Australian Government

Commonwealth Environmental Water Office

Commonwealth Environmental Water

Portfolio Management Plan

Border Rivers

2017–18

Front cover image credit: Dumaresq River, May 2017. Photo by Matt Mills.

Back cover image credit: Royal spoonbills on main nesting tree in Border Rivers anabranch. Photo by Commonwealth Environmental Water Office.

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.

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. Mr David Papps is the current Commonwealth Environmental Water Holder. He is supported by staff of the Commonwealth Environmental Water Office. The Office 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 for 2017–18. 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, 2017–18* (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. In Queensland our partners include: the Department of Natural Resources and Mines; Department of Agriculture and Fisheries; Department of Science, Information Technology and Innovation; and the Queensland Murray-Darling Committee Inc (QMDC). In NSW they include the Office of Environment and Heritage (OEH); Department of Primary Industries (Water and Fisheries department); and WaterNSW. Advice on the use of Commonwealth environmental water in the Border Rivers is also provided by Northern Tablelands Local Land Service (LLS) and individual landholders; Border Rivers Environmental Water Network (BREWN) and Border Rivers Food and Fibre (BRFF).

Your input

The management of Commonwealth environmental water relies on considerable advice and assistance from local organisations, state governments and 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 Office via: ewater@environment.gov.au.

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1. Environmental watering in the Border Rivers catchment

1.1. The Border Rivers catchment

The Border Rivers catchment covers around 49 500 km^2 in southern Queensland (QLD) and north eastern New South Wales (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 in 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 constructed, 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 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.

Environmental assets

The many streams of the Border Rivers system provide diverse habitat for aquatic organisms including the river channel itself, in-stream features such as bars, benches, riparian areas and low level wetlands (SKM 2009). The streams in the catchment support a relatively rich native fish fauna. Sixteen native species have been documented, including a number of threatened species or populations either listed under the *Environment Protection and Biodiversity Conservation Act* 1999 or identified by NSW DPI Fisheries as an important population in the Border Rivers. These include: Murray cod; silver perch; purple-spotted gudgeon; olive perchlet and eel-tailed catfish (NSW DPI 2015a). Assessments by NSW DPI (NSW DPI 2015c) and the second Sustainable Rivers Audit (Davies et al. 2012) concluded that overall the Border Rivers fish community is in moderate health, ranking it among the best catchments in the Basin for fish.

Environmentally significant river reaches that can potentially be targeted with Commonwealth environmental water include:

- The **Dumaresq River** is one of the few areas in the Queensland Murray-Darling Basin where dense aggregations of aquatic macrophytes occur. Reaches near Bonshaw and between the Yellowbank and Bengalla reserves support diverse native fish communities and high quality in-stream habitat (Butcher 2007). Observed species include olive perchlet and purple-spotted gudgeons with Murray cod and eel-tailed catfish, including evidence of breeding, observed at Bonshaw (NSW DPI 2015a; QLD DNRM 2015).
- The **Macintyre River** from Mungindi to the Severn River is a key movement corridor, has high fish biodiversity including threatened species, and provides hydrodynamic diversity and dry period refuge (MDBA 2014a).
- The **NSW Severn River** below Pindari Dam sustains high fish diversity and provides good refuge conditions for native fish. Wetlands upstream of Ashford power station and within Kwiambal National Park are important ecological features that rely on natural flow variability and freshes to maintain health and diversity (NSW DWE 2009b). The reach also supports a small platypus community.

- The **lower Macintyre River** between Goondiwindi and Boomi supports low lying floodplain lagoons that are likely to be important for breeding and recruitment of native species including olive perchlet and spangled perch. The reach is also a key fish movement corridor supporting high biodiversity and threatened species including silver perch and Murray cod (NSW DPI 2015a).
- The **QLD Severn River in Sundown National Park** is in near natural condition and sustains high fish diversity, including threatened species such as silver perch and provides significant dry period refuge conditions for native fish (QLD DNRM 2015; MDBA 2014a)

In the lower catchment multiple effluent creeks and anabranches break off the main channel of the Macintyre River (DWE 2009a). These break outs, which include Callandoon and Dingo creeks and the Little Weir River in QLD, and Whalan Creek and the Boomi River in NSW, flow away from the trunk stream only when certain river levels are reached and meander across the floodplain forming a network of billabongs and wetlands. Hydrological connectivity of this floodplain area relies on overbank flows and when flooded it provides large amounts of dissolved organic carbon to the river ecosystem, driving food webs (MDBA 2012). Intermittent connection of anabranches, which occurs at flows below overbank level, also stimulates nutrient and carbon cycling and is significant contributor to overall inputs (Thoms et al. 2005; McGinness and Arthur 2011; Reid et al. 2012).

Semi-permanent and intermittent billabongs and lagoons bordering the main channel and on prior river channels are a key feature of the floodplain from Yetman on the Macintyre River and Texas on the Dumaresq River to around Boomi. When flooded, billabongs and wetlands in the lower Macintyre have supported breeding for a range of nationally and internationally important birds such as brolgas, black-necked storks, and magpie geese (MDBA 2012) and provide a wide range of aquatic habitats and drought refugia (NSW OEH 2014). The Morella Watercourse/Boobera Lagoon/Pungbougal Lagoon complex, located on the floodplain just south-west of Goondiwindi, is listed in the *Directory of Important Wetlands in Australia* (Environment Australia 2001). Boobera Lagoon is considered to be one of the most important Aboriginal sites in south-eastern Australia. The local Aboriginal people, the Gamilaraay, believe that Boobera Lagoon is the resting place of the rainbow serpent, Garriya.

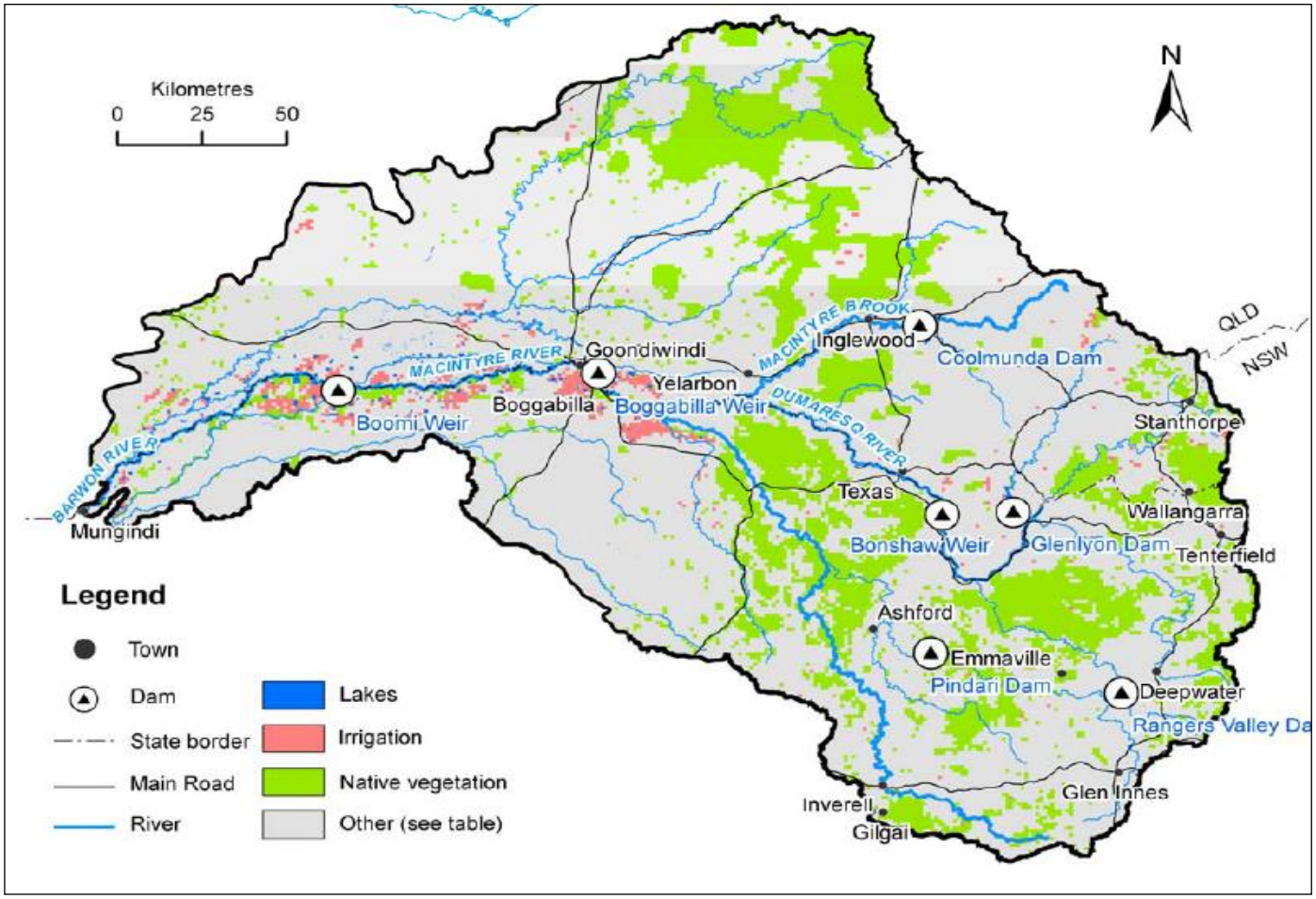

Figure 1: Map of the Border Rivers catchment (CSIRO 2007)

1.2. Environmental objectives in 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 (MDBA 2012, MDBA 2014a). The expected outcomes relevant for the Border Rivers are described in Attachment A.

Basin state governments are also developing long-term watering plans for each catchment. These plans 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 developed, these plans will provide the key information on the long-term environmental water demands in the catchment. Prior to the development of long-term watering plans, the 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.

Based on these strategies and plans, and in response to best available knowledge from environmental watering monitoring programs, the objectives for environmental watering in the Border Rivers are summarised in Table 1 below. The objectives and expected outcomes 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

BASIN-WIDE MATTERS (Outcomes in red link to the Basin-wide Environmental Watering Strategy)	**ENVIRONMENTAL OBJECTIVIES FOR BORDER RIVERS ASSETS**		
	IN-CHANNEL ASSETS	**OFF-CHANNEL ASSETS**	
	Severn (NSW and QLD), Dumaresq, Macintyre and Barwon Rivers	**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, freshes, 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 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 2 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. Also, 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 delivery constraints are described in Attachment B.

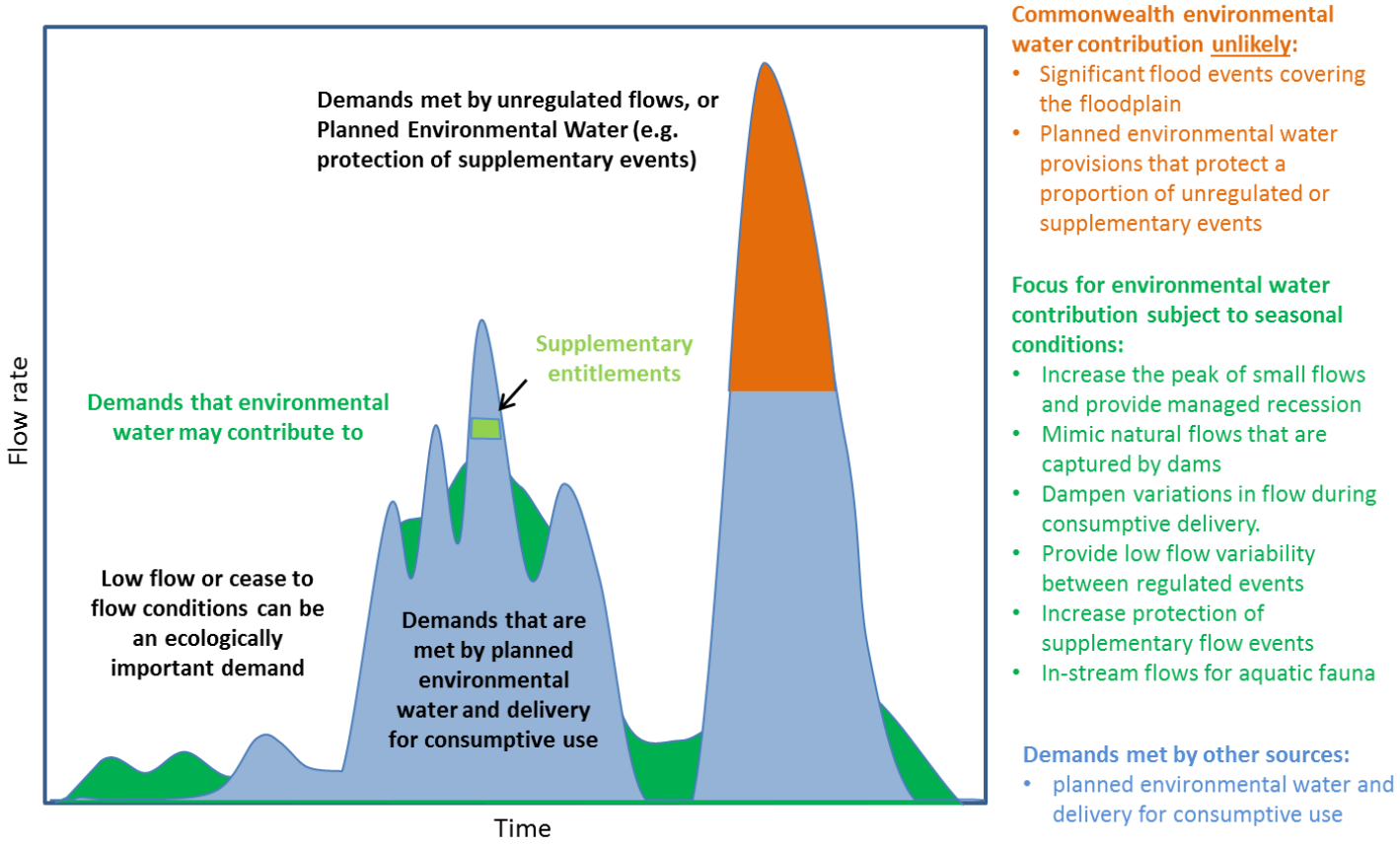

Figure 2: Scope of demands that environmental water may contribute to in the Border Rivers catchment

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.

There are significant knowledge gaps in the Border Rivers for key environmental demands essential to the watering objectives and outcomes identified for the catchment. These gaps include requirements for aquatic biota and in-stream processes in the Dumaresq River and watering requirements for floodplain wetlands and anabranches. Notional demands for these environmental assets are included in Table 3 along with any partial or possible flow (demand) requirements, noting noting that specific flow indicators for these demands are yet to be confirmed.

1.4. Monitoring and adaptive management

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. The Office is funding two short-term intervention monitoring projects in the Border Rivers aimed at collecting important data to inform proposed watering actions for fish outcomes. The habitat mapping project will record key habitat features used by aquatic fauna in the Dumaresq River, targeting habitat needed by native fish during breeding and recruitment to determine volumes required for inundation. The fish and flows project will undertake targeted sampling in 2017–18 to determine the status of native fish populations in the Dumaresq and NSW Severn rivers and enable assessment of fish response to proposed watering actions.

The outcomes from these monitoring activities are used to inform portfolio management planning and adaptive management decision-making as outlined in Section 2.

2. Portfolio management in 2017–18

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 below and summarised in the sections below.

2.1. Antecedent and current catchment conditions and the demand for environmental water in 2017–18

In 2016–17, the Border Rivers region experienced periods of 'above average' rainfall that resulted in the largest flow events in the catchment since January 2013. These events included a series of medium to large in-channel pulses from August to October 2016, likely providing the first connection to the lower Macintyre River floodplains in three years. The region further experienced two heavy rainfall events in late March 2017 following ex cyclone Debbie, leading to a large in-channel pulse of short duration and minor flooding at end of system. Preceding August 2016, the only key flow events were a series of small freshes in 2014–15 and 2015–16.

This range of in-channel pulses in 2016–17 has met environmental demands of the majority of assets across the system. From the late 2016 flows, there was strong evidence of threatened Murray cod breeding on the Dumaresq River with young of year observed during monitoring in April 2017 (pers. comm. A. Townsend May 2017 NSW DPI Fisheries). Monitoring also recorded several native fish species across the NSW Severn and Dumaresq rivers, including olive perchlet, purple-spotted gudgeon, silver perch, crimson rainbowfish and Australian smelt. These observations are particularly important for short-lived fish species requiring low flows for spawning, like the threatened olive perchlet and purple-spotted gudgeon, as the recession of large in-channel pulses in late summer provided conditions for breeding. For the near channel anabranches and wetlands, there has been evidence of waterbird activity in early 2017 with royal spoonbills breeding in the anabranches of Callandoon Creek (pers. comm. R. Millward 2017 CEWO) and straw-necked Ibis foraging across the Lower Dumaresq floodplains (pers. comm. H. McGuiness 2017 CSIRO). The response of these species across the catchment, especially in the lower floodplains, suggest there were a number of ecological outcomes from these flows. Likely outcomes include enhanced carbon and nutrient cycling, increased primary production, increased access to additional in-stream habitat for aquatic fauna and improvement of native vegetation communities for foraging waterbirds. Further, the large scale movement, spawning and recruitment of several native fish species may have improved population resilience of threatened species in the Border Rivers, especially for low flow spawning fish which have relatively short life spans (< three years).

Even after recent events, and associated ecological outcomes, the Border Rivers is still recovering from prolonged periods of restricted flows over the last 13 years. Prior to the very high flows in 2010–11, high flows in 2011–12 and moderate flows 2012–13, the region had not experienced widespread connection with the lower Macintyre River floodplain since 2004. During these years of low to very low flows, small freshes from local rainfall are the only events able to fully, or partially, meet some of the demands of environmental assets. These freshes are not able to achieve widespread connection to wetlands, anabranches and floodplains, but can result in continuous end of system flows. Although these freshes do, in part, help protect some assets, including some breeding of the threatened Murray cod and eel-tailed catfish, the majority asset demands need further protection in 2017–18.

Environmental water demands for environmental assets in the Border Rivers catchment in 2017–18 are represented in Table 3 and are summarised below:

River channel: Low 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. There is a moderate demand for a medium to large pulse in late winter–early spring in the Dumaresq River to stimulate fish movement and breeding that would strengthen the resilience of these threatened populations after prolonged periods of low flows. This large pulse would also scour the riverbed to provide a stimulus to food webs. If this priming flow occurs, there is a moderate demand for a long stable low flow in spring to early summer to support the completion of breeding and dispersal of large fish and to provide breeding and recruitment opportunities for small fish that spawn in low flows. Meeting any 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. If not met by unregulated flows in 2017–18, demand in the lower Macintyre will be higher in 2018–19 as the required frequency for a large in channel pulse (biennial) has not occurred for over four years. With increased holdings in the Border River, high resource availability, or increase protection of unregulated flows, a significant contribution could potentially be made to meet these demands in the future.

If a prolonged period of low or zero inflow eventuates in 2017–18, an end of system top-up flow to provide in stream refuge and improve water quality in the river channel may be required.

Anabranches: Moderate 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 2017–18, 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 moderate / 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 could become more critical if not met this year. Requirements could potentially be met through targeted infrastructure assisted delivery in 2017–18. Low to moderate for other wetlands between Goondiwindi and Boomi, as these areas have only recently 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 in both areas have only been recently met after suitable unregulated flows. 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 four years through unregulated flows, irrigation deliveries and stimulus flows.

Murray-Darling Basin-wide environmental watering strategy and 2017–18 annual priorities

In contributing to these demands, the Commonwealth Environmental Water Office will also be aiming to contribute to the expected outcomes in the Basin-wide environmental watering strategy (see Attachment A) and the following 2017–18 Basin annual environmental watering priorities relevant to the Border Rivers:

- Improve flow regimes and connectivity to maximise the ecological function of the Barwon-Darling river system for native fish
- Support viable populations of threatened native fish and maximise opportunities for range expansion and the establishment of new populations
- Improve the abundance and diversity of the Basin's waterbird population
- Enable recruitment of trees and support growth of understorey species within river red gum, black box and coolibah communities on floodplains that received overbank flooding during 2016 by inundating the floodplains again

The Commonwealth Environmental Water Holder will not inundate private land without prior approval from land holders while contributing to the Basin annual environmental watering priorities.

2.2. Water availability in 2017–18

Forecasts of Commonwealth water allocations

Water resource availability, in the context of contributing to environmental demands, comprises total allocations (including carryover) against entitlements held by the Commonwealth in the major dams as well as water that becomes available to unregulated entitlements in the main river channel during natural flow events. Natural inflows can be infrequent and unpredictable in the Border Rivers, therefore unregulated environmental water volumes are dependent on the characteristics of the trigger flow event and cannot be described in advance. However, in terms of average annual yield, the Commonwealth's unregulated entitlements in the Border River currently exceed its regulated water holdings.

Ongoing allocations against regulated water entitlements in the Border Rivers are determined by the Queensland and NSW governments based on dam inflows and criteria in the respective water resource plans. The following forecasts of total regulated water (Table 2) are based on the best available information including State forecasts and historical inflow scenarios.

The volume of Commonwealth environmental water likely to be carried over in the Border Rivers for use in 2017–18 is estimated to be approximately 14 GL.

Table 2: Forecasts of Commonwealth water allocations (including carryover) in 2017–18 in the Border Rivers as at 31 May 2017.

Entitlement type	Forecasts of Commonwealth water allocations (including carryover) in 2017–18 (GL)					
	Very dry ← → Very wet					
	95 percentile	90 percentile	75 percentile	50 percentile	25 percentile	10 Percentile
Supplemented (QLD) – medium	13.4	13.4	13.4	13.5	13.5	13.5
General Security (NSW)	0.5	0.5	0.6	0.9	1.1	1.4
Total – Border Rivers	**13.9**	**13.9**	**14.0**	**14.4**	**14.6**	**14.9**
Unsupplemented (QLD)	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL	Up to 26 GL

Information on allocations to Commonwealth environmental water holdings can be found at http://www.environment.gov.au/water/cewo/about/water-holdings 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. While neither the QLD nor NSW government has any held environmental water in the Border Rivers, other relevant resources include planned environmental water, natural and unregulated flows, conveyance water and consumptive water. Further detail on sources of environmental water in Border Rivers 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 low to high resource availability scenarios are in scope for 2017–18. However, very low resource availability would require a significant deterioration (drying) in conditions, while high and very high availability is only possible with significant new inflows and unregulated flows.

The resource availability for the start of 2017–18 is low to moderate. This resource availability scenario takes into account relatively low public dam storage levels and the limited overall volume in accounts in the NSW and QLD schemes – as at May 2017 around 25 per cent of entitlement volume was held in medium security accounts in the QLD system and around 15 per cent overall in NSW general security accounts. Overall allocations to QLD medium security entitlements were 25 per cent in 2016–17 (to May 2016) and 20 per cent for NSW general security. It is important to note that while Commonwealth regulated account volumes are reasonable in the historical context, carryover from previous years contributes significantly to this position.

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

Environmental water needs (demand) and water availability (supply) both influence 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 3 shows how current demands and forecasted supply are considered together.

The overall 'purpose' for managing the Commonwealth's water portfolio in the Border Rivers for 2017–18 is to **protect** the health and resilience of near channel wetlands and ecological processes in the lower Macintyre River, and fish habitat and life cycles in the Dumaresq River. If resource availability becomes very high there may be scope to **improve** the health of these assets. A secondary aim is to maintain the health and resilience of selected key wetlands and anabranches.

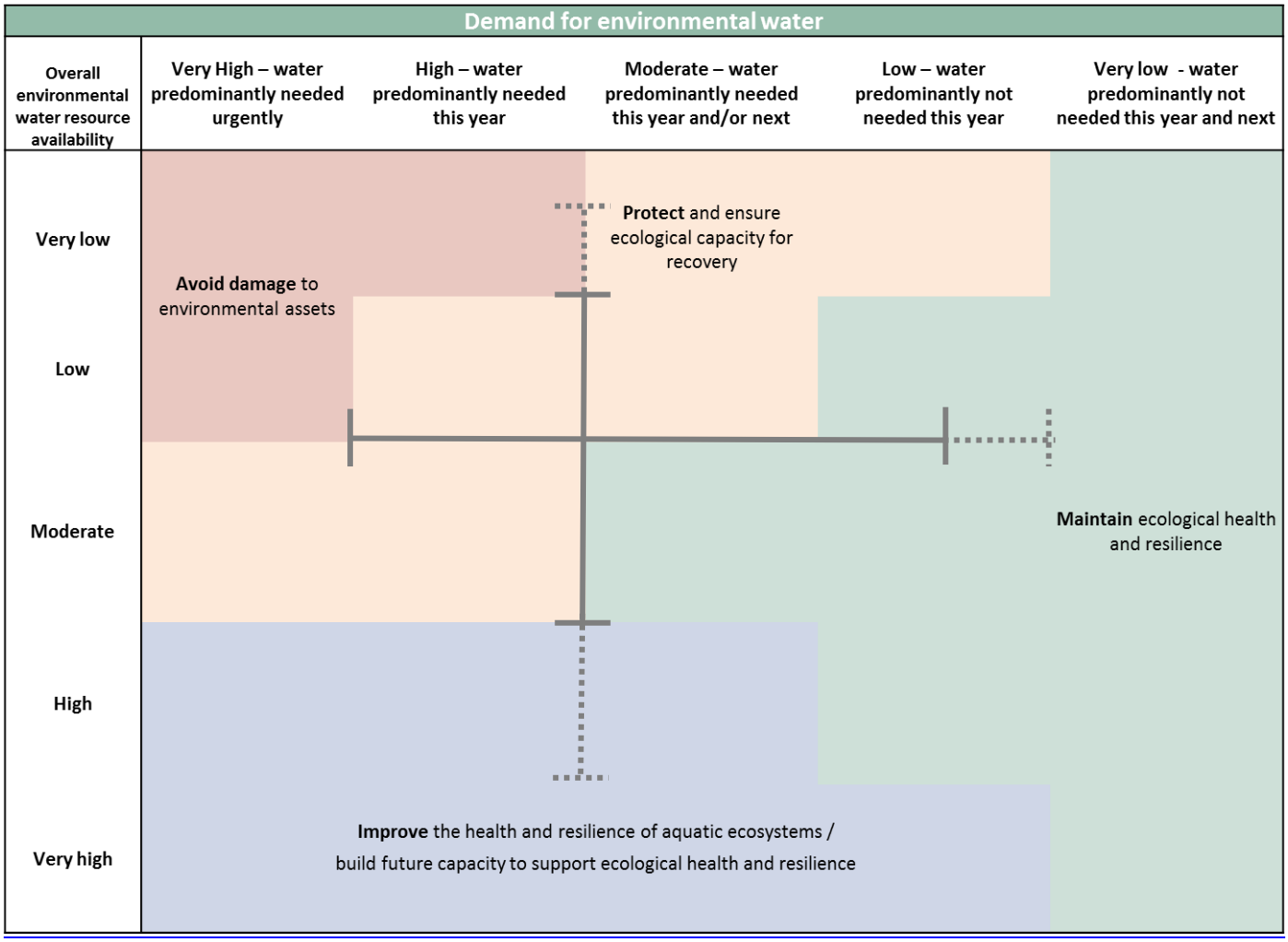

Figure 3: Determining a broad purpose for portfolio management in the Border Rivers for 2017–18. Note: grey lines represent potential range in demand and resource availability.

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, 2017–18* (available at: http://www.environment.gov.au/water/cewo/publications).

2.4. Water Delivery in 2017–18

The overall focus for use of Commonwealth environmental water in the Border Rivers (focusing on the main channels of the Dumaresq and Macintyre rivers, and the NSW Severn River) for 2017–18 is to support native fish reproduction and recruitment requirements subject to triggers and operational arrangements (see also Table 3 for supporting information regarding the basis for determining these watering intentions). There is a growing awareness of the importance of connecting flows across the northern basin. These connecting flows support populations of native fish and aquatic fauna in the Barwon-Darling and the northern tributaries including the Border Rivers. These flows provide hydrological connections that link a diversity of aquatic environments for feeding, breeding, dispersal, migration and re-colonisation, which is essential for the survival of native fish populations and other aquatic fauna. This importance will be taken into consideration when using Commonwealth environmental water for fish outcomes.

Commonwealth environmental water could also be used to maintain the health of some key floodplain assets (that are isolated from natural flows as a result of resource development), such as small volumes delivered to specific wetlands and/or anabranches in the lower Macintyre floodplain using public and private irrigation infrastructure.

Should unregulated flows not materialise, and the river dries significantly and system connectivity is lost, the focus will shift to supporting basic aquatic ecology. A watering action to replenish refuge pools and improve water quality to the end of the system would be considered.

Options (targets) for delivering Commonwealth environmental water in the main river channel will depend on the opportunities provided by unregulated flows and prevailing conditions. Going into 2017–18, the following options are priorities based on moderate resource availability and antecedent conditions:

- Stable flows in the Dumaresq and Severn rivers to provide reproduction and movement opportunities for native fish communities. The action would aim to improve available breeding habitat and support breeding and recruitment of native fish species including Murray cod, eel-tailed catfish, purple-spotted gudgeon and olive perchlet.

- Anabranch connectivity: 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).

- Wetland connectivity in the lower Dumaresq River to maintain health and resilience of wetland and riparian vegetation, and provide improved opportunities for lateral movement of aquatic biota between the river channel and wetlands, including opportunities for reproduction.

In the unexpected 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 proposed watering in the Border Rivers was sought from the Queensland Departments of Natural Resources and Mines and Agriculture and Fisheries, the NSW OEH, NSW Department of Primary Industries – Water and Fisheries, WaterNSW, BREWN, BRFF, QMDC and Northern Tablelands LLS.

There was general agreement around the proposed watering actions in the Dumaresq and Severn rivers to support fish outcomes. However, some questions were raised about the urgency of watering assets in 2017–18 considering that the majority of environmental demands were met in 2016–17. For fish outcomes, it was suggested the proposed watering actions be reviewed after initial short-term intervention monitoring results are received. The results will enable an assessment of the state of threatened fish populations in the Dumaresq and Severn rivers and also determine flow volumes specific to their breeding and recruitment requirements. These monitoring results will also confirm the feasibility of proposed watering actions with limited available environmental water and operational constraints.

There was general agreement that additional information is needed on the environmental values of some anabranches of the Macintyre River, as well as the wetlands of the lower floodplains (including Morella watercourse lagoons) to adequately determine urgency of watering and the need for environmental water.

Overall, there was considerable support for practical watering actions to be undertaken, if triggered. These actions should also adopt an adaptive approach to managing Commonwealth environmental water in the Border Rivers.

2.5. Trading water in 2017–18

The *Water Act 2007* provides for the trade of Commonwealth environmental water (allocations and entitlements) and specifies the conditions under which sales may occur. To improve environmental outcomes must be the primary reason for trade of Commonwealth Environmental water. The Commonwealth Environmental Water Holder has no plans to trade entitlements in 2017–18.

Planning on water trade considers supply and demand within the catchment and across the Basin. In the Border Rivers, inflows and allocations are highly variable. Where possible, retaining an account balance that will provide for environmental watering in future years under a range of climate scenarios is particularly important given the possibility of low to very low annual water allocation.

The Commonwealth Environmental Water Holder regularly assesses the environmental demand and supply position throughout the year, considering factors such as environmental condition and demand, current and forecast climate conditions, water availability, carryover capacity and market conditions. Any potential allocation trade would be subject to an assessment of the level of supply or demand for consumptive use within the Border Rivers water market. Should a decision be made to seek a trade, then further information will be made widely available at http://www.environment.gov.au/water/cewo/trade/current-trading-actions.

For more information on the rules and procedures governing the trade of Commonwealth environmental water, refer to the Commonwealth environmental water Trading Framework at: http://www.environment.gov.au/water/cewo/publications/water-trading-framework-dec2014.

2.6. Carrying over water for use in 2018–19

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 QLD (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 QLD 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 2018–19 will depend upon resource availability and demand throughout the year. Commonwealth environmental water in the Border Rivers may be carried over to 2018–19 if it is not required for priority in-channel actions in 2017–18 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 2018–19 include:

- Late winter or spring flows for fish conditioning and/or breeding purposes in the Dumaresq River
- 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 (150ML to 300ML 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 2017–18.

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 based upon best information available at the time.

More information on how the Commonwealth makes decisions on carryover is available at: http://www.environment.gov.au/water/cewo/portfolio-mgt/carryover

2.7. Identifying Investment Opportunities

Changes to the *Water Act 2007* in 2016 have increased the flexibility for the Commonwealth Environmental Water Holder (CEWH) to use the proceeds of water allocation sales to invest in environmental activities. Under these amendments environmental activities must improve environmental outcomes and be undertaken for the purpose of protecting and restoring environmental assets in the Basin.

The CEWH will publically release a Discussion Paper seeking feedback on what type of activities stakeholders would like the CEWH to consider when developing a framework for future investment in environmental activities.

It should be noted that proceeds of past water sales must be managed based on the legislation in place at that time, and are not available to be used for these activities.

Table 3a: Environmental demands, priority for watering in 2017–18 and outlook for coming years in the Border Rivers catchment – LOW WATER RESOURCE AVAILABILITY (moderate carryover, low inflows and allocations) IN 2017–18

Environmental assets	Physical and process assets	Indicative demand (for all sources of water in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	Required frequency (maximum dry interval)	2013–14 (Low–moderate)	2014–15 (Low)	2015–16 (Very low)	2016–17 (Moderate–wet)	Predominant urgency of environmental demand for water	Purpose under low resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19 / Not met in 2018–19
River channel **Severn (NSW), Macintyre, Dumaresq, Barwon River to Mungindi**	Fish resilience, maintain pool habitat during low flows, water quality and longitudinal connectivity	Base flow, flow variability and connectivity in Dumaresq and/or Macintyre Rivers[1,2] Up to 5 000 ML[14]	As required in extreme dry conditions or to provide variability. (trigger: flow <10 ML/d for more than 12 weeks at Mungindi)	Met by flows some months. Nov and Jan low-nil flow periods	Not met July to Dec ceased to flow at Mungindi.	Met by small unreg flow pulses and irrigation deliveries	Met by natural flows late 2016 and early 2017, with irrigation deliveries in Jan 2017	LOW	**Maintain**	Possible use of base flow / refuge protection if river dries down significantly later in the year	LOW	LOW	
												MODERATE	
	Fish movement, spawning/ reproduction/ recruitment (Threatened long-lived species i.e. Murray cod and eel-tailed catfish)	Dumaresq and NSW Severn: Small stable in-channel pulse 30–60 days	8 in10 years[15,16] (frequency aligned with BWS) Aug–Oct (peak spawning season for species)	Dumaresq – unknown	Dumaresq – unknown	Met (cod bred in Dumaresq)	Met by stable low flows in Oct–Dec	MODERATE to HIGH (required frequency should be protected to meet expected outcomes of BWS)	**Protect**	Possible / likely use in the Dumaresq. Subject to agreement on operational arrangements. If triggered, likely contribution to a watering action for specific fish outcomes	MODERATE	MODERATE	
				Unknown – NSW Severn	Unknown – NSW Severn	Met (cod bred in Severn)	Met by stable flows in Nov-Dec					HIGH	
	Fish movement, spawning/ reproduction/ recruitment (Threatened stable low flow spawning fish species i.e. olive perchlet, purple-spotted gudgeon)	Dumaresq and NSW Severn: Small stable in-channel pulse 30–60 days[14]	1 in 1 to 2 years[13] (low uncertainty) Up to 3 years[13] (high uncertainty) Sept–Dec (peak spawning season for species)	Probably not met in Dumaresq	Probably not met in Dumaresq	Probably met	Met by stable low flows in Oct–Dec	MODERATE to HIGH (required frequency should be protected to meet expected outcomes of BWS)	**Protect**	Possible / likely use in the Dumaresq. Subject to agreement on operational arrangements. If triggered, likely contribution to a watering action for specific fish outcomes	MODERATE	MODERATE	
				NSW Severn - unknown	NSW Severn - unknown	Probably met	Met by stable flows in Nov–Dec					HIGH	
	Scouring, inundate inter-connected riparian areas. Fish movement, spawning and conditioning of all native species	Medium to large in-channel pulse (Aug–Dec[5]) NSW Severn River: Flows > 2 000 ML/day[3,4] to change periphyton species 4 000 –16 000 ML Dumaresq River Flow height, duration and volume unknown	Stimulus flow can be released yearly if available. (max dry interval unknown) 1 in 2 to 3 years[6,9,15] for fish outcomes	Met in NSW Severn by stimulus flow	Not met in NSW Severn	Not met in NSW Severn	Met in NSW Severn by Sept–Oct 2016 flows	MODERATE to HIGH (required frequency for the Dumaresq should be protected after prolonged periods of not being met)	**Protect**	Possible small contribution in NSW Severn if required for a stimulus flow	MODERATE to HIGH (Dumaresq)	LOW	
				Probably not met in Dumaresq	Possibly partially met in Dumaresq	Possibly partially met in Dumaresq	Met by a series of medium to large flow events in Aug–Oct 2016			Insufficient environmental water in the Dumaresq to meet this demand		HIGH	
	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 for a minimum 5 days[6]	1 in 3 to 4 years[6] (max dry interval of 7–14 years[16]) Oct–Dec (needs of threatened fish)	Not met	Not met	Not met	Met by large pulses in Sep–Oct 2016 and mid-April 2017	LOW to MODERATE (moderate urgency outlined after prolonged periods of not being met)	**Maintain**	Insufficient environmental water to meet this demand. Unregulated entitlements will contribute if there are in-range unregulated flows	LOW to MODERATE	LOW to MODERATE	
			1 in 2 to 3 years[6] (max dry interval of 6–8 years[16]) Oct–Mar (needs of native fish)									MODERATE	

Environmental assets	Physical and process assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	Required frequency (maximum dry interval)	2013–14 (Low–moderate)	2014–15 (Low)	2015–16 (Very low)	2016–17 (Moderate–wet)	Predominant urgency of environmental demand for water	Purpose under <u>low</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19 / Not met in 2018–19
		Large in-channel pulse 4 000 ML/day at Mungindi for a minimum 11 days[6]	Occur twice a year every 1 in 3 to 4 years [6] (max dry interval unknown) Oct–Dec (support ecosystem functions)	Not met	Not met	Not met	Not met	HIGH (over 4 years since last met and maximum unterval unknown)	**Avoid damage**	Insufficient environmental water to meet this demand	HIGH	LOW to MODERATE CRITICAL	
Anabranches downstream of Yetman/Texas *Infrastructure assisted*	Nutrient and carbon cycling, enhanced primary production. Support fish movement and condition. Maintain riparian habitat for other species i.e. foraging and breeding habitat for waterbirds	1 500–4 000 ML per action (infrastructure assisted) to target anabranch(es) with long-term flow deficit	Unknown. Frequency and maximum interval depends on pre-development regime	Not met	Landholder watered Booberanna Creek Rest not met	Not met	Not met	HIGH (several anabranches might have long-term flow deficit)	**Avoid damage**	Possible infrastructure assisted delivery to an anabranch with high demand and environmental values, subject to additional information needed to support watering action	HIGH (several high commence to flow anabranches still dry)	MODERATE CRITICAL	
In conjunction with natural flows		7 500[7]–10 000[8] ML/day at Goondiwindi for 7 days[7] (connect 4 main anabranches: Callandoon, Dingo, Whalan, Boomi)	Possibly yearly[6,9] 1 in every 2 to 3 yrs for fish outcomes. (Maximum dry interval unknown)	Not met	Partially met Jan and April 2015 (not duration)	Partially met Aug and Nov 2015 (not duration)	Possibly met by large pulses in Sep 2016 and mid-Apr 2017	MODERATE to HIGH (some anabranches may still need protection as demand has not been met in over 4 years)	**Protect**	Unlikely contribution – insufficient environmental water to meet this demand. Need to review anabranch flow requirements	HIGH (majority of high commence to flow anabranches have been dry for long period)	LOW to MODERATE HIGH	
Wetlands, lagoons and billabongs *Infrastructure assisted* Eg. Morella watercourse lagoons	Maintain refuge for aquatic biota, fish and riparian vegetation health, nutrient/ carbon cycling	1 500–4 000 ML per action (infrastructure assisted) to target specific wetlands with long-term flow deficit	Max: up to 10 years between filling (Morella watercourse)	Not met	Not met	Not met	Not met	MODERATE to HIGH (lagoons with low to no connectivity have had partial to no inflow for over 7 years)	**Protect**	Detailed investigations are still required for some lagoons, including understanding environmental values and operational support	HIGH (assuming no major natural fill event for lagoons with low connectivity)	LOW HIGH to CRITICAL (depending on wetland / dry spell)	
In conjunction with unregulated flows Lower Dumaresq wetlands	Support movement, spawning and recruitment of aquatic species. Riparian vegetation health. Nutrient and carbon cycling	<u>NSW Severn River:</u> 1 200 ML/day[4] to connect upper reach wetlands	1 in 3 to 4 years for wetland vegetation[15] 1 in 2 to 3 years for fish outcomes[6,9,15] (short-lived threatened species)	Met for NSW Severn from stimulus flow in Aug and other flows	Met for NSW Severn from unregulated flows	Met for NSW Severn from unregulated flows	Met for NSW Severn from unregulated flows	LOW	**Maintain**	Possible small contribution in NSW Severn if required for a stimulus flow	LOW	LOW MODERATE	
		<u>Dumaresq River</u>: Flow height, duration unknown		Probably not met Dumaresq	Probably not met Dumaresq	Probably not met Dumaresq	Met for Dumaresq (largest flow pulse in 3 years)	MODERATE to HIGH (required frequency should be protected for fish outcomes after prolonged periods of not being met)	**Protect**	Unlikely contribution – insufficient environmental water to meet this demand. Subject to agreement on operational arrangements and or purchase arrangement	HIGH	LOW HIGH	

Environmental assets	Physical and process assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	Required frequency (maximum dry interval)	2013–14	2014–15	2015–16	2016–17	Predominant urgency of environmental demand for water	Purpose under <u>low</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19 / Not met in 2018–19
				(Low–moderate)	(Low)	(Very low)	(Moderate–wet)						
In conjunction with unregulated flows Lower Macintyre River wetlands	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. waterbirds	>20 000 ML/day at Goondiwindi – 7 days[10] (connects 90% wetlands and anabranches – Goondiwindi to Mungindi) >60 000 ML/day at Goondiwindi – duration unknown (connects billabongs with low connectivity) 10 000–15 000 ML/day at Goondiwindi and 4 000–6 000 ML/day at Terrewah – 4–8 days Oct to Mar[17] (low level wetland connection in Lower Macintyre i.e. Booberoi lagoon)	1 in 3 to 4 years for wetland vegetation[15] 1 in 2 to 3 years for native fish outcomes[6,9,15] Every 3 years for low flows spawning fish outcomes[13]	Not met	Not met	Not met	Met for majority of wetlands / anabranches by large pulses in Sep 2016 and Apr 2017. In both events, it only peaked over 60000 ML/day for one day	MODERATE to HIGH (minimal watering for wetlands / billabongs with high commence to fill rates i.e. >60 000 ML/day)[10]	**Protect**	Unlikely contribution (including targeting Terrewah) – insufficient environmental water to meet this demand	HIGH (assuming no major natural fill event for lagoons with high commence to fill rates)	LOW HIGH
									Carryover potential	Dependent on the triggering of a watering option to use regulated entitlements (up to 10 GL) – approved to June 2018	Low–moderate proportions of allocations carried over into 2018–19 unless watering options are triggered and priority actions undertaken	Levels of carryover will depend on the triggering of a watering options in 2017–18 and any additional regulated allocations.	
									Trade potential	There may be a need to adjust the availability of allocations through trade. Any potential allocation trade would be subject to an assessment of supply and demand within the water market in the Border Rivers				

References (Basin Wide Strategy and EWR's for assets)

[1] SKM (2009)
[2] NSW DWE (2009a)
[3] NSW Office of Water (2011)
[4] Davie and Mitrovic (2014); pers. comm. N Foster, DPI Water
[5] NSW DWE (2009b)
[6] MDBA (2012)
[7] SKM (2012); McGinness and Thoms (2002); Lowes et al (2008)
[8] SKM (2009)
[9] Reid et al (2012)
[10] Reid (2006) cited in CSIRO (2007); Reid et al (2015)
[15] NSW DPI (2015a)
[16] MDBA (2014b)
[17] Hutchison et al (2008)

Gauging stations

[11] NSW Real Time Water Data http://realtimedata.water.nsw.gov.au/water.stm?ppbm=DAILY
[12] QLD DNRM Water monitoring portal https://www.dnrm.qld.gov.au/water/water-monitoring-and-data/portal

Additional scientific input

[13] pers. comm. J Kerr, QDNRM (Stable low flows spawning fish)
[14] in-house estimates (i.e. maintain 50–100 ML/d at Mungindi or in the Dumaresq for 50 days)

Key - events in previous years

- means demand was met by Commonwealth environmental water or any other source
- means demand was partially met by Commonwealth environmental water or any other source (may be used to indicate infrastructure assisted delivery)
- means water not provided (or not required)

Note that not all demands require water every year; drying phases are important for floodplains and temporary wetlands or streams

Key - potential watering in 2016-17

- means a high priority for Commonwealth environmental watering (full or partial contribution, and subject to seasonal and operational considerations)
- means a secondary priority for Commonwealth environmental watering, likely to be met via other means (other water holders, or natural flows)
- means a low priority for Commonwealth environmental watering

Key - urgency of environmental demands

- means critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage
- means high demand for water i.e. needed in that particular year
- means moderate demand for water i.e. water needed that particular year and/or next
- means low demand for water i.e. water generally not needed that particular year
- means 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

Table 3b: Environmental demands, priority for watering in 2017–18 and outlook for coming years in the Border Rivers catchment – MODERATE WATER RESOURCE AVAILABILITY (moderate carryover, moderate inflows, low allocation) IN 2017–18

Environmental assets	Physical and process assets	Indicative demand (for all sources of water in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	Required frequency (maximum dry interval)	2013–14 (Low–moderate)	2014–15 (Low)	2015–16 (Very low)	2016–17 (Moderate–wet)	Predominant urgency of environmental demand for water	Purpose under moderate resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19 / Not met in 2018–19
River channel **Severn (NSW), Macintyre, Dumaresq, Barwon River to Mungindi**	Fish resilience, maintain pool habitat during low flows, water quality and longitudinal connectivity	Base flow, flow variability and connectivity in Dumaresq and/or Macintyre Rivers[1,2] Up to 5 000 ML[14]	As required in extreme dry conditions or to provide variability. (trigger: flow <10 ML/d for more than 12 weeks at Mungindi)	Met by flows some months. Nov and Jan low-nil flow periods	Not met July to Dec ceased to flow at Mungindi.	Met by small unreg flow pulses and irrigation deliveries	Met by natural flows late 2016 and early 2017, with irrigation deliveries in Jan 2017	LOW	Maintain	Irrigation deliveries and unregulated flows are expected to meet demand	LOW	LOW	
												MODERATE	
	Fish movement, spawning/ reproduction/ recruitment (Threatened long-lived species i.e. Murray cod and eel-tailed catfish)	Dumaresq and NSW Severn: Small stable in-channel pulse 30–60 days	8 in10 years[15,16] (frequency aligned with BWS) Aug–Oct (peak spawning season for species)	Dumaresq – unknown	Dumaresq – unknown	Met (cod bred in Dumaresq)	Met by stable low flows in Oct–Dec	MODERATE to HIGH (required frequency should be protected to meet expected outcomes of BWS)	Protect	Possible / likely use in the Dumaresq. Subject to agreement on operational arrangements. If triggered, likely contribution to a watering action for specific fish outcomes	MODERATE	LOW to MODERATE	
				Unknown – NSW Severn	Unknown – NSW Severn	Met (cod bred in Severn)	Met by stable flows in Nov–Dec					HIGH	
	Fish movement, spawning/ reproduction/ recruitment (Threatened stable low flow spawning fish species i.e. olive perchlet, purple-spotted gudgeon)	Dumaresq and NSW Severn: Small stable in-channel pulse 30–60 days[14]	1 in 1 to 2 years[13] (low uncertainty) Up to 3 years[13] (high uncertainty) Sept–Dec (peak spawning season for species)	Probably not met in Dumaresq	Probably not met in Dumaresq	Probably met (small pulse)	Met by stable low flows in Oct–Dec	MODERATE to HIGH (required frequency should be protected to meet expected outcomes of BWS)	Protect	Possible / likely use in the Dumaresq. Subject to agreement on operational arrangements. If triggered, likely contribution to a watering action for specific fish outcomes	MODERATE	LOW to MODERATE	
				NSW Severn – unknown	NSW Severn – unknown	Probably met (small pulse)	Met by stable flows in Nov–Dec					HIGH	
	Scouring, inundate inter-connected riparian areas. Fish movement, spawning and conditioning of all native species	Medium to large in-channel pulse (Aug–Dec[5]) NSW Severn River: Flows > 2 000 ML/day[3,4] to change periphyton species 4 000 –16 000 ML Dumaresq River Flow height, duration and volume unknown	Stimulus flow can be released yearly if available. (max dry interval unknown) 1 in 2 to 3 years[6,9,15] for fish outcomes	Met in NSW Severn by stimulus flow	Not met in NSW Severn	Not met in NSW Severn	Met in NSW Severn by Sept–Oct 2016 flows	MODERATE to HIGH (required frequency for the Dumaresq should be protected after prolonged periods of not being met)	Protect	Likely small contribution in NSW Severn if required for a stimulus flow	MODERATE	LOW	
				Probably not met in Dumaresq	Possibly partially met in Dumaresq	Possibly partially met in Dumaresq	Met by a series of medium to large flow events in Aug–Oct 2016			Possible contribution in the Dumaresq. Subject to agreement on operational arrangements		MODERATE	
	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 for a minimum 5 days[6]	1 in 3 to 4 years[6] (max dry interval of 7–14 years[16]) Oct–Dec (needs of threatened fish)	Not met	Not met	Not met	Met by large pulses in Sep–Oct 2016 and mid-April 2017	LOW to MODERATE (moderate urgency outlined after prolonged periods of not being met)	Maintain	Insufficient environmental water to meet this demand. Unregulated entitlements will contribute if there are in-range unregulated flows	LOW to MODERATE	LOW to MODERATE	
			1 in 2 to 3 years[6] (Max dry interval of 6–8 years[16]) Oct–Mar (needs of native fish)									MODERATE	

Environmental assets	Physical and process assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	Required frequency (maximum dry interval)	2013–14 (Low–moderate)	2014–15 (Low)	2015–16 (Very low)	2016–17 (Moderate–wet)	Predominant urgency of environmental demand for water	Purpose under <u>moderate</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19 / Not met in 2018–19
		Large in-channel pulse 4 000 ML/day at Mungindi for a minimum 11 days[6]	Occur twice a year every 1 in 3 to 4 years [6] (max dry interval unknown) Oct–Dec (support ecosystem functions)	Not met	Not met	Not met	Not met	HIGH (over 4 years since last met and maximum unterval unknown)	**Avoid damage**	Insufficient environmental water to meet this demand. Unregulated entitlements will contribute if there are in-range unregulated flows	HIGH	LOW / CRITICAL	
Anabranches downstream of Yetman/Texas *Infrastructure assisted*	Nutrient and carbon cycling, enhanced primary production. Support fish movement and condition. Maintain riparian habitat for other species i.e. foraging and breeding habitat for waterbirds	1 500–4 000 ML per action (infrastructure assisted) to target anabranch(es) with long-term flow deficit	Unknown. Frequency and maximum interval depends on pre-development regime	Not met	Landholder watered Booberanna Creek; Rest not met	Not met	Not met	HIGH (several anabranches might have long-term flow deficit)	**Avoid damage**	Possible infrastructure assisted delivery to an anabranch with high demand and environmental values, subject to additional information needed to support watering action	HIGH (several high commence to flow anabranches still dry)	MODERATE / CRITICAL	
In conjunction with natural flows		7 500[7]–10 000[8] ML/day at Goondiwindi for 7 days[7] (connect 4 main anabranches: Callandoon, Dingo, Whalan, Boomi)	Possibly yearly[6,9] 1 in every 2 to 3 yrs for fish outcomes. (max dry interval unknown)	Not met	Partially met Jan and April 2015 (not duration)	Partially met Aug and Nov 2015 (not duration)	Possibly met by large pulses in Sep 2016 and mid-Apr 2017	MODERATE to HIGH (some anabranches may still need protection as demand has not been met in over 4 years)	**Protect**	Unlikely contribution – insufficient environmental water to meet this demand. Need to review anabranch flow requirements.	HIGH (majority of high commence to flow anabranches have been dry for long period)	LOW / HIGH	
Wetlands, lagoons and billabongs *Infrastructure assisted* Eg. Morella watercourse lagoons	Maintain refuge for aquatic biota, fish and riparian vegetation health, nutrient/ carbon cycling	1 500–4 000 ML per action (infrastructure assisted) to target specific wetlands with long-term flow deficit	Maximum: up to 10 years between filling (Morella watercourse)	Not met	Not met	Not met	Not met	MODERATE to HIGH (lagoons with low to no connectivity have had partial to no inflow for over 7 years)	**Protect**	Detailed investigations are still required for some lagoons, including understanding environmental values and operational support	HIGH (assuming no major natural fill event for lagoons with low connectivity)	LOW / HIGH to CRITICAL (depending on wetland / dry spell)	
In conjunction with unregulated flows Lower Dumaresq wetlands	Support movement, spawning and recruitment of aquatic species. Riparian vegetation health. Nutrient and carbon cycling	<u>NSW Severn River:</u> 1 200 ML/day[4] to connect upper reach wetlands	1 in 3 to 4 years for wetland vegetation[15] 1 in 2 to 3 years for fish outcomes[6,9,15] (short-lived threatened species)	Met for NSW Severn from stimulus flow in Aug and other flows	Met for NSW Severn from unregulated flows	Met for NSW Severn from unregulated flows	Met for NSW Severn from unregulated flows	LOW	**Maintain**	Possible small contribution in NSW Severn if required for a stimulus flow	LOW	LOW / MODERATE	
		<u>Dumaresq River</u>: Flow height, duration unknown		Probably not met Dumaresq	Probably not met Dumaresq	Probably not met Dumaresq	Met for Dumaresq (largest flow pulse in 3 years)	MODERATE to HIGH (required frequency should be protected for fish outcomes after prolonged periods of not being met)	**Protect**	Unlikely contribution – insufficient environmental water to meet this demand. Subject to agreement on operational arrangements and or purchase arrangement	HIGH	LOW / HIGH	

Environmental assets	Physical and process assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	Required frequency (maximum dry interval)	2013–14	2014–15	2015–16	2016–17	Predominant urgency of environmental demand for water	Purpose under <u>moderate</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19 / Not met in 2018–19
				(Low–moderate)	(Low)	(Very low)	(Moderate–wet)						
In conjunction with unregulated flows Lower Macintyre River wetlands	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. waterbirds	>20 000 ML/day at Goondiwindi – 7 days[10] (connects 90% wetlands and anabranches – Goondiwindi to Mungindi) >60 000 ML/day at Goondiwindi – duration unknown (connects billabongs with low connectivity) 10 000–15 000 ML/day at Goondiwindi and 4 000–6 000 ML/day at Terrewah – 4–8 days Oct to Mar[17] (low level wetland connection in Lower Macintyre i.e. Booberoi lagoon)	1 in 3 to 4 years for wetland vegetation[15] 1 in 2 to 3 years for native fish outcomes[6,9,15] Every 3 years for low flows spawning fish outcomes[13]	Not met	Not met	Not met	Met for majority of wetlands / anabranches by large pulses in Sep 2016 and Apr 2017. In both events, it only peaked over 60000 ML/day for one day	MODERATE to HIGH (minimal watering for wetlands / billabongs with high commence to fill rates i.e. >60 000 ML/day)[10]	**Protect**	Unlikely contribution – insufficient environmental water to meet this demand	HIGH (assuming no major natural fill event for lagoons with high commence to fill rates)	LOW HIGH	

Carryover potential	Dependent on the triggering of a watering option to use regulated entitlements (up to 10 GL) – approved to June 2018	Moderate proportions of allocations carried over into 2018–19 unless watering options are triggered and priority actions undertaken	Levels of carryover will depend on the triggering of a watering options in 2017–18 and any additional regulated allocations.
Trade potential	There may be a need to adjust the availability of allocations through trade. Any potential allocation trade would be subject to an assessment of supply and demand within the water market in the Border rivers		

References (Basin Wide Strategy and EWR's for assets)

[1] SKM (2009)
[2] NSW DWE (2009a)
[3] NSW Office of Water (2011)
[4] Davie and Mitrovic (2014); pers. comm. N Foster, DPI Water
[5] NSW DWE (2009b)
[6] MDBA (2012)
[7] SKM (2012); McGinness and Thoms (2002); Lowes et al (2008)
[8] SKM (2009)
[9] Reid et al (2012)
[10] Reid (2006) cited in CSIRO (2007); Reid et al (2015)
[15] NSW DPI (2015a)
[16] MDBA (2014b)
[17] Hutchison et al (2008)

Gauging stations

[11] NSW Real Time Water Data http://realtimedata.water.nsw.gov.au/water.stm?ppbm=DAILY
[12] QLD DNRM Water monitoring portal https://www.dnrm.qld.gov.au/water/water-monitoring-and-data/portal

Additional scientific input

[13] pers. comm. J Kerr, QNRM (Stable low flows spawning fish)
[14] in-house estimates (i.e. maintain 50-100 ML/d at Mungindi or in the Dumaresq for 50 days)

Key - events in previous years

- means demand was met by Commonwealth environmental water or any other source
- means demand was partially met by Commonwealth environmental water or any other source (may be used to indicate infrastructure assisted delivery)
- means water not provided (or not required)

Note that not all demands require water every year; drying phases are important for floodplains and temporary wetlands or streams

Key - potential watering in 2016-17

- means a high priority for Commonwealth environmental watering (full or partial contribution, and subject to seasonal and operational considerations)
- means a secondary priority for Commonwealth environmental watering, likely to be met via other means (other water holders, or natural flows)
- means a low priority for Commonwealth environmental watering

Key - urgency of environmental demands

- means critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage
- means high demand for water i.e. needed in that particular year
- means moderate demand for water i.e. water needed that particular year and/or next
- means low demand for water i.e. water generally not needed that particular year
- means 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

Table 3c: Environmental demands, priority for watering in 2017–18 and outlook for coming years in the Border Rivers catchment – HIGH WATER RESOURCE AVAILABILITY (moderate carryover, high inflows, low to moderate allocations) IN 2017–18

Environmental assets	Physical and process assets	Indicative demand (for all sources of water in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	Required frequency (maximum dry interval)	2013–14 (Low–moderate)	2014–15 (Low)	2015–16 (Very low)	2016–17 (Moderate–wet)	Predominant urgency of environmental demand for water	Purpose under high resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19 / Not met in 2018–19
River channel **Severn (NSW), Macintyre, Dumaresq, Barwon River to Mungindi**	Fish resilience, maintain pool habitat during low flows, water quality and longitudinal connectivity	Base flow, flow variability and connectivity in Dumaresq and/or Macintyre Rivers[1,2] Up to 5 000 ML[14]	As required in extreme dry conditions or to provide variability. (trigger: flow <10 ML/d for more than 12 weeks at Mungindi)	Met by flows some months. Nov and Jan low–nil flow periods	Not met July to Dec ceased to flow at Mungindi.	Met by small unreg flow pulses and irrigation deliveries	Met by natural flows late 2016 and early 2017, with irrigation deliveries in Jan 2017	LOW	Maintain	Irrigation deliveries and unregulated flows are expected to meet demand	LOW	LOW	MODERATE
	Fish movement, spawning/reproduction/ recruitment (Threatened long-lived species i.e. Murray cod and eel-tailed catfish)	Dumaresq and NSW Severn: Small stable in-channel pulse 30–60 days	8 in10 years[15,16] (frequency aligned with BWS) Aug–Oct (peak spawning season for species)	Dumaresq – unknown	Dumaresq – unknown	Met (cod bred in Dumaresq)	Met by stable low flows in Oct–Dec	MODERATE to HIGH (required frequency should be protected to meet expected outcomes of BWS)	Maintain	Flows expected to meet demand in Dumaresq and / or contain stable low flow delivery outcomes	LOW	LOW	MODERATE to HIGH
				Unknown – NSW Severn	Unknown – NSW Severn	Met (cod bred in Severn)	Met by stable flows in Nov–Dec			If triggered by NSW, small contribution to a stimulus flow in the Severn			
	Fish movement, spawning/ reproduction/ recruitment (Threatened stable low flow spawning fish species i.e. olive perchlet, purple-spotted gudgeon)	Dumaresq and NSW Severn: Small stable in-channel pulse 30–60 days[14]	1 in 1 to 2 years[13] (low uncertainty) Up to 3 years[13] (high uncertainty) Sept–Dec (peak spawning season for species)	Probably not met in Dumaresq	Probably not met in Dumaresq	Probably met	Met by stable low flows in Oct–Dec	MODERATE to HIGH (required frequency should be protected to meet expected outcomes of BWS)	Maintain	Flows expected to meet demand in Dumaresq and / or contain stable low flow delivery outcomes	LOW	LOW	MODERATE to HIGH
				NSW Severn – unknown	NSW Severn – unknown	Probably met	Met by stable flows in Nov–Dec			If triggered by NSW, small contribution to a stimulus flow in the Severn			
	Scouring, inundate inter-connected riparian areas. Fish movement, spawning and conditioning of all native species	Medium to large in-channel pulse (Aug– Dec[5]) NSW Severn River: Flows > 2 000 ML/day[3,4] to change periphyton species 4 000 –16 000 ML Dumaresq River Flow height, duration and volume unknown	Stimulus flow can be released yearly if available. (max dry interval unknown) 1 in 2 to 3 years[6,9,15] for fish outcomes	Met in NSW Severn by stimulus flow	Not met in NSW Severn	Not met in NSW Severn	Met in NSW Severn by Sept–Oct 2016 flows	MODERATE to HIGH (required frequency for the Dumaresq should be protected after prolonged periods of not being met)	Maintain	Possible small contribution in NSW Severn if required for a stimulus flow.	LOW	LOW	LOW
				Probably not met in Dumaresq	Possibly partially met in Dumaresq	Possibly partially met in Dumaresq	Met by a series of medium to large flow events in Aug–Oct 2016			Possible contribution in the Dumaresq. Subject to agreement on operational arrangements			MODERATE
	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 for a minimum 5 days[6]	1 in 3 to 4 years[6] (max dry interval of 7–14 years[16]) Oct–Dec (needs of threatened fish) 1 in 2 to 3 years[6] (max dry interval of 6–8 years[16]) Oct–Mar (needs of native fish)	Not met	Not met	Not met	Met by large pulses in Sep–Oct 2016 and mid-April 2017	LOW to MODERATE (moderate urgency outlined after prolonged periods of not being met)	Maintain	Unlikely contribution - insufficient environmental water to meet this demand.	LOW to MODERATE	LOW to MODERATE	MODERATE

Environmental assets	Physical and process assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	**Required frequency (maximum dry interval)**	**2013–14** (Low–moderate)	**2014–15** (Low)	**2015–16** (Very low)	**2016–17** (Moderate–wet)	**Predominant urgency of environmental demand for water**	**Purpose under <u>high</u> resource availability**	**Potential Commonwealth environmental water contribution?**	**Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18**	**2019–20 Range of likely demand**	Met in 2018–19 / Not met in 2018–19
		Large in-channel pulse 4 000 ML/day at Mungindi for a minimum 11 days[6]	Occur twice a year every 1 in 3 to 4 years [6] (max dry interval unknown) Oct–Dec (support key ecosystem functions)	Not met	Not met	Not met	Not met	HIGH (over 4 years since last met and maximum unterval unknown)	**Avoid damage**	Possible contribution, in conjunction with a large unregulated flow, subject to sufficient held water. Would also meet lower Macintyre wetlands demand, subject to obtaining additional unregulated access in the lower Macintyre	HIGH	LOW to MODERATE	CRITICAL
Anabranches downstream of Yetman/Texas *Infrastructure assisted*	Nutrient and carbon cycling, enhanced primary production. Support fish movement and condition. Maintain riparian habitat for other species i.e. foraging and breeding habitat for waterbirds	1 500–4 000 ML per action (infrastructure assisted) to target anabranch(es) with long-term flow deficit	Unknown. Frequency and maximum interval depends on pre-development regime	Not met	Landholder watered Booberanna Creek Rest not met	Not met	Not met	HIGH (several anabranches might have long-term flow deficit)	**Avoid damage**	Demand likely to be partially met by unregulated flows	LOW to MODERATE	LOW	HIGH
In conjunction with natural flows		7 500[7]–10 000[8] ML/day at Goondiwindi for 7 days[7] (connect 4 main anabranches: Callandoon, Dingo, Whalan, Boomi)	Possibly yearly[6,9] 1 in every 2 to 3 yrs for fish outcomes. (Maximum dry interval unknown)	Not met	Partially met Jan and April 2015 (not duration)	Partially met Aug and Nov 2015 (not duration)	Possibly met by large pulses in Sep 2016 and mid-Apr 2017	MODERATE to HIGH (some anabranches may still need protection as demand has not been met in over 4 years)	**Protect**	Demand may be met by unregulated flows / irrigation deliveries. Need to review anabranch flow requirements and operational arrangements	MODERATE (as majority of high commence to flow anabranches have been dry for long period)	LOW	HIGH
Wetlands, lagoons and billabongs *Infrastructure assisted* Eg. Morella watercourse lagoons	Maintain refuge for aquatic biota, fish and riparian vegetation health, nutrient/ carbon cycling	1 500–4 000 ML per action (infrastructure assisted) to target specific wetlands with long-term flow deficit	Maximum: up to 10 years between filling (Morella watercourse)	Not met	Not met	Not met	Not met	MODERATE to HIGH (lagoons with low to no connectivity have had partial to no inflow for over 7 years)	**Protect**	Detailed investigations are still required for some lagoons, including understanding environmental values and operational support	HIGH (assuming no major natural fill event for lagoons with low connectivity)	LOW	HIGH to CRITICAL (depending on wetland / dry spell)
In conjunction with unregulated flows Lower Dumaresq wetlands	Support movement, spawning and recruitment of aquatic species. Riparian vegetation health. Nutrient and carbon cycling	<u>NSW Severn River:</u> 1 200 ML/day[4] to connect upper reach wetlands	1 in 3 to 4 years for wetland vegetation[15] 1 in 2 to 3 years for fish outcomes[6,9,15] (short-lived threatened species)	Met for NSW Severn from stimulus flow in Aug and other flows	Met for NSW Severn from unregulated flows	Met for NSW Severn from unregulated flows	Met for NSW Severn from unregulated flows	LOW	**Maintain**	Possible small contribution in NSW Severn if required for a stimulus flow	LOW	LOW	LOW to MODERATE
		<u>Dumaresq River</u>: Flow height, duration unknown		Probably not met Dumaresq	Probably not met Dumaresq	Probably not met Dumaresq	Met for Dumaresq (largest flow pulse in 3 years)	MODERATE to HIGH (required frequency should be protected for fish outcomes after prolonged periods of not being met)	**Protect**	Demand likely to be partially met by unregulated flows	MODERATE	LOW	HIGH

Environmental assets	Physical and process assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history[11,12] (from all sources of water)				2017–18			Implications for future demands		
		Flow/volume	Required frequency (maximum dry interval)	2013–14 (Low–moderate)	2014–15 (Low)	2015–16 (Very low)	2016–17 (Moderate–wet)	Predominant urgency of environmental demand for water	Purpose under <u>high</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19 / Not met in 2018–19
In conjunction with unregulated flows Lower Macintyre River wetlands	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. waterbirds	>20 000 ML/day at Goondiwindi – 7 days[10] (connects 90% wetlands and anabranches – Goondiwindi to Mungindi) >60 000 ML/day at Goondiwindi – duration unknown (connects billabongs with low connectivity) 10 000–15 000 ML/day at Goondiwindi and 4 000–6 000 ML/day at Terrewah – 4–8 days Oct to Mar[17] (low level wetland connection in Lower Macintyre i.e. Booberoi lagoon)	1 in 3 to 4 years for wetland vegetation[15] 1 in 2 to 3 years for native fish outcomes[6,9,15] Every 3 years for low flows spawning fish outcomes[13]	Not met	Not met	Not met	Met for majority of wetlands / anabranches by large pulses in Sep 2016 and Apr 2017. In both events, it only peaked over 60000 ML/day for one day	MODERATE to HIGH (minimal watering for wetlands / billabongs with high commence to fill rates i.e. >60 000 ML/day)[10]	**Protect**	Demand likely to be partially met by unregulated flows Unlikely contribution (including targeting Terrewah) - insufficient environmental water to meet this demand	MODERATE (still a deficit in frequency over 10 years and long term)	LOW MODERATE to HIGH	
									Carryover potential	Dependent on the triggering of a watering option to use regulated entitlements (up to 10 GL) – approved to June 2018	Moderate–high proportions of allocations carried over into 2018–19 unless watering options are triggered and priority actions undertaken	Levels of carryover will depend on the triggering of a watering options in 2017–18 and any additional regulated allocations.	
									Trade potential	Market activity may be thin and opportunities to trade allocation would be subject to an assessment of supply and demand within the water market in the Border Rivers.			

References (Basin Wide Strategy and EWR's for assets)

[1] SKM (2009)
[2] NSW DWE (2009a)
[3] NSW Office of Water (2011)
[4] Davie and Mitrovic (2014); pers. comm. N Foster, DPI Water
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Gauging stations

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

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 4, planning allows the 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.

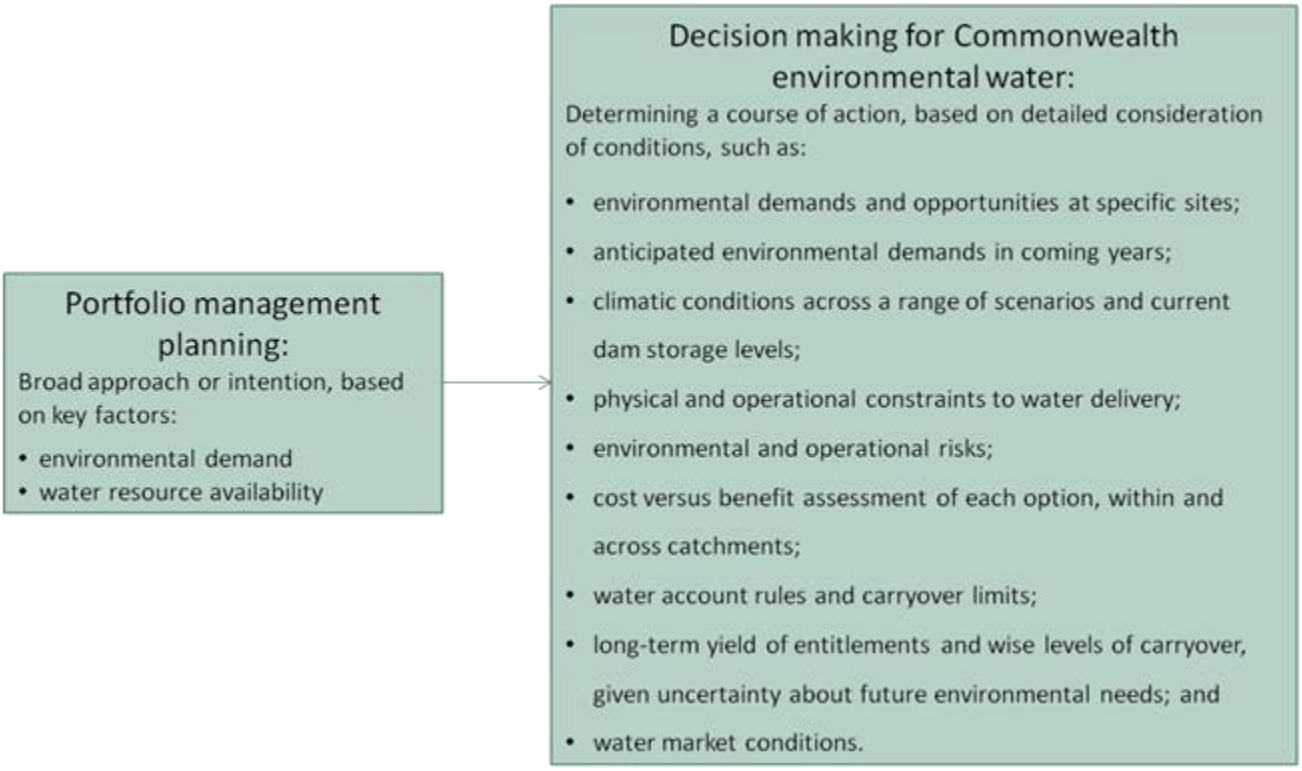

Figure 4: Planning and decision making for Commonwealth environmental water use

3.2. Further information

For further information on how the Office plans for water use, carryover and trade, please visit our web site: http://www.environment.gov.au/water/cewo

- 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: *Discussion Paper – Trade of Commonwealth Environmental Water* and *Commonwealth Environmental Water Trading Framework:* http://www.environment.gov.au/water/cewo/trade/trading-framework

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(QLD) *Water Resource (Border Rivers) Plan 2003*.

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New South Wales–Queensland Border Rivers Intergovernmental Agreement 2008.

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

Expected outcomes from the Basin-wide environmental watering strategy (MDBA 2014a) 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 freshes 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

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

Key native fish species for the Border Rivers catchment include:

Species	Longevity / Recruitment Frequency	Specific outcomes	In-scope for Commonwealth water in the Border Rivers?
Freshwater catfish (*Tandanus tandanus*)	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 (*Ambassis agassizii*)	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 (*Mogurnda adspersa*)	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.
River blackfish (*Gadopsis marmoratus*)	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
Silver perch (*Bidyanus bidyanus*)	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# (*Maccullochella peelii*)	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# (Macquaria ambigua)	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)

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

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 refuge	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 (QLD)		*		*	*	*	Yes (unregulated holdings)

Attachment B – Library of watering actions

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 QLD DNRM and NSW DPI Water.
- The long travel times for water orders (e.g. 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 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 protected from extraction in the Barwon-Darling. As a result, environmental deliveries undertaken during regulated/low flow conditions could potentially trigger pumping access in the Barwon or Darling rivers. End of system flows into the Barwon River during unregulated flow conditions are also not protected and could lead to additional extraction and loss of environmental water if the enhanced flows led to triggers for the next access licence class in the Barwon-Darling being met and/or extended the period that triggers were exceeded.

The risk of extraction of Commonwealth environmental water from the QLD 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 Rivers) 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 catchment and the levels of water resource availability that relate to these actions.

Table 4: Summary of potential watering actions for the Border Rivers

<table>
<tr><th rowspan="2">Broad Asset</th><th rowspan="2">Indicative demand</th><th colspan="5">Applicable level(s) of resource availability</th></tr>
<tr><th>Very Low</th><th>Low</th><th>Moderate</th><th>High</th><th>Very High</th></tr>
<tr><td rowspan="4">River channel (Macintyre, Severn (NSW), Dumaresq, Barwon River to Mungindi)</td><td rowspan="4">• Baseflows
• 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</td><td colspan="2">1. Refuge pools and water quality contingency: Contribute flows to refresh drought refuges and mitigate degrading water quality and provide longitudinal connectivity to Mungindi</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="3">2. Fish reproduction and recruitment flows: low stable flow to provide breeding habitat and support completion of breeding and/or recruitment of native fish (subject to agreement on operational arrangements)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">3. Scouring and conditioning flows: Contribute to flows to scour algae and reset biofilm processes, provide migration, spawning and dispersal cues for fish, connect with riparian areas</td></tr>
<tr><td></td><td></td><td colspan="3">4. Habitat availability and nutrient/carbon cycling: Contribute to flows to increase access to in-stream habitats, support movement, spawning and recruitment opportunities of native aquatic species</td></tr>
<tr><td rowspan="2">Anabranches</td><td rowspan="2">• 1 500–4 000 ML per site
• 7 500–10 000 ML/day at Goondiwindi for 7 days (November to February)</td><td></td><td colspan="3">5. Infrastructure assisted delivery: 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)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">6. Anabranch connectivity: Contribute to flows to support connectivity to and between anabranches and floodplain wetlands and river channel (subject to agreement on operational arrangements)</td></tr>
</table>

<table>
<tr><th rowspan="2">Broad Asset</th><th rowspan="2">Indicative demand</th><th colspan="5">Applicable level(s) of resource availability</th></tr>
<tr><th>Very Low</th><th>Low</th><th>Moderate</th><th>High</th><th>Very High</th></tr>
<tr><td rowspan="2">Wetlands</td><td rowspan="2">• 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. Booberoi</td><td></td><td colspan="4">7. Wetland connectivity: Contribute to unregulated flows to support lateral connectivity, primary production, nutrient and carbon cycling, and biotic dispersal and movement</td></tr>
<tr><td></td><td colspan="3">5. Infrastructure assisted delivery: 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)</td><td></td></tr>
</table>

Note: Under certain resource availabilities, options may be not 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.

Potential watering actions – standard operating arrangements

Table 4 identifies the range of potential watering actions in the Border Rivers catchment 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.

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. 8 weeks at Mungindi or suitable site in Dumaresq, threshold to be confirmed) 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.
- Release pattern would be based on the flow rates and duration required to achieve a sustained end of system flow, and provide some low flow variability in the system.

Typical extent: Dumaresq and Macintyre (main stem) rivers to Mungindi. The action will also provide flows into the Barwon River.

Approvals: Consult with QLD DNRM, SunWater, NSW DPI Water, WaterNSW, QLD and NSW Fisheries, NSW Office of Environment and Heritage, before implementing this action. Also inform key stakeholders, including BREWN, BRFF, Northern Tablelands LLS 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 the full volume (5 000 ML) to Mungindi may need to be negotiated as it will potentially require additional conveyance water to standard operations.

2. River channel – Fish reproduction and recruitment flow:

*Watering action: M*aintain a long stable low flow to support the completion of breeding of larger bodied fish, primarily Murray cod and eel-taled 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 low flow spawning fish in the Dumaresq River. Target species include purple-spotted gudgeon, olive perchlet, Western carp gudgeons and crimson 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).

<u>Flow to support Murray cod recruitment (NSW Severn or Dumaresq):</u>

- 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/d in the Severn; threshold in Dumaresq to be confirmed) followed by a long slow recession over 30 to 40 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 breeding and recruitment of 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 that will determine thresholds for inundation of key macrophyte habitat.
- 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.

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 Office of Water 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 bya suitable unregulated tributary flow event (medium to large flow pulse).
- Action is contingent on confirming operational arrangements Also, this action is is only feasible under high resource availability and/or with increased water holdings, to enable enhanced flow rates, 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 DPI Water in consulation with NSW OEH. These agencies, WaterNSW and NSW Fisheries would be consulted prior to a contribution being made to the stimuls flow. For the Dumaresq option, consult with QLD DNRM, NSW DPI Water, SunWater, WaterNSW, NSW OEH, QLD and NSW Fisheries, before implementation. Also inform relevant stakeholders; including BREWN, BRFF, Northern Tablelands LLS and QMDC, before implementing this 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.
- As an alternative, Commonwealth regulated holdings could be converted through trade and/or a swap process into additional supplementary(NSW)/water harvesting (QLD) access, to protect more of the unregulated flow event for targeted flow improvements in the lower Macintyre River.
- Commonwealth unregulated entitlements in the Dumaresq and Macintyre (in particular) would contribute to the action, contributing in-stream flows that are in additon 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 minumum 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 QLD DNRM, NSW DPI – Water, SunWater, WaterNSW, NSW OEH, NSW and QLD Fisheries before implementing this action. Inform relevant stakeholders; including BREWN, BRFF, Northern Tablelands LLS and QMDC, before implementing this action. May require development and implementation of a process for swapping and/or purchase and sale of relevant allocations.

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 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, QLD DNRM, WaterNSW, NSW DPI – Water, QMDC, BREWN and landholders would be undertaken before implementing this 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 enitltlements 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 aggrement on operational arrangements, if Commownealth 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. .

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. Alternatively, trade could be used to obtain additional unregulated access in the target reach of the lower Macintyre.
- 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 (QLD Severn River) and in Macintyre Brook (the latter being a very recent addition to the portfolio)
- New South Wales Border Rivers General B Security in Pindari dam.

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 QLD 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 QLD 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 fresh in the NSW Severn River (August to December). The release is triggered by an inflow into Pindari dam of over 1 200 ML (in one day) in the period April to August. Unused flows can be carried over to a maximum of 8 000 ML.

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