordination and governance arrangements and need for better understanding of drought refuge persistence.

2.6. Trading water in 2019–20

The Water Act 2007 requires the Commonwealth Environmental Water Holder to trade for the purpose of protecting and restoring the environment. In addition to the obligations of the Water Act 2007, the Commonwealth Environmental Water Holder and Commonwealth Environmental Water Office staff are required to comply with a wide range of existing legislative requirements.

This includes: financial management arrangements for Commonwealth agencies; freedom of information; and policies relating to information management, auditing, employee conduct and accountability.

Planning on water trade considers supply and demand within the catchment and across the Basin. As part of the planning process, the Commonwealth Environmental Water Office undertakes a Basin-wide analysis to identify opportunities to use allocation trade to better match differing demands across catchments. Consideration is given to the water available to meet both current and future environmental needs. Additionally these decisions are influenced by current climatic conditions, as well as implications of trade for commercial outcomes in communities.

Large parts of the Northern Basin are currently experiencing pressures from water scarcity, with low storage levels and rainfall deficiencies evident in most northern catchments. It is likely that insufficient water resources will be a major constraint on achieving proposed actions however acquisition to meet environmental needs is unlikely to be feasible until water availability improves. Significant rainfall is required to break the drought and shortfalls in reserves need to be captured in storage before new allocations can be made.

No specific trade of water in the Border River Valley has been identified for 2019-20. Trade opportunities will be reviewed in the valley throughout the water year and as conditions change. Further information will be provided to the market ahead of any trade of Commonwealth environmental water at:

<http://www.environment.gov.au/water/cewo/trade>

For more information on the rules and procedures governing the trade of Commonwealth environmental water, see the Commonwealth environmental water Trading Framework available at:

<http://www.environment.gov.au/water/cewo/publications/water-trading-framework-nov2016>

2.7. Carrying over water for use in 2020-21

Regulated entitlements in all Border Rivers water supply schemes are managed on a continuous accounting (and continuous sharing in Queensland schemes) basis. Any unused water held in accounts can be carried over to the following year. However, account limits apply that limit carryover and use.

- For the Queensland (Glenlyon) scheme, where the majority of Commonwealth regulated entitlement is held, a maximum of 85 per cent of entitlement volume can be held in accounts at any point in time and a maximum of 100 per cent can be distributed to accounts in any year.
- For NSW general security entitlements the instantaneous account limit is 100 per cent of entitlement volume.
- The Queensland Macintyre Brook scheme allows for more than 200 per cent of entitlement volume to accrue in accounts over time.
- The annual usage limit in all three schemes is 100 per cent of the entitlement volume.

The volume of water carried over for use in 2020-21 will depend upon resource availability and demand throughout the year. Commonwealth environmental water in the Border Rivers may be carried over to 2020-21 if it is not required for priority in-channel actions in 2019-20 in the Dumaresq and lower Macintyre rivers, or if trigger conditions (primarily the presence of other flows) for these actions are not met.

As documented in Table 3 below, potential demands in 2020-21 include:

- Flow to top up drought refuges downstream of major storages (Glenlyon and Pindari) (similar to likely watering actions in 2019-20 and the Northern Fish Flow in 2018-19) seeking to avoid damage to the fish communities in these areas.
- Late winter or spring flows for fish conditioning and/or breeding purposes in the upper Border Rivers.
- Flows into anabranches to protect their environmental values until reconnection to the main channel.
- Flows to connect with riparian areas and near channel wetlands in the lower Dumaresq and lower Macintyre rivers.
- Wetlands with high commence to fill levels in the lower Macintyre that have not received inflows for more than seven years.
- Flows < 2 000 ML (150 ML to 300 ML over 5-7 days) to top up refuge pools and improve water quality through to the end of the system, if prolonged dry conditions prevail in the later part of 2019-20.

Carryover volumes will be adjusted throughout the year as the season unfolds in response to both current and future demands and the water available to meet these demands. Carrying water over for maintaining drought refuges will be considered. These decisions will be based upon best information available at the time.

More information on how the Commonwealth makes decisions on carryover is here:

<http://www.environment.gov.au/water/cewo/portfolio-mgt/carryover>

2.8. Identifying Investment Opportunities

Under the *Water Act 2007*, the Commonwealth Environmental Water Holder has the flexibility to use the proceeds from the sale of water allocations to fund environmental activities in the Basin.

'Environmental activities' must be consistent with the Commonwealth Environmental Water Holder's obligation to exercise their function to protect and restore environmental assets. Environmental activities must also improve the capacity of the Commonwealth Environmental Water Holder to meet the

objectives of the Basin Plan environmental watering plan, and be directly linked to current or future delivery of water for the environment.

The option of investing the proceeds in environmental activities will be considered alongside other available water management options, such as purchasing water at another time or place.

The Commonwealth Environmental Water Holder is finalising an Investment Framework and an Annual Investment Plan to inform future investment in environmental activities.

Table 3: Environmental demands, priority for watering in 2019–20 and outlook for coming year in the Border Rivers catchment (whether any can be met depends on water availability)

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2019–20		Implications for future demands
	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely environmental demand in 2020–21 if watering occurred as planned in 2019–20
Border Rivers main channels: Dumaresq, Severn (NSW), Macintyre, lower Macintyre to Mungindi (including Weir River) • Native fish reproduction, conditioning and maintenance. Fish resilience, maintain in-channel habitats during low flows, water quality and longitudinal connectivity. • Instream aquatic ecosystem processes e.g. scouring habitat inundation	Base flow, flow variability and connectivity in Dumaresq and/or Macintyre Rivers^{1,2}. <u>Dumaresq</u> 100 ML/day at Glenarbon. Duration/volume dependent on required outcomes (e.g. 7 days between September and March in 1 in 1-2 years (75%)) to provide connectivity between pools and riffles and along channels, sufficient depth for fish movement within reaches) (NSW OEH 2018) <u>Severn/Macintyre Rivers</u> 50 ML/day at Ducca Marrin. Duration/volume dependent on required outcomes(as above) <u>Lower Macintyre River</u> 400 ML/day at Mungindi for connectivity. Duration/volume dependent on required outcomes (as above).	As required in extreme dry conditions or to provide variability. Potential triggers extended cease-to-flow: <20 ML/day for more than 25 days gauged at Glenarbon(Dumaresq) and/or Ducca Marrin (Severn) impacting on persistence of larger waterholes in the Dumaresq or Severn) To provide variability (triggers: cease to flow (<20ML/d) for more than 30 days at Mungindi) (MDBA 2018)	<u>Dumaresq and Severn:</u> Demand met annually since 2012. Required annually – therefore a high demand. <u>Lower Macintyre:</u> Demand met annually 2012-2017-18 with exception of 2014–15. Demands not met 2018-19. Required annually – therefore a high demand.	High	A high priority for watering in 2019–20, even in low resource availability.	High (Critical for lower Macintyre)
	Fish spawning/recruitment flow targeting long-lived in-channel specialist species Small in-channel pulse for 14 – 34 days <u>Dumaresq River</u> Spawning – 515 to 1,040 ML/day at Roseneath for minimum 14 days Recruitment – 340 to 600 ML/day at Roseneath for minimum 20 days <u>NSW Severn / Macintyre rivers</u> Priming pulse – initial peak of 2,000 ML/day @ Ducca Marrin followed by recession (duration variable) <u>Lower Macintyre River</u> Large scale spawning and recruitment aligned with large unregulated pulse in the Weir River post winter (at least 2m rise and water temp > 23c)	8 in 10 years July–Aug (Priming pulse before spawning and recruitment) Aug–Oct (Peak recruitment season for Murray cod and freshwater catfish)	<u>Dumaresq River and NSW Severn/Macintyre</u> Demands not met 2012-2015, met 2015-16 to 2017-18. Not achieved in 2018-19. Moderate demand 2019-20, becoming moderate to high in 2020-21 if not met in 2019-20. <u>Lower Macintyre River</u> Met 2015-2017. Not met in 2017-18 or 2018-19. Moderate to high demand 2019-20, becoming high in 2020-21 if not met in 2019-20.	Moderate	Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate-high resource availability); or water demand likely to met by other means.	Moderate to High (High For Lower Macintyre)

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2019–20		Implications for future demands
	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely environmental demand in 2020–21 if watering occurred as planned in 2019–20
	Fish spawning / recruitment flow targeting long-lived flow dependent specialists Small to medium in-channel pulse for at least 3 days <u>Dumaresq River / NSW Severn / Macintyre rivers</u> Flow height with at least a 2m rise and water temp > 23c) Duration and volume unknown <u>Lower Macintyre River</u> Large scale spawning and recruitment aligned with large unregulated pulse in the Weir River post winter (at least 2m rise and water temp > 23c) Consideration to contribute is higher if optimal pre-spawning conditions – first post-winter pulse	8 in 10 years ^{15,16} Oct–April ¹⁸ (Recruitment season for silver and golden perch)	<u>Dumaresq and NSW Severn / Macintyre rivers</u> Not met 2012-2015, achieved 2015-18. Not achieved 2018-19. Moderate to high demand in 2019-20, becoming high in 2020-21 if not met in 2019-20. <u>Lower Macintyre River</u> Demand met 2015–16 and 2016–17. Not met 2018-19. Moderate to high demand in 2019-20, becoming high in 2020-21 if not met in 2019-20.	Moderate to High	Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate-high resource availability); or water demand likely to met by other means.	High
	Fish condition and maintenance flow targeting long lived in-channel specialists and flow-dependent fish guilds Large in-channel pulse for minimum 5 days <u>Dumaresq River</u> Up to 2,300 – 6,250 ML/day at Roseneath <u>NSW Severn / Macintyre rivers</u> Peak up to 2,000 ML/day at Ducca Murrin <u>Lower Macintyre River</u> Natural inflows in the lower Macintyre River reach, including Weir river. Optimal flow height, duration and volume unknown.	1 in 1 to 2 years (Maximum dry interval unknown) June–July (Pre-spawning conditioning) March–May (Pre-winter maintenance)	<u>Dumaresq River</u> Not met 2018-19. Moderate demand (becoming moderate to high 2020-21 if not met in 2019-20). <u>NSW Severn / Macintyre rivers</u> Met 2015-2018. Demand not met 2018-19. Moderate demand (becoming moderate to high 2020-21 if not met in 2019-20). <u>Lower Macintyre River</u> Not met since 2017. Moderate to high demand (becoming high 2020-21 if not met in 2019-20).	Moderate	Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate-high resource availability); or water demand likely to met by other means.	Moderate to High (Dumaresq and NSW Severn/Macintyre) High (lower Macintyre)
	Fish movement, spawning / reproduction / recruitment flows targeting short lived stable low flow spawning fish species Stable low flow for 7–60 days (spawning*/reproduction / recruitment) * A minimum stable low flow 7–21 days needed for spawning <u>Dumaresq River</u> Up to 100 ML/day at Roseneath <u>NSW Severn and Macintyre rivers</u> 50 ML/day at Ducca Marrin	1 in 1 to 2 years (low uncertainty) Up to 3 years (high uncertainty) Sept–Dec (Peak spawning season for olive perchlet, includes purple-spotted gudgeon)	<u>Dumaresq River</u> Met 2015-16, 2016-17 and 2018-19. Moderate demand (becoming moderate to high 2020-21 if not met in 2019-20). <u>NSW Severn and Macintyre rivers</u> Stable flows not met 2015-19. High demand (becoming high to critical 2020-21 if not met in 2019-20).	Moderate		Moderate to High
				High to critical	Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate-high resource availability); or water demand likely to met by other means.	

	Scouring, inundate inter-connected riparian areas and improved longitudinal connectivity for fish movement, (including maintenance and conditioning) of all native species Large in-channel pulse (Aug– Dec) <u>Dumaresq River</u> Peak between 6,250–19,000 ML/day at Roseneath <u>NSW Severn and Macintyre rivers:</u> Flows > 2,000 ML/day to change periphyton species 4 000–16 000 ML	<u>All reaches</u> Up to 3 years for scouring (Maximum dry interval unknown) Anytime (only if naturally occurring)	<u>Dumaresq River</u> Achieved 2016-17, not achieved 2017-18 or 2018-19. Assessed as moderate for 2019-20, moving to moderate to high in 2020-21 if not achieved in 2019-20. <u>NSW Severn and Macintyre rivers</u> Achieved in 2016-17, 2017-18 and 2018-19. Need assessed as low.	Moderate	Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate-high resource availability); or water demand likely to met by other means.	Moderate to high
				Low		Low
	Inundate key habitat (large woody debris), support key ecosystem functions (nutrient, sediment and carbon cycling) and support recruitment opportunities for a range of native aquatic species (fish, frogs, turtles and invertebrates) Large in-channel pulse 4,000 ML/day at Mungindi (end of system) for a minimum 5–11 days	1 in 3 to 4 years (Maximum dry interval of 7-14 years) Oct –Dec (inundate habitat) 1 in 2 to 3 years (Maximum dry interval of 6-8 years) Oct – Mar (support key ecosystem functions) Occur twice a year every 1 in 3 to 4 years (maximum dry interval unknown) Oct –Dec (needs of threatened native fish)	Last met 2016 (not met 2013, 2014 or 2015). Not met 2017-18 or 2018-19. Environmental demand moderate to high (moving to high if not met in 2019-20) Last met 2012–13. Environmental demand high (moving to high to critical if not met in 2019-20)	Moderate to high	Unable to receive Commonwealth environmental water due to constraints without exceeding channel capacity	High to critical
				High		
Anabranches downstream of Yetman/Texas <ul style="list-style-type: none"> Nutrient and carbon cycling, enhanced primary production. Support fish movement and condition. 	Infrastructure assisted watering to provide connection to disconnected anabranches	Unknown. Frequency and maximum interval depends on pre-development regime.	Last met in full 2010-11, partially met 2013 and 2016. Not met 2017-18 or 2018-19. High environmental demand.	High	Possible for environmental water contribution, if additional information supports a watering action.	High
	Unregulated flows that provide connection to anabranches 7,500–10,000 ML/day at Goondiwindi for 7 days (connect 4 main anabranches: Callandoon, Dingo, Whalan, Boomi)	1 in every 2 to 3 yrs for fish outcomes (Maximum dry interval unknown)	Met in 2015-16, 2016-17, partially met 2017-18, not met 2018-19. Moderate to high environmental demand (moving to high if not met in 2019-20)	Moderate to high	Unable to receive Commonwealth environmental water due to constraints without exceeding channel capacity.	High

<p>Wetlands, lagoons and billabongs</p> <ul style="list-style-type: none"> Support movement, spawning and recruitment of aquatic species. Riparian vegetation health. Nutrient and carbon cycling Maintain refuge for aquatic biota, fish and riparian vegetation health, nutrient/ carbon cycling Lateral and longitudinal connectivity and nutrient and carbon cycling. Support movement, spawning and recruitment of aquatic species. Maintain riparian habitat for other species i.e. water birds 	<p>Infrastructure assisted watering to maintain refuge habitat</p> <p>E.g. Morella watercourse lagoons (if agreed with landholders)</p> <p>1,500–4,000 ML per action (infrastructure assisted) to target specific wetlands with long-term flow deficit</p>	<p>Maximum: up to 10 years between filling (Morella watercourse)</p>	<p>Little to no inflows since 2010. high environmental demand (moving to high to critical if not met in 2019-20).</p>	High	<p>Additional information needed before supporting a watering action.</p>	High to critical
	<p>Connection to lower Dumaresq wetlands / NSW Severn wetlands</p> <p><u>Dumaresq River</u></p> <p>Large pulse to connect >30% of wetlands in the Dumaresq reach > 1,040 ML/day @ Roseneath</p> <p><u>NSW Severn and Macintyre rivers:</u></p> <p>1,200 ML/day to connect upper reach wetlands</p>	<p>1 in 3 to 4 years for wetland vegetation</p> <p>1 in 2 to 3 years for fish outcomes</p>	<p><u>Dumaresq River</u></p> <p>Demands met 2017-18 and 2018-19, but not met between 2012-2017. Low to moderate demand, moving to moderate if not met in 2019-20.</p> <p><u>NSW Severn and Macintyre rivers</u></p> <p>Met annually since 2012. Low environmental demand, moving to moderate if not met in 2019-20.</p>	Low to moderate	<p>A low priority for Commonwealth environmental water contribution under low to moderate water resource availability scenarios. Potential for contribution under a high water resource availability scenarios and in conjunction with similar flow requirements for fish outcomes</p>	Moderate
	<p>Connection to lower Macintyre River wetlands</p> <p>>20,000 ML/day (low connectivity) to >60 000 ML/day (high connectivity) at Goondiwindi - 7 days (connect wetlands and anabranches - Goondiwindi to Mungindi)</p> <p>10,000–15,000 ML/day at Goondiwindi and 4,000–6,000 ML/day at Terrewah – 4–8 days Oct to Mar (low level wetland connection in Lower Macintyre)</p>	<p>1 in 3 to 4 years for wetland vegetation</p> <p>1 in 2 to 3 years for native fish outcomes</p> <p>Every 3 years for small fish outcomes</p>	<p>Not met since 2012-13. High environmental demand, moving to high to critical if not met in 2019-20.</p>	High		
				Carryover potential	<p>The volume of Commonwealth environmental water likely to be carried over in the Border Rivers catchment for use in 2019–20 is estimated to be 2,193 ML.</p>	<p>A low proportion of available allocations may be carried over to 2020–21</p>
				Trade potential	<p>No specific commercial trade of water has been identified for 2019-20. Trade opportunities will be reviewed in the valley throughout the water year and as conditions change.</p>	<p>Potential to trade will depend on environmental demands, resource availability and market conditions.</p>

Key - potential watering in 2019–20

<div></div>	High priority for Commonwealth environmental watering (likely to receive water even under low water resource availability)
<div></div>	Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate – high water resource availability); or water demand likely to be met via other means
<div></div>	Low priority for Commonwealth environmental watering (under high – very high water resource availability)
<div></div>	Unable to provide Commonwealth water due to constraints

Key - environmental demands

<div></div>	critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage
<div></div>	high demand for water i.e. needed in that particular year
<div></div>	moderate demand for water i.e. water needed that particular year and/or next
<div></div>	low demand for water i.e. water generally not needed that particular year
<div></div>	very low demand for water i.e. water generally not needed that particular year or the following year

Note that demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime

Note: Contributions to meet Barwon-Darling environmental requirements may be considered subject to water availability, antecedent conditions, and environmental demands. Refer to *Commonwealth Environmental Water Portfolio Management Plan: Barwon-Darling 2019–20*.

3. Next steps

3.1. From planning to decision making

It is important to distinguish between planning and operational decision making. As shown in Figure 8, planning allows the Commonwealth Environmental Water Office to manage the environmental water portfolio in a holistic manner and is an exercise in developing a broad approach or intention, based on the key drivers (demand and supply).

Decision making throughout each year builds on the intention by considering in more detail the specific prevailing factors and additional factors such as costs, risks, and constraints to water delivery and market conditions.

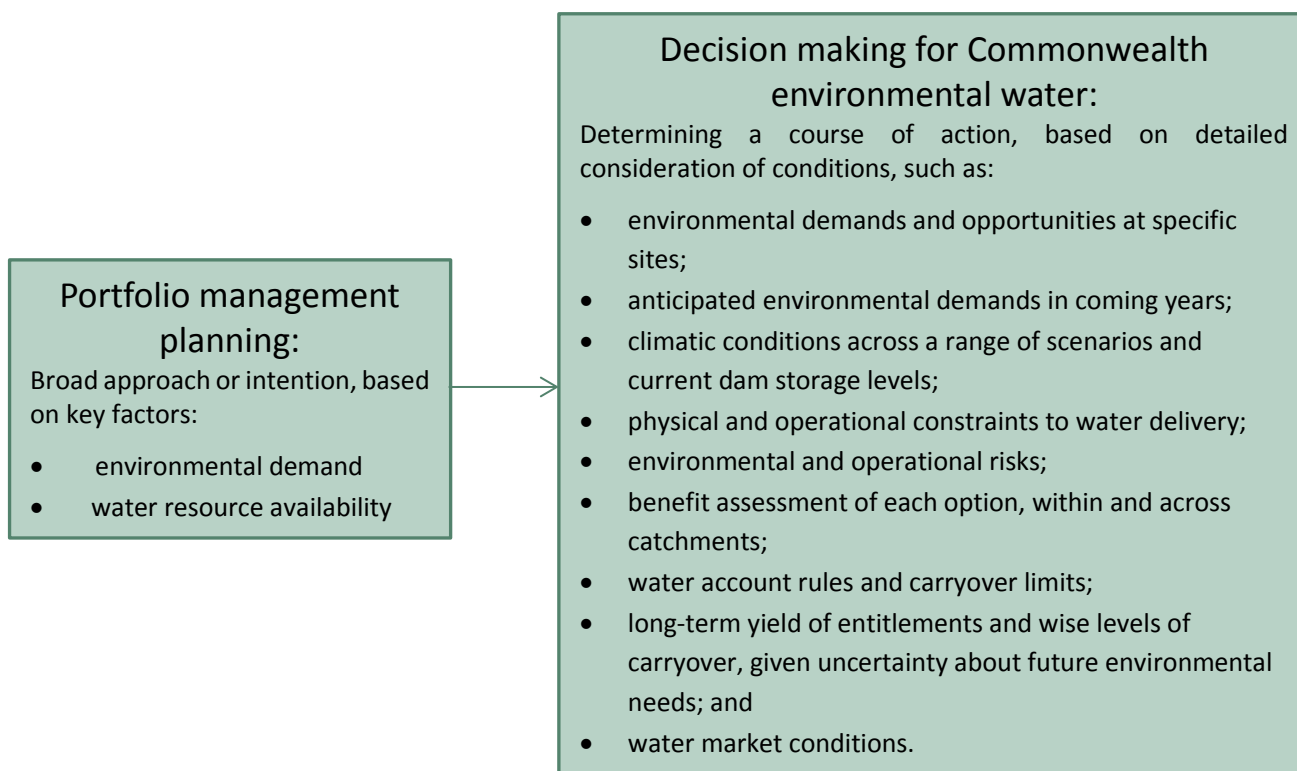


Figure 8: Planning and decision making for Commonwealth environmental water use

3.2. Monitoring

Operational monitoring is undertaken for all Commonwealth environmental watering actions and involves collecting on-ground data with regard to environmental water delivery such as volumes delivered, impact on the river systems hydrograph, area of inundation and river levels. It can also include observations of environmental outcomes.

Information on the monitoring activities is available at <http://www.environment.gov.au/water/cewo/catchment/border-rivers/monitoring>. Monitoring information is also provided by state governments.

3.3. Further information

For further information on how the Commonwealth Environmental Water Office plans for water use, carryover and trade, please visit our web site: <http://www.environment.gov.au/water/cewo> or the sites below:

- Water use: www.environment.gov.au/topics/water/commonwealth-environmental-water-office/assessment-framework
- Carryover: <http://www.environment.gov.au/topics/water/commonwealth-environmental-water-office/portfolio-management/carryover>
- Trade: <http://www.environment.gov.au/water/cewo/trade/trading-framework>

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Attachment A – Expected outcomes from the Basin-wide environmental watering strategy

Expected outcomes from the Basin-wide environmental watering strategy (MDBA 2014) that are relevant to the Border Rivers catchment are described below.

RIVER FLOWS AND CONNECTIVITY

Baseflows are at least 60 per cent of the natural level

Contribute to a 10 per cent overall increase in flows in the Barwon-Darling

A 10–20 per cent increase in the frequency of pulses and bankfull flows

VEGETATION

Maintain the current extent of forest and woodland vegetation and non woody vegetation

No decline in the condition of black box, river red gum and coolibah

Improved condition of lignum shrublands by 2024

Improved recruitment of trees within black box, river red gum and coolibah communities

Table 4: Vegetation extent

Area of river red gum (ha)*	Area of black box (ha)*	Area of coolibah (ha)*	Shrublands	Non-woody water dependent vegetation
10 700	3 800	35 200	Lignum in the lower Border rivers region	Closely fringing or occurring within the within the Barwon, Dumaresq, Macintyre rivers and Macintyre Brook

* Area (ha) is based on: Cunningham, S.C., White, M., Griffioen, P., Newell, G. and MacNally, R. (2013). *Mapping vegetation types across the Murray-Darling Basin*. Murray-Darling Basin Authority, Canberra

WATERBIRDS

Maintain current species diversity

Increase Basin-wide abundance of waterbirds by 20–25 per cent by 2024

A 30–40 per cent increase in nests and broods (Basin-wide) for other waterbirds

Up to 50 per cent more breeding events (Basin-wide) for colonial nesting waterbird species

FISH

No loss of native species

Improved population structure of key species through regular recruitment, including

- Short-lived species with distribution and abundance at pre-2007 levels and breeding success every 1–2 years
- Moderate to long-lived with a spread of age classes and annual recruitment in at least 80 per cent of years

Increased movements of key species

Expanded distribution of key species and populations

Table 5: Key native fish species for the Border Rivers catchment

Species	Longevity / Recruitment Frequency	Specific outcomes	In-scope for Commonwealth water in the Border Rivers?
Freshwater catfish (<i>Tandanus tandanus</i>)	Moderate to long-lived / 8 years in 10	Expand core range of 3–5 existing populations (Border Rivers is a candidate site)	Yes
Olive perchlet (<i>Ambassis agassizii</i>)	Short-lived / Annual	Expand range (or core range) of at least 3 existing populations (Border Rivers is a candidate site)	Yes. This species could be supported by connection and reconnection between low lying wetlands and the river channel in the lower Macintyre and low stable flows in the spawning season in the Dumaresq.
Southern purple-spotted gudgeon (<i>Mogurnda adpersa</i>)	Short-lived / Biennial	Expand the range (or core range) of at least 3 existing populations Establish or improve the core range of 2-5 additional populations (priority catchments include the Border Rivers/Gwydir)	Yes. Stable low flows in the spawning season could support this species in the Dumaresq.
Silver perch (<i>Bidyanus bidyanus</i>)	Moderate to long-lived / 8 years in 10	Expand the core range of at least two existing populations in the Northern Basin#	Yes, seasonally appropriate flows for conditioning and habitat availability. High peak flows to target spawning and recruitment are not in scope
Murray cod# (<i>Maccullochella peelii</i>)	Moderate to long-lived / 8 years in 10	A 10–15 per cent increase of mature fish in key populations	Yes. Stable low flows following a spawning trigger could support this species (Dumaresq)
Golden perch# (<i>Macquaria ambigua</i>)	Moderate to long-lived / 8 years in 10	A 10–15 per cent increase of mature fish in key populations	Yes, in conjunction with unregulated flows (Border Rivers main stem)
River blackfish (<i>Gadopsis marmoratus</i>)	Moderate to long-lived / 8 years in 10	Expand the range of at least two current populations Establish 1-3 additional populations (candidate sites include upland portion of the Border Rivers)	No. Populations occur upstream of regulated water storages and/or in unregulated reaches where there are no Commonwealth holdings

Not identified in the Basin-wide environmental watering strategy (MDBA 2014) as a key species or outcome for the Border Rivers catchment, but included based on advice from NSW DPI Fisheries.

Table 6: Important environmental assets for native fish in the Border Rivers

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought	In-scope for C'th e-water
Macintyre River – floodplain lagoons Goondiwindi to Boomi	*	*	*		*	*	Yes, in combination with unregulated flows
Macintyre River – Mungindi to Severn in NSW	*	*		*	*	*	Yes (unregulated holdings or secondary benefits of regulated deliveries)
Severn River within Sundown National Park (Queensland)		*		*	*	*	Yes (unregulated holdings)

Attachment B – Operational details for watering

Operational considerations in the Border Rivers catchment

The delivery of environmental water from regulated entitlements in the Border Rivers is potentially constrained by release capacities from storages and some re-regulating structures, travel time for deliveries, access conditions for unregulated licence holders, and standard river operation procedures. Channel constraints are unlikely to be triggered by flows that could be targeted for environmental purposes in the Dumaresq or Macintyre rivers, given the relatively large channel capacities of these rivers.

Large flows are required for full lateral connectivity across the floodplain. The volumes of environmental water available would make very little difference under these conditions. Therefore contributing to large overbank flow across the floodplain is out of scope for the provision of regulated Commonwealth environmental water at this stage in the water recovery process.

With use of unregulated entitlements activated at higher flows there is some potential to exceed channel constraints in the lower Macintyre River, leading to overbank flows and potential flooding of public or private lands. However, contributions from unregulated Commonwealth entitlements during flows of these magnitudes will comprise a small portion of the overall event and have a minimal effect on peak flows.

In Macintyre Brook use is constrained due to small environmental water holdings, to contributing to low flows. The volume of regulated environmental water available under any water resource scenario is also likely to limit capacity of overall holdings to contribute to larger in-stream and wetland connecting flows in the Dumaresq and Macintyre rivers and these demands will need to be met primarily through unregulated flows. Limited volume of environmental water also constrains the ability to undertake multiple actions in any given year targeting different environmental demands.

Watering actions will be developed in consideration of the following constraints:

- Ability to protect environmental releases from extraction through irrigation areas between Goondiwindi and Mungindi and along the Weir River during unregulated flow conditions.
- Outlet capacity of 5,000 ML/day at Pindari Dam, 3,540 ML/day at Glenlyon Dam and 390 ML/day at Coolmunda Dam (MDBA 2013).
- Storage capacity at Boggabilla weir (5.9 GL) and restricted draw down rate (0.5 m/day or 650–700 ML/day) could limit the ability to supply required volumes to meet in-stream flow targets in the lower Macintyre River. The discharge capacity of the Boomi regulator (60–70 ML/day under low flow conditions and 120–130 ML/day when the weir is overtopping (MDBA 2013) could constrain delivery into the Boomi River including to Budelah Nature Reserve.
- Minor flood levels of 21,300 ML/day at Boggabilla, 12,100 ML/day at Goondiwindi and 8,800 ML/day at Mungindi (MDBA 2013).
- During unregulated flow conditions, loss of regulated deliveries and/or unregulated contributions from the Macintyre to the Weir River at the Newinga regulator at flows above 600–800 ML/day.
- Adherence to default operational procedures whereby regulated water orders are met from unregulated river flows in preference to releases from storage needs to be considered when developing and finalising the environmental watering plan with Queensland DNRME and NSW DoI Water.
- The long travel times for water orders (e.g. 16 - 21 days for a release from Glenlyon or Pindari Dam ordered to Mungindi), and limited volumes of regulated holdings, mean that the use of Commonwealth environmental water is unlikely to enhance the environmental outcomes of larger natural flow events in the lower system.

- In-stream weirs and the long travel distances (and lag times for water orders) to target river reaches will also impact the ability to achieve and maintain a desired hydrograph in the Dumaresq River using releases from Glenlyon Dam.
- Channel constraints could limit active use of unregulated entitlements, such as temporary water purchase, in high flow events due to the risk of contributing to overbank flows and flooding.

Protection of environmental water

Leaving environmental water in-stream carries the potential risk that the additional flows are extracted by downstream users in a particular event. MDBA (2013) considers this to be the primary constraint for delivery of environmental water to the lower Macintyre River including end of system flows. The primary effect of additional regulated and/or unregulated environmental water in the system is likely to be in extending the period of unregulated access (and hence potentially the volume extracted) by maintaining flows at key gauges above the cut-off thresholds for water harvesting/supplementary access for longer. As demand (water orders) in the system is excluded from assessment of the volume of unregulated flow available for take, regulated deliveries made during unregulated flow conditions should not increase the announced volume of access.

Unregulated environmental flows in the Weir River could also bring forward achievement of flow triggers and announcement of unregulated access by increasing flows at Mascot, as well as increasing the total volume authorised for extraction in the Border Rivers main stem.

In the NSW sections of the Dumaresq and Macintyre rivers, unregulated access is based on local river flow thresholds. Regulated deliveries and unregulated water left in-stream could bring forward and/or extend access periods. Impacts would be limited because daily extractive capacity in these reaches is small compared to below Goondiwindi and water cannot be stored on farm.

Flows that reach end of system (Mungindi) are not currently protected from extraction in the Barwon-Darling, although embargoes under Section 324 of the NSW Water Management Act can be sought on a case-by-case basis. In 2018 and 2019, the NSW Government agreed to the protection of environmental water (through the use of Section 324 provisions under the NSW Water Act) from the Border Rivers in order to provide water to key parts of the system. Any future delivery of environmental water will consider the available options to protect this water from legal take. The Barwon-Darling and tributaries including the Border Rivers are an area of policy focus and review by the NSW and Commonwealth governments. The provision of environmental water will be adapted to any relevant changes in policy.

The risk of extraction of Commonwealth environmental water from the Queensland Severn River is moderate because unregulated access conditions of downstream users along the Dumaresq River allows the extraction of some of the additional environmental water left in-stream. However, the Commonwealth contribution to unregulated flows here is small relative to other flows in the system.

There may also be a risk of extraction of environmental water provided actively to anabranches (pumping and use of private infrastructure) and lagoons along watercourses (could impact unregulated access conditions and stock and domestic use in these systems). This risk of extraction also extends to passive delivery of environmental water (via enhanced in-stream flows), either impacting unregulated access conditions or potentially regulated water use in the main anabranches (Callandoon and Yambocully creeks). Further investigation of this risk is needed.

The protection of environmental water during unregulated flow conditions currently relies on existing water resource management systems including the Murray-Darling Basin Cap on diversions (specified for each valley) and existing rules governing the access of other users to unregulated flows. Additional arrangements are also being investigated as by the NSW and Queensland governments.

Existing rules provide a high degree of protection of in-stream flows from Commonwealth's unregulated entitlements in Queensland (unsupplemented water allocations) within the Macintyre River. Access is based on flow triggers at Goondiwindi (or at sites further downstream on the Macintyre River and on the Weir River) that capture the major unregulated inflows into the system.

Available unregulated flows are shared between all users in line with entitlement share, regardless of actual use.

This protects the Commonwealth's share of the flow event from extraction by others, with no management action required. However, the extent to which additional environmental flows in the system may extend the duration of access and total volumes available (in the case of unregulated contributions) is unclear.

Potential watering actions under different levels of water resource availability

Under certain levels of water resource availability, watering actions may not be pursued for a variety of reasons, including that environmental demand may be met by unregulated flows and that constraints and/or risks may limit the ability to deliver environmental water. Table 4 identifies the range of potential watering actions in the Border Rivers and the levels of water resource availability that relate to these actions.

Table 7: Summary of potential watering actions for the Border Rivers catchment in 2019-20

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
River channel (Macintyre, Severn (NSW), Dumaresq, Barwon River to Mungindi)	<ul style="list-style-type: none"> • Baseflows (no flow conditions) • Stable low flow pulse to inundate breeding habitat (Aug–Dec) • Scouring flows above 2,000 ML/day in NSW Severn (Aug–Dec) • Medium (scouring) flow pulse in the Dumaresq • Large in-channel pulse over 4,000 ML/day at Mungindi for minimum of 5 days 	1. <i>Refuge pools and water quality contingency:</i> Contribute flows to refresh drought refuges and mitigate degrading water quality and provide longitudinal connectivity downstream of storages (Dumaresq and Severn) to junction with the Macintyre (potentially as far as Boggabilla) (possible triggers cease to flow (<20ML/d) for more than 25 days at Glenarbon or Ducca Marrin and 30 days at Mungindi)				
			2. <i>Fish reproduction and recruitment flows:</i> low stable flow to provide breeding habitat and support completion of breeding and/or recruitment of native fish (subject to agreement on operational arrangements)			
				3. <i>Scouring and conditioning flows:</i> Contribute to flows to scour algae and reset biofilm processes, provide migration, spawning and dispersal cues for fish, connect with riparian areas		
				4. <i>Habitat availability and nutrient/carbon cycling:</i> Contribute to flows to increase access to in-stream habitats, support movement, spawning and recruitment opportunities of native aquatic species		
Anabranches	<ul style="list-style-type: none"> • 1,500–4,000 ML per site • 7,500–10,000 ML/day at Goondiwindi for 7 days (November to February) 		5. <i>Infrastructure assisted delivery:</i> Use irrigation infrastructure to deliver water to specific anabranches for localised connectivity, nutrient/carbon cycling and habitat benefits (subject to additional information to support an action)			
				6. <i>Anabranch connectivity:</i> Contribute to flows to support connectivity to and between anabranches and floodplain wetlands and river channel (subject to agreement on operational arrangements)		

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
Wetlands	<ul style="list-style-type: none"> • 1,500–4,000 ML per site • 1,200 ML/day NSW Severn to connect upper reach wetlands • ~ 6,000 ML/day at Terrewah (Sept–Jan) to connect lower Macintyre wetlands i.e. Boobera 		7. <i>Wetland connectivity</i> : Contribute to unregulated flows to support lateral connectivity, primary production, nutrient and carbon cycling, and biotic dispersal and movement			
			5. <i>Infrastructure assisted delivery</i> : Use irrigation infrastructure to water specific wetlands for localised connectivity, nutrient and carbon cycling and to support riparian and wetland vegetation and any naturally triggered breeding events (subject to delivery and accounting arrangements being in place)			

Potential watering actions – standard operating arrangements

Table 4 identifies the range of potential watering actions in the Border Rivers in the Murray–Darling Basin that give effect to the long-term demands and flow regime identified as being in scope for the contribution of Commonwealth environmental water in any given year. The standard considerations associated with these actions are set out below.

Watering Action [1] River Channel – Refuge pools and water quality contingency:

Watering action: Contribute to/or provide base flows to refresh drought refuges, ensure the persistence of pools, and mitigate the risk of degrading water quality.

Standard operational considerations:

- Water would be delivered primarily from Glenlyon Dam. A coordinated release of the small volumes held in Coolmunda and Pindari dams could also be considered.
- Triggered by an extended period of low/nil flow conditions (e.g. cease to flow (<20ML/d) for more than 25 days at Glenarvon or Ducca Marrin and 30 days at Mungindi) and/or degrading water quality due to dry, hot conditions.
- Commonwealth water would be released if irrigation deliveries/stock and domestic replenishment flow (Pindari) are not expected to meet this demand, or to supplement these deliveries. Irrigation releases are not expected from Glenlyon or Pindari without significant additional inflows in 2019-20.
- Release pattern would be based on the flow rates and duration required to achieve a sustained end of system flow (or as far down the Dumaresq and Severn to their junctions with the Macintyre), and provide some low flow variability in the system.

Typical extent: Dumaresq and Macintyre (main stem) rivers to Mungindi (if sufficient water available). In the absence of significant inflows over coming months the extent will be the Dumaresq from downstream of Glenlyon Dam to the junction with the Macintyre (Boggabilla) and/or from Pindari Dam on the Severn to the junction with the Macintyre. Additional inflows are likely to be required to be able to achieve significant connectivity with the downstream Barwon-Darling.

Approvals: Consult with Queensland DNRME, SunWater, NSW DoI Water, WaterNSW, Queensland and NSW Fisheries, and NSW OEH before implementing this action. Also inform key stakeholders, including BRFF, LLS groups and QMDC before implementing this action. Delivery of water from NSW entitlements can be linked to appropriate water supply works, including Mungindi weir. A similar delivery arrangement for Queensland entitlements may be required. Delivery of any significant volume would require discussion of system considerations with river operators.

Watering Action [2]: River channel – Fish reproduction and recruitment flow:

Watering action: Maintain a long stable low flow to support the completion of breeding of larger bodied fish, primarily Murray cod and freshwater catfish. Alternatively, or in addition to, the flow could provide suitable breeding habitat (submerged macrophyte beds) and favourable conditions for completion of breeding and recruitment of stable low flow spawning fish in the Dumaresq River. Target species include purple-spotted gudgeon, olive perchlet, Western carp gudgeon and Murray-Darling rainbowfish.

Typical extent: Target reaches are the Dumaresq River below the Pike Creek inflow and the NSW Severn River below Pindari Dam (separate actions).

Standard operational considerations:

- Commonwealth environmental water would be released from either Glenlyon Dam (for the Dumaresq action) or Pindari dam (for the NSW Severn River action).

Flow to support Murray cod recruitment (NSW Severn or Dumaresq):

- The action would be considered if there had been preceding unregulated flow pulse in early winter that provided cues for movement and breeding, or there is evidence of breeding activity.
- Preferred timing is late August to early September following the main spawning period for cod.

- Release to achieve a low peak to inundate suitable cod habitat (approx. 200 ML/day in the Severn; 515-1,040 ML/day in the Dumaresq) followed by a recession over 20 days.
- Commonwealth environmental water for the NSW Severn River would be delivered in conjunction with the NSW stimulus flow. Irrigation deliveries or translucency flows from Pindari Dam could also provide some of the desired flow outcome.

Flow to support silver perch recruitment (NSW Severn or Dumaresq):

- The action would be considered if risks to spawning aggregation can be identified and mitigated.
- Preferred timing is late September to early October, during warmer flow conditions and before irrigation deliveries.
- Release to achieve a high peak to stimulate aggregation (approx. 2,000 ML/day at Ducca Marrin for at least 3 days).
- Commonwealth environmental water for the NSW Severn River would be delivered in conjunction with the NSW stimulus flow. Irrigation deliveries or translucency flows from Pindari dam could also provide some of the desired flow outcome by providing a stable recession.

Flow to support breeding and recruitment of stable low flow spawning fish (Dumaresq)

- Preferred timing is October to December, the peak spawning season for the target threatened species.
- Releases from Glenlyon dam would aim to maintain a stable low flow (minimal fluctuation in stream height and flow velocity) at around water levels that inundates macrophyte beds and provide suitable breeding habitat to low flow spawning fish.
- Target flow rates will be based on aquatic habitat mapping by NSW DPI Fisheries (~50-100 ML/day at Glenarvon) and confirmation of macrophyte habitat availability, if a scouring flow has recently occurred.
- Commonwealth environmental water from Glenlyon Dam could supplement irrigation deliveries and/or be released after a small unregulated flow pulse.
- The ability to maintain long duration low flows (up to 60 days to cover egg laying through development) will depend on whether larger unregulated flows occur and/or operational arrangements are in place.

Approvals: As for watering option 1.

Watering Action [3] River Channel – Scouring and conditioning flows:

Watering action: Medium to large in-channel pulse to scour algae and reset benthic periphyton (biofilm) processes to stimulate production through all levels of the aquatic food chain; provide migration, spawning, dispersal and recruitment cues to native fish (dependent on timing); and wet and interconnect riparian areas and, improve access to aquatic habitat.

Typical extent: The Severn River (NSW) below Pindari Dam or the Dumaresq River below Glenlyon Dam (separate actions). Use of Commonwealth environmental water would also seek to achieve continuing environmental benefits downstream in the Macintyre River.

Standard operational considerations:

NSW Severn River

- Target flow rates above 2,000 ML/day to reset periphyton species (NSW DPI OoW 2011) subject to managing cold water pollution impacts.
- Commonwealth environmental would be delivered from Pindari Dam in conjunction with the NSW stimulus flow, and only if the latter is available. Irrigation deliveries and translucency flows could also contribute to meeting demand in the target reach.
- Delivery arrangements to minimise losses (e.g. downstream ordering point, timing releases when there is low downstream demand etc) and safeguard Commonwealth environmental water from extraction below Frazers Creek and in the Macintyre River are a consideration for proceeding.
- Early release in the stimulus flow window (August to December) is preferred to reduce cold-water pollution impacts on fish.

Dumaresq River

- Commonwealth environmental water would be delivered from Glenlyon Dam, triggered by a suitable unregulated tributary flow event (medium to large flow pulse).
- Action is contingent on confirming operational arrangements. Also, this action is only feasible under high resource availability and/or with increased water holdings, to enable enhanced flow rates of 2,300 to 6,250 ML/day at Roseneath, improved flow recession and to minimise cold water pollution impacts.
- Maximum release capacity from Glenlyon Dam (3,540 ML/day) and cold water pollution impacts are potential constraints on delivery.
- A downstream ordering point and release pattern would be sought that achieves desired outcomes in the target reaches while providing continued benefits as far downstream as possible.

Approvals: For the NSW Severn Option, the timing, rate, volume and duration of the stimulus flow is determined by NSW DoI Water in consultation with NSW OEH. These agencies, WaterNSW and NSW Fisheries would be consulted prior to a contribution being made to the stimulus flow. For the Dumaresq option, consult with Queensland DNRME, NSW DoI Water, SunWater, WaterNSW, NSW OEH, Queensland and NSW DPI Fisheries before implementation. Also inform relevant stakeholders; including BRFF, LLS groups and QMDC, before implementing this action.

Watering Action [4]: River Channel – Habitat availability and nutrient and carbon cycling:

Watering action: Contribute to a large in-channel pulse to increase access to in-stream habitat (benches, large woody debris, macrophyte beds); stimulate carbon and nutrient cycling; support movement, spawning and recruitment opportunities of native aquatic species; and provide longitudinal connectivity to Mungindi.

Standard operational considerations:

- Commonwealth environmental water would be delivered from Glenlyon and/or Pindari dams, triggered by a suitable large unregulated tributary flow event.
- Conjunctive use with the NSW stimulus flow could also be possible for an action based from Pindari. All available sources of water be sought to maximise event volumes and flow peaks.
- Commonwealth unregulated entitlements in the Dumaresq and Macintyre (in particular) would contribute to the action, contributing in-stream flows that are in addition the 25 per cent of unregulated flows protected under water resource plans.
- Target flow rates and timing will be dependent on the prevailing flow conditions, priority outcomes sought at that point in time and operational considerations.
- An upper target for increasing access fish habitat (woody debris) and stimulating nutrient and carbon inputs into the river is 4,000 ML/day at Mungindi for a minimum of 5 to 11 days (MDBA 2012).
- Where fish outcomes are targeted, the timing and duration of the flows would be considered (e.g. late winter-early spring to stimulate spawning and mitigate cold water pollution impacts).
- Action would be contingent on confirming operational arrangements to release Commonwealth environmental water from Glenlyon Dam in conjunction with unregulated flows and/or obtaining additional unregulated access in the lower Macintyre. High flows in the lower Macintyre may only be feasible under high resource availability and/or with increased water holdings.

Typical extent: The Macintyre River to Mungindi and in the Dumaresq and/or NSW Severn Rivers depending on which dams are used to deliver Commonwealth environmental water. Extent of influence of environmental water may depend on antecedent conditions and water availability.

Approvals: Consult with Queensland DNRME, NSW DoI Water, SunWater, WaterNSW, NSW OEH, NSW and Queensland Fisheries before implementing this action. Inform relevant stakeholders; including BRFF, LLS groups and QMDC before implementing this action.

Watering Action [5]: Anabranches and Wetlands– infrastructure assisted delivery

Watering action: Provide water to targeted wetlands and or anabranches to provide localised connectivity and access for aquatic biota, support riparian vegetation, persistence of waterholes and terrestrial primary production.

Standard operational considerations:

- Action requires further investigation but may include diverting/pumping water from regulated or unregulated Commonwealth entitlements into channels, anabranches or offstream wetlands to restore ecological function to these areas.
- Likely to target areas with high environmental values and where multiple benefits can be achieved (wetlands or anabranches) and that have a long-term reduction in inflows due to water resource development and/or altered flow paths from floodplain structures and works.
- Delivery could also be used to meet short-term environmental requirements in discrete wetlands or channels, such as supporting completion of a naturally triggered waterbird breeding event or to consolidate benefits of previous flows.
- Delivery will include use of private irrigation infrastructure (channels, pumps, on farm storage).
- The Commonwealth Environmental Water Office will continue to investigate the feasibility of such options and will seek input from interested parties.

Typical extent: Wetlands and anabranches of the Macintyre floodplain (e.g. Boomi, Whalan and Morella watercourses), floodplain wetlands in the area around junction of Macintyre and Dumaresq rivers. Creek systems between the Macintyre and the Weir River may also be targeted.

Approvals: Access to infrastructure would need to be negotiated with landholders and/or relevant Water Boards and agreement for inundation of privately owned wetlands. Consultation with NSW OEH, Queensland DNRME, WaterNSW, NSW DoI Water, NSW and Queensland Fisheries, QMDC and landholders would be undertaken before implementing this action.

Watering Action [6]: Anabranch connectivity:

Watering action: Contribute to flows to support connectivity of anabranches to facilitate nutrient and carbon exchange and the movement of biota between anabranches, wetlands and the river channel. Flows could also support movement, spawning and condition of native fish and other aquatic species.

Standard operational considerations:

- Action requires further investigation. The release of Commonwealth environmental water from Glenlyon and/or Pindari dams could be triggered by suitable unregulated flows or large regulated flows (e.g. irrigation deliveries, stimulus flow, stock and domestic replenishment flow) to achieve/extend connection of anabranches to the river, or provide re-connection to build on previous environmental outcomes.
- Commonwealth unregulated entitlements will contribute if flows trigger unregulated access
- Target flow rates will depend on prevailing flow conditions, specific outcomes sought at the time and operational considerations. Indicative flows to connect the main Macintyre anabranches are 7,500 to 10,000 ML/day at Goondiwindi.
- If fish outcomes are sought, the timing and duration of the action may depend on the target species and life cycle stage (spawning, migration, conditioning etc).
- Action is subject to agreement on operational arrangements, if Commonwealth environmental water needs to be released within an unregulated flow event.
- Protection of in-stream flows (unregulated access conditions) in these watercourses and maintenance of water levels in levels in waterholes and wetlands (stock and domestic access) is a potential risk.

Typical extent: Anabranches of the Macintyre floodplain.

Approvals: This action may require close cooperation with river operators in both states and water and land holders in the target area(s). Any diversions to anabranches would occur in collaboration with relevant stakeholders.

Watering Action [7]: Wetlands – Connectivity:

Watering action: Contribute to a medium to large flow pulse to support lateral and longitudinal connectivity to low lying floodplain wetlands to boost invertebrate production; trigger breeding activity in birds, fish and amphibians and subsequent recruitment and movement of those species; maintain wetland and riparian vegetation and provide opportunities for reproduction.

Standard operational considerations:

- Upper reach wetlands in the NSW Severn River would be targeted with Commonwealth environmental water from Pindari Dam: flows 1,200 ML/day required (Davie and Mitrovic 2014).
- Releases from Pindari Dam would be in conjunction with the NSW stimulus flow and/or irrigation deliveries.
- Wetlands in the lower Macintyre could be targeted with releases from both or either dam.
- For lower reach floodplain wetlands (Dumaresq and Macintyre) this action should be in conjunction with suitable medium to large unregulated flows and would need operational arrangements in place.
- Commonwealth unregulated entitlements will contribute to connection of lower Macintyre wetlands if unregulated access is triggered.
- Target flow rates will be dependent on the prevailing flow conditions, estimated commence to flow levels for target wetlands, the range outcomes sought and operational considerations.
- Water could be used to maintain and increase inundation or assist re-connection of wetlands and anabranches to the river channel to improve exchange of nutrients and carbon and ensure biota can return to the river.
- Water could be used provide extended recession to enhance cues for biota to move back to the river. Serial connection of wetlands may be particularly important for dispersal of some native fish species.
- Contribution to connection events for wetlands in the lower Dumaresq and Macintyre rivers may be limited by the small holdings in the Border. Third party impacts are unlikely but still possible: minor flooding at Goondiwindi and Boggabilla occurs at flows of 12,100 and 21,300 ML/day, respectively.

Typical extent: upper reach wetlands on the Severn (NSW) River; low lying wetlands on the Macintyre (downstream of Yetman) and Dumaresq rivers (downstream from Texas) to Mungindi, including on Boomi River.

Approvals: This action would require close cooperation with river operators in Queensland and NSW and potentially the irrigation community.

Attachment C – Long-term water availability

Commonwealth environmental water holdings

The Commonwealth holds the following entitlements in the Border Rivers:

- Queensland medium security 'supplemented' water allocations in the Border Rivers Water Supply Scheme and a small parcel of similar allocations in the Macintyre Brook Water Supply Scheme.
- Queensland 'unsupplemented' water allocations in the Border River Water Management Area (Dumaresq, Macintyre and Barwon zones), the Stanthorpe Water Management Area (Queensland Severn River) and in Macintyre Brook.
- New South Wales Border Rivers General B Security in Pindari Dam.
- New South Wales 'supplementary' water allocation in the Border Rivers.

The full list of Commonwealth environmental water holdings can be found at www.environment.gov.au/topics/water/commonwealth-environmental-water-office/about-commonwealth-environmental-water/how-much and is updated monthly.

Other sources of environmental water

There are currently no other sources of held environmental water in the Border Rivers.

Planned environmental water

In addition to water entitlements held by environmental water holders, environmental demands may also be met via natural or unregulated flows and water provided for the environment under rules in state water plans (referred to as 'planned environmental water').

Key rules in the Border Rivers catchment protect some unregulated flows and inflows to dams:

- Low flows in river reaches below Coolmunda (Macintyre Brook) and Pindari (NSW Severn River) dams are protected by translucency rules that pass small inflows into the dams (in the range 50 to 200 ML/day) downstream. A rule in both state water plans protects natural low flows throughout the system in the warmer months (September to March) by requiring that unregulated inflows up to 100 ML/day at Mungindi are not used to supply regulated water orders.
- Take of water during unregulated flows is restricted to announced access periods (water harvesting in Queensland and supplementary access in NSW), governed by river flow thresholds for the commencement and cessation of take. For large scale irrigators, access generally requires flows of at least 10,000 ML passing Goondiwindi over 2 days and ceases when two day flows fall below 3,650 ML. Site specific passing flow thresholds also apply to small scale irrigation enterprises on the Macintyre River in NSW and the Queensland and NSW sides of the Dumaresq River.
- Flow-limited take periods are supported by a rule in both state water plans requiring that 25 per cent of all inflows to the system during announced unregulated events are protected from extraction to Mungindi.
- Overall these rules strive to achieve average end of system flows that are at least 61 per cent of pre-development levels. A rule in the NSW water sharing plan (applies to only 50 per cent of available unregulated flows) also allows for supplementary access to be restricted at times when these flows are needed in the Barwon–Darling River to provide for critical town water supplies or mitigate algal blooms. The NSW water sharing plan also reserves 4,000 ML per year for a stimulus flow release to mirror a natural pulse in the NSW Severn River (August to December). The release is triggered by a volume of over 1 200 ML (in one day) into Pindari Dam in the period April to August. Unused flows can be carried over to a maximum of 8,000 ML