



Australian Government

Commonwealth Environmental Water Office

Commonwealth Environmental Water

Portfolio Management Plan

Northern Unregulated Rivers

2016–17



Front cover image credit: Culgoa River. Photo by Commonwealth Environmental Water Office

Back cover image credit: Narran Lakes. Photo by Commonwealth Environmental Water Office

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Commonwealth environmental water portfolio management planning

Commonwealth environmental water

The Commonwealth Environmental Water Holder is an independent statutory position established by the *Water Act 2007* to manage the Commonwealth environmental water holdings. The Commonwealth Environmental Water Holder leads and is supported by the Commonwealth Environmental Water Office (the Office), a division of the Australian Government Department of the Environment.

Under the *Water Act 2007*, Commonwealth environmental water must be managed to protect or restore environmental assets, so as to give effect to relevant international agreements. The *Water Act 2007* also requires that the Commonwealth Environmental Water Holder perform its functions and exercise its powers consistently with and in a manner that gives effect to the Basin Plan and that Commonwealth environmental water is managed in accordance with the Basin Plan's environmental watering plan.

Purpose of the document

This document sets out the plans for managing the Commonwealth environmental water portfolio in the Northern unregulated rivers for 2016–17. Efficient and effective management of Commonwealth environmental water requires the utilisation of all portfolio management options, including water delivery, carryover and trade. To support improved outcomes from water use over time, carryover provides the opportunity to optimise water use across water years and to improve water availability early in a water year, while trade provides further capacity to optimise use over the long-term as well as across catchments.

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 the Commonwealth environmental water portfolio, consistent with Basin Plan obligations including the expected outcomes in the Basin-wide environmental watering strategy and the Basin annual environmental watering priorities.

To learn more about the portfolio management planning approach see *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water 2016-17* (available at: <http://www.environment.gov.au/water/cewo/publications>).

Delivery partners

Commonwealth environmental water is managed with advice from a range of partners. In the northern unregulated rivers, our partners include the Queensland departments of Natural Resources and Mines and Agriculture and Fisheries, New South Wales Office of Environment and Heritage, New South Wales Department of Primary Industries – Water and Fisheries, Sunwater and WaterNSW.

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 northern unregulated rivers

1.1. The northern unregulated rivers

The northern unregulated rivers make up a significant proportion of the northern Murray-Darling Basin, and include the Moonie River, Condamine Balonne River, Nebine Creek, Warrego River and Barwon-Darling River systems (Figure 1). Reaches of the Border Rivers where the Commonwealth holds significant unregulated entitlement (and potentially in northern NSW catchments in the future) are also considered part of the unregulated rivers in terms of environmental water management. The Paroo River, which is the western-most river in the Basin, is unregulated but is not covered in this plan due to there being minimal water resource development and no environmental water holdings in this catchment.

The catchments in this group drain about 60 per cent of the Murray-Darling Basin above Menindee Lakes. Flow in these systems is dominated by natural flows in response to rainfall events rather than being primarily controlled by dams and other infrastructure as occurs in 'regulated' catchments of the Basin. There are still some dams and water supply schemes (notably in the Condamine-Balonne and Border Rivers). However, the majority of water use and entitlement is in the form of diversion of river flows and water that breaks out of rivers onto the floodplain (known as overland flow) during periodic unregulated flow events. Large-scale irrigation in the region is supported by large capacity pumps that divert water during unregulated flow events into on-farm storages ('ring tanks') for later use. Small-scale diversion of unregulated flows direct to cropped areas or small storages also occurs in areas where floodplains are limited or flows are too unreliable (e.g. effluent channels) to support large scale irrigation.

The northern unregulated rivers include headwater and slopes zones but for most of their length flow through flat semi-arid rangelands. The Barwon-Darling River from Mungindi to Menindee flows for 1,640 kilometres through semi-arid lowland. The tributary channels below St George – the Culgoa, Narran and Bokhara/Ballandool/Birrie rivers– in total traverse a similar length through the Lower Balonne floodplain.

The northern unregulated river systems are characterised by highly variable rainfall and ephemeral (intermittent) river flows. Significant flow events generally result from heavy rainfall in elevated headwater areas, with runoff from lowland areas making only a minor contribution. No flow periods of several months are common and may extend to several years in some systems during prolonged dry conditions. The degree of intermittency varies. The main channels of the Border Rivers are characterised by continuous flow but may experience short periods of low or no flow during droughts or extended dry spells. The Barwon-Darling is occasionally intermittent (experiencing zero flow up to 5 percent of the time). Most of the Lower Balonne system and the Moonie, Warrego, Nebine and Paroo systems are highly intermittent, experiencing zero flow for 50 percent or more of the time on a long term basis.

The flat landscape, low local runoff and intermittent flow conditions have led to the evolution of distinctive ecology in lowland river reaches. Aquatic and floodplain species are adapted to high flow variability and 'boom and bust' cycles. This is characterised by episodes of intense reproduction and high productivity by opportunistic plants and animals – (the 'boom') associated with periods of flooding, followed by periods of stress and reduced production – 'the bust' (Arthington and Balcombe 2011; Sheldon et al. 2010).

Other common environmental features of the northern unregulated river systems include:

Extensive wetlands and floodplains: Flat landscapes and highly variable flows have led to the formation of branching channels (tributaries and anabranches) in the downstream reaches of these rivers that distribute flow across large areas of floodplain and have created large areas of wetland. The Condamine-Balonne and Warrego systems have the largest area of wetlands of any of the catchments in the Basin and these take diverse forms (Nairn and Kingsford 2013; Eco Logical Australia 2016). Major wetland areas include the Narran Lakes system in the Lower Balonne, Cuttaburra Basin-Yantabulla Swamp in the lower Warrego, and the Talyawalka-Teryaweynya Creek system that splits off the Darling River around Wilcannia (Figure 1). The floodplain of the Lower Balonne Rivers covers nearly two million hectares; more than 890,000 hectares of floodplain in the Warrego was estimated to be inundated in a large flood in 1990 (Kingsford et al. 2001).

When inundated, wetlands and floodplains provide feeding and breeding opportunities for aquatic biota and waterbirds. A range of waterbirds feed and breed in the region including colonial nesting species (ibis, egrets, spoonbills), freckled duck, pelicans and brolga.

Waterholes: In between boom periods river channels typically dry to a series of disconnected waterholes which may then be reconnected by the next significant flow event. Semi-permanent and permanent waterholes in the main river channels and distributary creeks and anabranch systems are critical to ensuring species survival between boom periods and their capacity to recolonise the system in subsequent floods (Balcombe et al. 2007, DERM 2010). Much of the riverine fauna (e.g. fish, turtles, invertebrates) of the northern unregulated systems is dependent upon the persistence of a network of refugial waterholes during frequent and often prolonged no flow periods (QLD DSITI 2015).

Fish: The northern Basin native fish community includes species listed as threatened at the state and/or Commonwealth level, such as Murray cod and silver perch. It supports important remnant populations of olive perchlet, purple spotted gudgeon and eel tailed catfish that are no longer present in the southern Basin (NSW DPI 2015a). Golden perch, a medium bodied fish valued by anglers is also widely distributed in the north. There are a number of species that do not occur in the southern Basin, including Rendahl's and Hyrtl's tandan.

Native vegetation: Common riparian and floodplain vegetation in the dryland catchment areas include lignum, black box, coolibah and river red gum. River cooba is also widespread in woodland communities with yapunyah gum (in the Cuttaburra Creek system in the Warrego-Paroo) and belah also present in drier parts. Expansive native grasslands are a feature in the higher parts of the lower Balonne floodplain. There is a high proportion of remnant vegetation in good condition in the Warrego catchment (QMDC & SWNRM 2004) and a large part of the Culgoa River floodplain is also in relatively natural condition, with high species diversity and low presence of weed species (Dick 1993).

1.2. Environmental assets of the northern unregulated rivers

Key flow-dependent environmental assets in systems of the northern unregulated river catchments include:

Lower Balonne

- Wetlands cover more than 1.4 million hectares of the Condamine-Balonne-Nebine Creek catchment (Nairn and Kingsford 2012), including nationally and internationally important sites:
 - **Balonne River Floodplain** (nationally significant): several hundred hectares of billabongs and swamps within a larger floodplain area below St George in Queensland.
 - **Narran Lakes:** a large system of lakes and floodplain wetlands at the terminus of the Narran River in the Lower Balonne that supports internationally significant waterbird and migratory bird habitat. The northern part of the system is a Ramsar wetland. Narran Lakes is an important breeding site for many species, particularly straw-necked ibis, and also the Australian pelican, great cormorant, pied cormorant, rufous night heron, little egret, intermediate egret and the gull-billed tern (Thoms et al 2008). The lignum shrub lands in the Narran Lake Nature Reserve are some of the largest undisturbed communities of their type in NSW (NSW NPWS 2000).
 - **Culgoa River floodplain:** adjacent national parks in NSW and Queensland protect over 100,000 hectares of the interlinked floodplains of the Culgoa River and Nebine Creek. The Culgoa floodplain is noted for its high plant diversity and low percentage of introduced species (Dick 1993) and large relatively intact expanses of native grassland and coolibah woodland (Hunter 2005), including samples of the threatened ecological community coolibah-blackbox woodland.
- **Lower Balonne River floodplain:** The Lower Balonne River floodplain, covering two million hectares in Queensland and New South Wales, supports the largest area of wetland of any catchment in the Murray-Darling Basin. Native grasslands and coolibah woodlands on the floodplain are some of the most extensive in Australia and are considered to be in near natural condition. The distributary channels of the lower Balonne provide habitat for many aquatic plants and animals, including threatened species such as silver perch and Murray cod. Refugial waterholes that persist in these channels for up to 18 months in the absence of any inflow, are critical to the survival of in-stream fauna (QLD DSITI 2015).

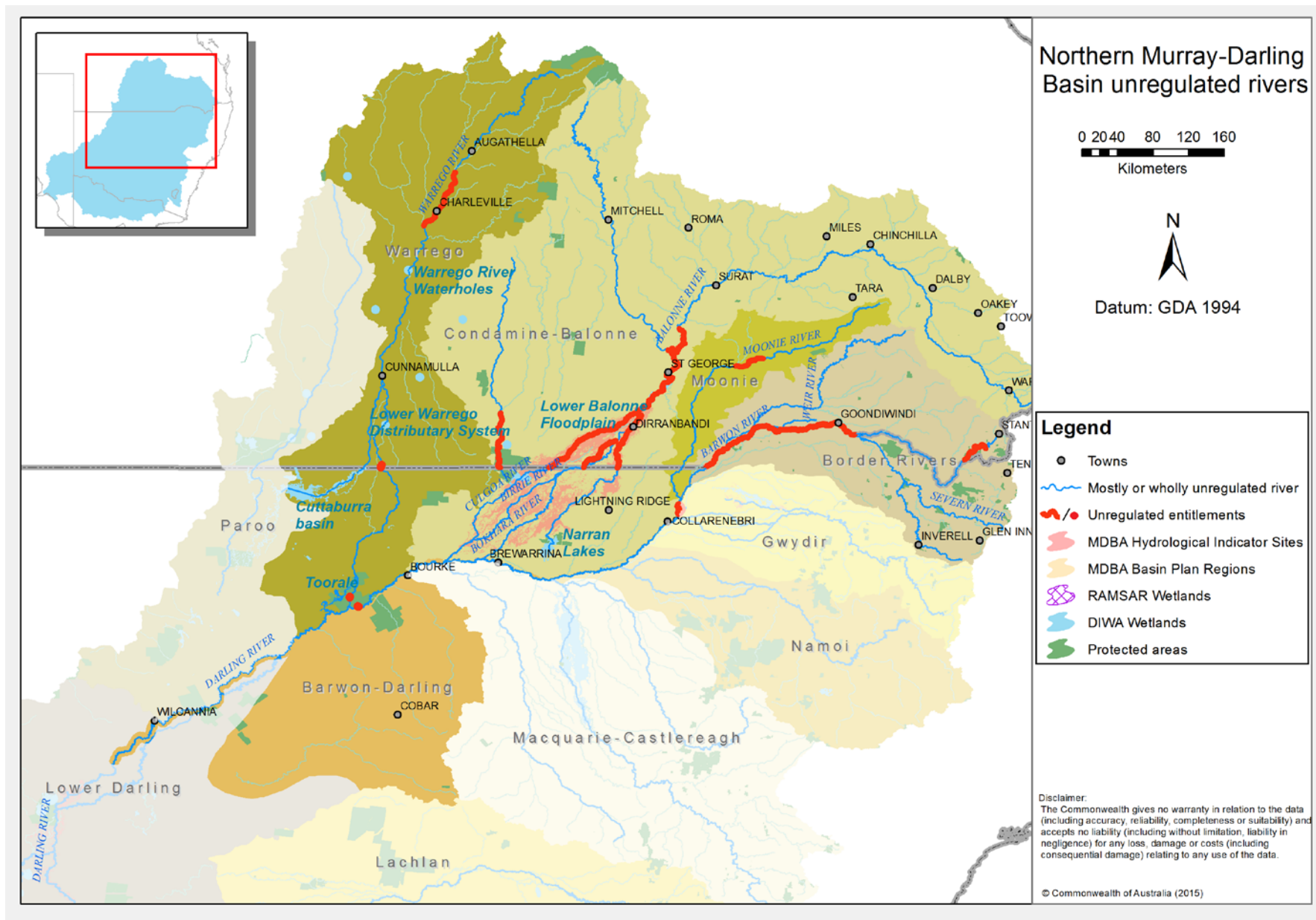


Figure 1: Map of the northern unregulated rivers.

Warrego

- The Warrego catchment also supports a very large area of wetlands, including lignum swamps, flood channels and waterholes, black box and spike rush swamps, claypans, freshwater lakes and saline lakes (Nairn and Kingsford 2012). Several wetlands are of national importance including the following sites which are dependent on low-medium seasonal flows and large floods in the main river (Holz et al. 2008):
 - **The Warrego River Waterholes:** a string of large, permanent and intermittent waterholes and billabongs covering 500 hectares along the Warrego River channel between Charleville to south of Wyandra. The waterholes support a rich native fish fauna including Murray cod and silver perch. Flows that reconnect the waterholes have been shown to be important for redistributing previously isolated native fish assemblages and for driving recruitment of several species (Balcombe et al. 2006). Significant waterbird populations can also inhabit the waterholes after flooding.
 - **The Warrego River Distributary System** covers 12,000 hectares of open woodlands of coolibah and lignum shrubs in distributary creeks (and their associated floodplain swamps) that break from the Warrego above and below Cunnamulla. They comprise Widgeegoara, Noorama, Thrulgoonia and Tuen Creeks which flow to the south-east and Cuttaburra and Irara Creeks flowing to the south-west.
 - **Cuttaburra Basin** includes the nationally significant Yantabulla Swamp, a mosaic of channels, floodways and wetlands covering 37,000 hectares. The swamp consistently supports large numbers and a high diversity of waterbirds and when flooded provides breeding sites for ducks and colonial waterbirds (Kingsford et al. 1994; Kingsford et al. 2013). It is considered the most important breeding site in north-west NSW for the vulnerable freckled duck. The channels of Cuttaburra Creek also support large numbers of waterbirds (Kingsford et al. 1997) and a distinctive woodland vegetation comprising river red gum on the banks of the waterholes and floodplains dominated by Yapunyah gum (limited distribution in NSW), coolibah and black box, with cane grass grassland and lignum also present (King et al. 1995).
- The '**Western Floodplain**' at Toorale near the junction of the Warrego and Darling rivers, is a large wetland covering over 10,000 hectares. Key vegetation species include coolibah and black box trees in the upper story, river cooba in the mid-storey and a scattered to dense shrub layer of lignum. The floodplain includes examples of coolibah-black box woodland endangered ecological community listed under Commonwealth legislation. (Gowans et al. 2012)

The Western Floodplain provides habitat for number of international migratory bird species including the rainbow bee-eater, great egret, and glossy ibis; nationally threatened waterbirds including Australian painted snipe and Australasian bittern; and waterbirds listed as threatened in NSW including the brolga, freckled duck and blue-billed duck (Alluvium 2016). Other fauna recorded in the wetland include the desert froglet and the Murray turtle (Capon 2009).

- **Waterholes** along the Warrego River in Queensland, Cuttaburra Creek and other Warrego distributary channels and permanent waterbodies on the Warrego at Toorale provide valuable refuge habitat for fauna including waterbirds, fish, birds and aquatic macroinvertebrates during dry periods. Ten species of native fish have been recorded in waterholes in the lower Warrego in Queensland (Balcombe et al. 2006) including threatened species listed in state or Commonwealth legislation. The storages at Toorale also intermittently support significant numbers and numerous species of waterbirds (Capon 2009). Waterbird breeding activity, in the Australasian darter, black-fronted dotterel, royal spoonbill and freckled duck, has also been observed at Boera Dam and Ross Billabong (Eco Logical Australia 2015).

Barwon-Darling

- **The Barwon-Darling river channel** connects all the rivers, lakes and wetlands in the northern Basin, providing a critical dry period refuge and movement corridor for fish and waterbirds. Diverse in-stream habitats including channels, deep pools, riffles, inset and higher floodplain benches, snags and woody debris, gravel beds and aquatic and riparian vegetation (NSW DPI 2007) support a significant native fish community and a healthy community of turtles, mussels, shrimp and other aquatic species. Lakes and wetlands along the floodplain provide water bird breeding sites and staging posts for migratory species.

- **Wetlands:** the Barwon-Darling River river supports a high density and wide variety of wetlands that receive flows from the main river prior to overbank inundation. More than 580 wetlands were mapped between Mungindi and Menindee from aerial photographs, including anabranches, flood runners, billabongs, deflation basins, lakes and swamps. (Brennan et al. 2002)
- **Talyawalka Anabranch-Teryaweynya Creek** is a nationally important wetland system to the west of the main Darling River channel between Wilcannia and Menindee. The channels and lakes of Talyawalka Anabranch and its distributary Teryaweynya Creek support extensive areas of floodplain vegetation and black box woodland in particular. When inundated the system's lakes provide habitat for large numbers of waterbirds. Poopelloe Lake, Talyawalka Creek and Pelican Lake (in the Teryaweynya system), along with the Darling River floodplain near Louth are known or predicted to support 20,000 or more waterbirds (Kingsford et al. 1997).

Moonie

- Over 100 wetlands exceeding one hectare in area have been mapped in the Moonie, many of which are in the lower catchment below Nindigully (CSIRO 2008). Thallon waterholes have been observed to support between 10,000 and 20,000 waterbirds (Kingsford et al. 1997). There is past evidence of black swans, grey teal and little black cormorants breeding at the waterholes (QLD DNR 1999).
- Threatened waterbirds including the Australian painted snipe and freckled duck and fish including purple spotted gudgeon and eel tailed catfish have been observed in the Moonie (CSIRO 2008).
- The Moonie has relatively long and deep waterholes that have been shown to be critical refugia for sustaining native fish populations in the often long periods between flows in the system. Species including golden perch, bony bream, eel tailed catfish and smelt moved significant distances (up to 70 kilometres) in response to waterhole reconnecting flows, enabling recolonisation of the system and genetic mixing (QLD DERM 2010; Marshall et al. 2016).

1.3. Environmental objectives and outcomes in the northern unregulated rivers

The long-term environmental objectives and expected outcomes for the Murray-Darling Basin are described in the Basin Plan's environmental watering plan and the Basin-wide environmental watering strategy. The Basin-wide environmental watering strategy includes quantified environmental outcomes at both a Basin-scale and for each catchment. Outcomes relevant for the northern unregulated rivers are described in [Attachment A](#). They include a 10 per cent increase in inflows to the Barwon-Darling and a 30 to 60 per cent increase in low floodplain flows in the Condamine-Balonne catchment. Numerous river reaches and wetlands in the northern Basin are identified as important native fish and waterbird assets, respectively. The Border Rivers and the Condamine River in particular are priority streams for expansion of the range and/or establishment of new populations of the threatened species eel tailed catfish, olive perchlet and purple spotted gudgeon. Similarly, the Barwon-Darling and Condamine are priority streams for silver perch.

Comprehensive assessments of environmental water requirements were undertaken by the Murray-Darling Basin Authority (MDBA) in 2012 for key environmental assets in the northern unregulated rivers as part of the determining the sustainable diversion limits under the Basin Plan. These assessments cover the Lower Balonne River floodplain system (MDBA 2012a); Narran Lakes (MDBA 2012b) and in-channel flows for the lower Border Rivers and Barwon-Darling systems (MDBA 2012c&d). The resulting requirements are a suite of indicators covering key flow components (low flows, freshes, bankfull, overbank) expressed as flow rates and durations at specific sites with target frequencies to be achieved over the long term.

Environmental water requirements for the Lower Balonne and Barwon-Darling river systems are being reassessed by the MDBA as part of the northern Basin review (2014 to 2016) to inform potential revised sustainable diversion limits for the northern Basin. Preliminary site specific flow indicators for these two systems that have been identified in new science and knowledge review projects commissioned for the northern Basin review, are included in Table 3 and Table 4.

In the context of unregulated rivers and entitlements, long term flow indicators for specific assets or river reaches and Basin-wide environmental watering strategy outcomes are a benchmark against which the flow improvements and environmental outcomes of ongoing in-stream use are evaluated. Evidence that long term outcomes are not being met will inform priorities for remaining recovery and/or future rebalancing of the environmental water portfolio, as well as highlighting short-term or urgent environmental demands that where feasible, could be addressed through active management (refer section 2).

In the long term the Office seeks whole-of-system environmental outcomes in unregulated systems through having a targeted portfolio of entitlements that restores ecologically important flows that were formerly diverted for irrigation and other uses. Although seasonal flow patterns have largely been preserved in the unregulated northern rivers, diversions during unregulated flow events and flow changes due to small regulated water schemes (Condamine-Balonne, Border Rivers) and in-stream weirs have reduced the volume, duration and frequency of flows that support in-stream and floodplain communities, and terminal wetlands in some areas. End of system flows have been reduced in all systems. Low flow regimes have also been affected in some areas including an increase in the percentage of time with no flow and the maximum period between events that refill waterholes and re-establish hydrological connectivity throughout the system.

The Office has worked closely with Commonwealth and state government water recovery teams to ensure that unregulated entitlements recovered in the northern Basin provide flows that will contribute to key flow regime deficits, long term water requirements of environmental assets and the outcomes for native fish, longitudinal and lateral connectivity, riparian and floodplain vegetation and waterbirds identified in the Basin-wide environmental watering strategy.

1.4. Environmental flow requirements

Commonwealth unregulated entitlements contribute to all components of the flow regime, having the overall effect of improving natural flow variability. Flow improvements and associated environmental outcomes depend on the characteristics of the unregulated flow event (size, duration, timing, sequence), the extent to which access to Commonwealth unregulated entitlements is activated and diversions made by other users during the event. In-stream contributions are in proportion to the Commonwealth's share of total diversion opportunity in any given flow event, which in most catchments and events, is relatively small.

The largest relative contribution is in the Lower Balonne where the Commonwealth holds almost 20 per cent (at 31 May 2016) of total water harvesting entitlement in the system, as long-term yield. In the Barwon-Darling the cumulative contribution from in-catchment and upstream unregulated entitlements can be significant if tributary inflows coincide, as observed in autumn 2013 and March 2015. Residual flows of Commonwealth environmental water from regulated actions in tributary catchments can provide small inflows (up to around 10 GL per action/tributary stream) which may also contribute to low flow demands in the Barwon-Darling, as was observed in spring 2014 following a Commonwealth environmental watering action in the Gil Gil/Carole Creek system in the lower Gwydir.

Commonwealth environmental water contributions during small to moderate flow events are proportionately larger than during larger flow events. However, Commonwealth floodplain harvesting/overland flow and high flow threshold river access entitlements may, in higher flow events, contribute to floodplain wetting in areas including the Culgoa River floodplain, the Warrego Western Floodplain at Toorale National Park and in Nebine Creek.

A combination of held environmental water and unregulated flows will contribute to environmental demands. In unregulated systems the component of unregulated flow events that is not allocated for use through access 'rules' in water sharing plans is generally referred as planned environmental water. This component may be supplemented in certain instances (to a small degree) by specific flow event protection rules that reduce or defer extraction to achieve an environmental outcome. Examples include reduced extraction during dry spell breaking low flows in the lower Balonne and embargoes on extraction in the Barwon-Darling to maintain flows to mitigate algal blooms. Flow event protection rules across the northern Basin are summarised in [Attachment B](#). In some areas, occasional active management of unregulated water through temporary purchase, swapping entitlements or use of infrastructure may provide more targeted flow benefits to specific environmental assets in limited circumstances (refer to section 2).

1.5. Monitoring and adaptive management

Operational monitoring is undertaken for all Commonwealth environmental watering actions and involves collecting data such as volumes delivered, impact on the river system's hydrograph, area of inundation and river levels. It can also include observations of environmental outcomes.

The Office monitors stream flows in the northern Basin using real-time data from river gauges, to detect when access to Commonwealth unregulated entitlements is triggered. River flow data in conjunction with official announcements of water harvesting access in Queensland systems (Lower Balonne, Border Rivers, Warrego) is used to estimate in-stream use. Volumes are accounted in accordance with the specific access conditions of each entitlement in the same way that other water users manage their take. Accounting is based on the assumption that water is used at all available opportunities (when flow conditions are triggered) up to allowed limits. This reflects the use pattern of the majority of irrigators in unregulated systems and hence the volumes and pattern of flows that are likely to have been reinstated to the systems.

The hydrograph of the unregulated flow event at relevant points in each catchment is reviewed to determine if key ecological thresholds and flow indicators have been met, assess likely environmental outcomes and the contribution that the component of Commonwealth environmental water may have made to these outcomes. The difference between the hydrograph of the flow event with and without Commonwealth environmental water gives an indication of the incremental benefit of the in-stream contribution to overall flow and environmental outcomes.

Long Term Intervention monitoring is also being undertaken at the junction of the Warrego and Darling Rivers Selected Area (at Toorale). It aims to evaluate the contribution of Commonwealth environmental water delivery in relation to the expected outcomes at the local and Basin scale. At Toorale, this includes considering both local catchment-based Commonwealth unregulated flow contributions and residual inflows from upstream unregulated and regulated sources. Information on the monitoring activities is available at <http://www.environment.gov.au/water/cewo/catchment/northern-unregulated-rivers/monitoring>.

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

2. Portfolio management in 2016–17

In the northern unregulated catchments with in-stream use of entitlements, there is limited ability to manipulate use to achieve targeted flow and environmental outcomes. Water cannot be ordered from storage at a particular time – environmental water can only be sourced as a share of an unregulated flow event, determined by entitlement conditions. Carryover and management of account balance cannot generally be used to influence the timing and volumes of environmental water in river systems. There is limited public infrastructure such as dams, weirs and other structures in the region to regulate environmental flows to target particular assets.

Targeted acquisition of unregulated entitlements in water recovery programs and future rebalancing of the portfolio are the main ways to ensure maximum and targeted long term flow benefits. Ongoing in-stream use, under full Basin Plan recovery, will provide the basis for achieving the long-term water requirements of environmental assets in the northern unregulated rivers.

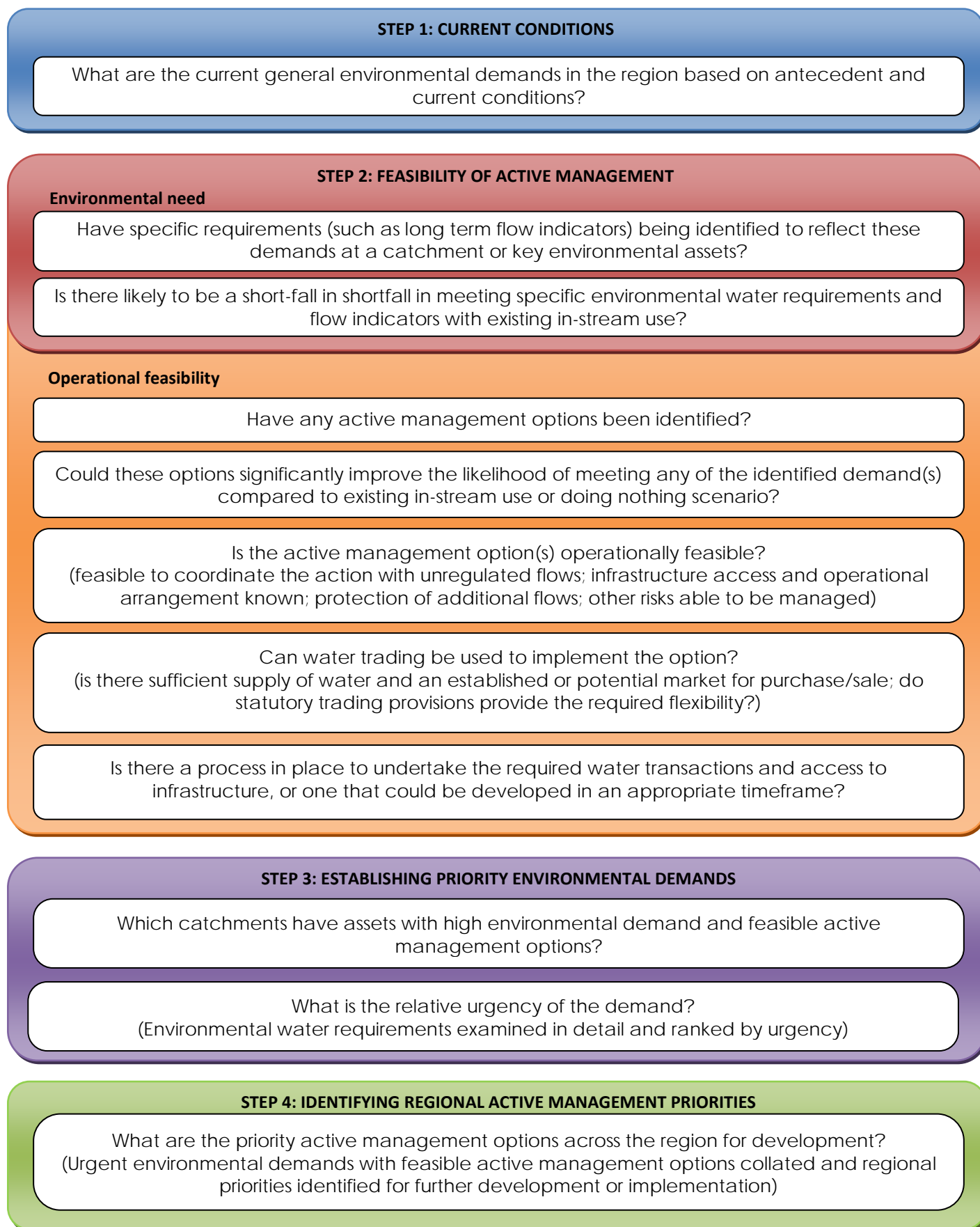
Most Commonwealth unregulated entitlements are left in-stream to provide environmental benefits by restoring flows that were formerly extracted and improving flow variability. The ongoing in-stream use of existing and future unregulated entitlements in the northern Basin (excluding the Toorale Warrego River entitlements and NSW supplementary water holdings) was approved by the Commonwealth Environmental Water Holder in November 2012. This decision does not preclude alternative uses but is the default management arrangement for these entitlements.

Active management of unregulated entitlements will be used on an occasional basis to contribute to urgent or specific environmental demands that in-stream use is unlikely to meet. 'Active management' encompasses mechanisms to achieve more targeted environmental outcomes from unregulated flow events, such as use of in-stream and on-farm infrastructure, water trading, modified pumping access and flow protection rules. Active management could be used to enhance overall flows, alter the timing or rate of flow or to direct flow to a different watercourse or an off-stream asset. Use of private irrigation infrastructure to divert, store, supply and/or re-direct environmental water, may play a key role in implementing active management due to the lack of public infrastructure in the region for this purpose.

Priorities and intentions for active management in the northern unregulated rivers in 2016–17 and 2017–18 were determined using the following steps (shown schematically in Figure 2):

1. Antecedent flows and current catchment conditions were reviewed to identify general environmental demands across the northern unregulated rivers region going into 2016–17 (Section 2.1).
2. Catchments where active management is able to be developed over the next two years were identified using criteria around long-term environmental demands and operational feasibility (Table 2). Some approaches take time to establish and implement so only active management option(s) that are feasible or could become feasible within the coming year or next have been prioritised. There are also areas where there is no need to augment or modify existing in-stream use now or in the future.
3. For catchments with generally high environmental demand (from Step 1) and feasible active management options (Step 2), environmental water requirements were examined in detail and ranked by urgency. This step focused on the Lower Balonne and Barwon-Darling systems where environmental water requirements have been comprehensively assessed and long term flow indicators identified (Table 3 and Table 4).
4. Urgent environmental demands with feasible active management options were collated to identify regional priorities for 2016–17 (Table 5).

Figure 2: Active management prioritisation process for the northern unregulated rivers



2.1. Antecedent and current conditions and the demand for environmental water in 2016–17

The last three years have been characterised by low and very low stream flow across the northern unregulated rivers. It has been five years (2011–12) since significant stream flow and floods were uniformly experienced (Table 1), with the exception of the Condamine-Balonne and Moonie Rivers which had moderate to high flows in 2012–13.

Table 1: Annual flows at key sites in the northern unregulated rivers 2007 to 2016

Catchment	Gauge (period of records)	Recent annual streamflow ¹								
		2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16
Border Rivers - Upper (Old)	Severn River at Farnbro (from 1962)	High	Low	Very Low	Highest on record	Low	Moderate	Very Low	Low	Very Low
	Macintyre River at Goondiwindi (from 1980)	Low	Moderate	Very Low	Highest on record	High	Moderate	Moderate	Low	Very Low
Moonie	Nindigully (from 1969)	High	Moderate	Very High	Highest on record	Very High	High	Low	Very Low	Very Low
Lower Balonne	St George (from 1971)	Moderate	Very Low	Very High	Highest on record	Very high	High	Low	Low	Low
Nebine Creek ²	Roseleigh Crossing (from 2007)	Very High	Moderate	Highest since 2007	High	High	Very Low	Low	Low	High
Warrego - Upper (Old)	Augathella (from 1967)	Very High	Moderate	High	Highest on record	Very High	Low	Very Low	Moderate	Lowest on record
	Wyandra (from 1966)	Very High	Low	Very High	Very High	Very High	Lowest on record	Very Low	Low	Low
	Ford's Bridge (from 1972)	Very High	Very Low	Very High	Very High	Very High	Very Low	Very Low	Low	Very Low
Barwon-Darling - Upper	Collarenebri (from 1980)	Moderate	Low	Moderate	Very High	Highest on record	High	Low	Low	Very Low
- Mid	Bourke (from 1972)	Moderate	Low	Moderate	Very High	Very High	Moderate	Very Low	Very Low	Very Low
- Lower	Wilcannia (from 1972)	Moderate	Low	High	Very High	Very High	Moderate	Very Low	Very Low	Very Low

Notes to Table 1:

¹ Annual catchment streamflow was defined at key locations as follows:

Very low: up to 17.5 per cent rank	Low: 17.5 – 37.5 per cent rank	Moderate: 37.5 – 62.5 per cent rank
High: 62.5 – 82.5 per cent rank	Very high: greater than 82.5 per cent rank	

A rank of 10 per cent means that 10 per cent of the years in the observed record have lower flows than occurred in that year, with 90 per cent of years having higher flows. Data is sourced from NSW Department of Primary Industries –Water (NSW gauge sites) and Queensland Department of Natural Resources and Mines (Queensland gauge sites).

² Indicative only. Gauged flow data is insufficient to accurately classify annual streamflow in the Nebine Creek catchment.

The past year has seen dry catchment conditions with above average day and night-time temperatures. Anecdotal reports and information from limited ecological monitoring in the northern Basin indicates that a range of assets are under stress due to the prolonged low flows and rainfall:

- There has been no appreciable inflow into Narran Lakes for three years, since April 2013. Lignum shrubland that provides the main waterbird nesting habitat in the Ramsar wetland site is stressed as a result, a state that is being exacerbated by feral goat predation. The condition and vigour of floodplain vegetation across Narran Lakes is declining (pers. comm. S. Bowen and P. Berney NSW OEH).

- The last large-scale waterbird breeding event observed in the northern unregulated catchments was in March 2012, at Narran Lakes.
- The Birrie and Bokhara rivers, inner channels of the Lower Balonne distributary system, experienced only short periods and low volumes of flow in the last two years; the bottom end of the Bokhara River has not received any flow in this period.
- It has been more than four years since woodland communities on the Culgoa River floodplain in the area around the QLD-NSW border, including the threatened coolibah- blackbox ecological community, have been inundated from river flows.
- The Warrego River has experienced a prolonged (> 4 year) period of very low flows. Inflows from the eastern tributaries of the Upper Warrego catchment (measured at Augathella) in 2015–16 were the lowest on record. The last flow that ran the length of the Warrego River to the Darling junction was in January-February 2015; prior to this a flow through had not been observed since April 2012.
- Reflecting the lack of significant inflows from the upstream Warrego River, the last large-scale inundation of the Western Floodplain at Toorale was in 2011–12. Since then, localised rainfall events and small flows in late summer in the last three years and June 2016 were the primary water inputs to the floodplain.
- The Barwon-Darling River has experienced a dry spell that is severe and prolonged in recent historical terms. The average flow in the Darling River (Wilcannia) for the last three years is significantly lower than in any other 3-year period in the observed record (45 years), and less than 5 per cent of the average of annual flows in the last 45 years.
- By May 2016 the Moonie River had ceased to flow for 10 months, with the last whole river-connecting flow observed in April 2015.

2.2. Feasibility of active management by catchment

Feasibility of active management in northern unregulated catchments is assessed in Table 2, using the criteria on operational readiness and environmental demand listed in Figure 2. Overall conclusions include:

- Development and implementation of new active management options in 2016–17 is likely to be limited to actions in the Lower Balonne and lower Border Rivers systems. Due to uncertainties around operational details and risks, actions in these areas will be developed in 2016–17 on a trial basis to test implementation and monitoring requirements.
- Active management of the Commonwealth's unregulated holdings on the Warrego River at Toorale will continue in accordance with the existing 5-year strategy for utilisation of these entitlements, approved by the Commonwealth Environmental Water Holder in December 2013. Water available after license conditions are triggered will be directed either downstream to enhance fresh flows in the lower Warrego and Darling rivers, or to wetland areas on the Warrego Western Floodplain, depending on the relative environmental demand in these two areas at the time of the flow. The strategy includes a decision tree that helps determine environmental priority and volumes to be used or carried over. Factors considered include antecedent flows, current in-stream and wetland conditions, the size and duration of the flow and implications for environmental water availability in future years.
- Active management in the Barwon–Darling River also has potential. Management of environmental flows from multiple sources (tributaries and entitlement types) is likely to be most effective in this system, leading to more complex operational issues around the coordination, protection and measurement of actively managed flows than in self-contained locations such as the Narran River. The Barwon-Darling may be a focus for scoping and development of active management options from 2017–18, informed by any trial actions undertaken in the Lower Balonne or Border Rivers.
- Active management is not feasible or required in 2016–17 in other catchments – the Warrego, Moonie and Nebine systems in Queensland and the NSW Intersecting Streams other than at Toorale.

Table 2: Potential for active management in northern unregulated river catchments

Catchment	Environmental need			Feasibility				Possible actions <i>[italicised actions are the proposed focus of development in 2016–17]</i>	Key issues	Priority for 2016–17? or from 2017–18
	Specific environmental demands for catchment or target asset?	Long-term shortfall in meeting demand	Active management contributes to environmental requirement	Established market or willing buyers & sellers?	Flexible statutory trading options	CEWO water trading framework	Operationally feasible in 2016–17			
Warrego Qld	NO	NO	NO	NO	NO	NO	NO	<ul style="list-style-type: none"> - Water off-stream wetland - Augment flows to Cuttaburra Creek 	<ul style="list-style-type: none"> - Suitable wetland(s) not identified - Demand is likely to be met under existing conditions/recovery 	NO
Warrego NSW (Toorale)	YES	YES	YES	N/A	N/A	NO	YES	<ul style="list-style-type: none"> - Enhance flows to: <i>The Darling River to improve low or small fresh flows OR Toorale Western floodplain for wetland vegetation and waterbird habitat</i> 	<ul style="list-style-type: none"> - Measurement and accounting of managed and overall flows - Timely access to infrastructure in wet conditions and due to remote location 	YES
Moonie (Qld)	NO	NO	NO	NO	NO	NO	NO	<ul style="list-style-type: none"> - Water off-stream wetland to benefit waterbird habitat/breeding and wetland vegetation - Augment end of system flows into the Barwon River 	<ul style="list-style-type: none"> - Suitable wetland(s) not identified - Limited volumes held or available for purchase - Protection of in-stream flows in the Moonie & Barwon-Darling 	NO
Nebine Creek (Qld)	NO	NO	NO	NO	NO	NO	NO	<ul style="list-style-type: none"> - None identified 	<ul style="list-style-type: none"> - Lack of data on flows, long term hydrology, environmental values 	NO
Lower Balonne (Qld)	YES	YES	YES	YES	NO But trade possible outside statutory system	YES Under development	YES	<ul style="list-style-type: none"> - <i>Waterhole filling flow in Lower Balonne tributary channels</i> - <i>Narran Lakes 25 GL inflow</i> - <i>Narran Lakes 50 GL inflow</i> - <i>Support waterbird breeding event in Narran Lakes</i> - <i>Enhance medium to large fresh in the Culgoa River for fish migration</i> 	<ul style="list-style-type: none"> - Water quality impacts of releases from private storages and Code of Practice to address this - Measurement and compliance measures to ensure additional purchased flows achieved - Risk of diversion of additional purchased flows and substitution for planned environmental water 	YES
Barwon-Darling (NSW)	YES	YES	YES	YES	YES	NO	NO May take several years to develop	<ul style="list-style-type: none"> - Dry spell breaking low flow to maintain basic aquatic habitat & water quality - Small fresh for connectivity for most of system - Small fresh at Louth for system wide connectivity - Larger fresh at Bourke for fish migration - Water off-stream wetland for waterbird, vegetation and potential cultural benefits 	<ul style="list-style-type: none"> - Protection of additional purchased in-stream flows - Risk of substitution of additional purchased volumes for planned environmental water - Requires further investigation of target water products, locations, timing and hydrological outcomes - Requires development of water purchase process and contracts - Coordination of managed flows over long distances 	From 2017–18
Border Rivers	YES For some assets		YES	YES	YES	YES Specialised system unlikely to be required	YES Under development	<ul style="list-style-type: none"> - <i>Improve wetland connectivity in lower Macintyre River by obtaining additional unregulated access</i> - <i>Direct water to a specific wetland or anabranch in the lower Border Rivers via private infrastructure</i> 	<ul style="list-style-type: none"> - Protection of additional flows - Infrastructure delivery and access arrangements - Anabranch and wetland water requirements, current impacts & environmental values uncertain - Accounting & compliance 	YES

2.3. Priority environmental demands

Comprehensive long term environmental water requirements for the Lower Balonne and Barwon-Darling systems have been identified during development of the Basin Plan and in the Northern Basin Review process. Prioritisation of environmental demands in these catchments is shown in Table 3 and Table 4. High flow/volume/duration demands that are out of scope for active management are also identified. The volumes of additional actively managed flows that are likely to be available would not make a material contribution to meeting these demands.

Environmental demands in the Border Rivers relevant to active management of unregulated flows were drawn from the *Portfolio Management Plan: Border Rivers 2016–17*. Determination of urgent environmental demands in other catchments was based primarily on antecedent conditions.

Priority demands in the different catchments were collated and ranked qualitatively to obtain a prioritised list of urgent environmental demands in the northern unregulated rivers going into 2016–17. This step is shown in Table 5.

Table 3: Environmental demands and priorities for active management of Commonwealth environmental water in the Lower Balonne for 2016–17

Umbrella environmental asset	Specific site /ecological process	Flow/volume, stream gauge	Duration (Days)	Average required frequency (maximum interval)	Likelihood of being met in the long term ^A	Watering history (from all sources of water)										Predominant urgency of environmental demand for water	2016-17	
						2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15		2015–16	Potential for <u>active management</u> of environmental water? ^{B,C}
								Moderate	Very Low	Very High	Highest on record	Very High	High	Low	Low		Low	
Lower Balonne River channels	Lower Balonne distributary channels - drought refuge (waterholes) ^{1,2}	Flow reaches end of all channels within a three month period, indicated by ¹ : 30 ML/day Birrie River @ Talawanta	1 day	Annually	Not Met												<u>High</u> Water is required annually to fill waterholes. While a filling flow has occurred in all of the last 11 years, the spell (interval) between events has exceeded 350 days, a critical threshold representing the average persistence time of key refugial waterholes in the Narran and Culgoa Rivers ² , on three occasions (grey shading).	Low to Moderate Likely to be met in the Culgoa and Narran River through existing Resource Operations Plan conditions and in-stream CEW. Active management (augmentation of flows and/or bifurcation weir operation) could be considered to meet requirements in the Bokhara River Action consistent with the 2016–17 Basin Environmental Watering Priority to: <i>Maintain waterholes in the Lower Balonne floodplain to provide critical refuge for water-dependent species</i>
		30 ML/day Bokhara River @ Goodwins											No end of system flow					
		30 ML/day Culgoa River @ Weilmorigle																
		30 ML/d Narran River @ Narran Park																
		Passing flow Culgoa River @ Weilmorigle ²		Annually (1.5 years)														
		Passing flow Narran River @ Narran Park ²		Annually (1.5 years)														
	Culgoa River - longitudinal connectivity ^{3,4}	Small in channel fresh 1 000 ML/day @ Brenda	7	8 to 9 in 10 years	Not Met												<u>High</u> A small fresh is required in most years to provide for basic ecological functions	Moderate Active management could be used to enhance flows in near miss events at all available opportunities given that this near annual demand is not likely to be met in the long term.
	Narran River – fish migration ^{3,4}	Large in-channel fresh 1 700 ML/day @ Wilby Wilby (August - May)	14	4 to 6 in 10 years	Not Met												<u>High</u> A small fresh needed this year to maintain healthy fish populations and provide for dispersal and recruitment. The interval since last flow (3 to 4 years) is near to the lifespan of short lived fish species	Moderate Active management could be used to enhance flows in near miss events. Demand could be met in the Narran River in conjunction with a purchase (water harvesting pumping opporutnity) to achieve a 25 GL inflow into Narran Lakes
	Culgoa River – fish migration ^{3,4}	Large in-channel fresh 3 500 ML/day @ Brenda (August - May)	14	4 to 6 in 10 years	Met												<u>Critical</u> A large fresh is required this year to maintain healthy fish populations and provide for dispersal and recruitment. Interval since the last flow - 4+ years - exceeds or approaches the lifespan of short lived fish species.	Low Potential for active management requires further investigation. Uncertain if sufficient additional flows could be obtained, and would likely have to target one channel not whole system
Lower Balonne River floodplain	Connectivity with the riparian zone ⁵⁻⁹	9 200 ML/day Culgoa River @ Brenda	12	Every 2 to 3 years	Not Met												<u>Critical</u> Inundation required this year to maintain ecosystem health and function. 4 years since last flow - exceeds critical interval (3 years) to maintain condition of river red gum forests ⁵	Probably out of scope for active management Benefit of supplying additional CEW would be negligible. In-stream CEW will contribute significantly to this demand
	Connectivity with the inner floodplain ⁵⁻⁹	15 000 ML/day Culgoa River @ Brenda	10	Every 3.5 to 4 years	Not Met												<u>High</u> Inundation required this year to maintain ecosystem health and function. Interval since last flow (4+ years) exceeds the critical interval to maintain condition of river red gum forests and within interval to sustain lignum (3 to 5 years) and vigorous growth of blackbox (5 to 7 years)	Out of scope for active management Benefit of supplying additional CEW would be negligible
	Connectivity with the mid floodplain ⁵⁻⁹	24 500 ML/day Culgoa River @ Brenda	7	Every 6 to 8 years	Met												<u>Low</u> Inundation required within the next two years to maintain ecosystem health and function	Out of scope for active management Benefit of supplying additional CEW would be negligible
	Connectivity with outer floodplain ⁵⁻⁹	38 000 ML/day Culgoa River @ Brenda	6	Every 10 to 20 years	May be Met												<u>Very low</u> Critical interval for inundation, since the 2010-11 and 2011-12 floods, will be around 2020	Out of scope for active management Benefit of additional CEW would be nealigible

Umbrella environmental asset	Specific site /ecological process	Flow/volume, stream gauge	Duration (Days)	Average required frequency (maximum interval)	Likelihood of being met in the long term ^A	Watering history (from all sources of water)										Predominant urgency of environmental demand for water	2016-17	
						2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15		2015–16	Potential for <u>active management</u> of environmental water? ^{B,C}
								Moderate	Very Low	Very High	Highest on record	Very High	High	Low	Low		Low	
Narran Lakes	Waterbird breeding habitat in northern lakes (Ramsar site) ^{8,10-14}	25 GL @ Narran Park (Narran River) over 60 days	N/A	Every 1 to 1.3 years	Met											<u>Critical</u> Inflows required this year to sustain core lignum waterbird habitat and ability to support waterbird breeding. Interval since last event (3.5 years) exceeds interval for vigorous growth and maximum without development spell	High Active management (temporary water purchase, bifurcation weir operation) could be used to augment near miss events Consistent with 2016–17 Basin Environmental Watering Priority: <i>In moderate conditions, support waterbird populations by watering critical breeding and feeding habitats at important Basin environmental assets for waterbirds</i>	
	Waterbird breeding and foraging habitat northern lakes zone ^{8,10-14}	50 GL @ Narran Park over 90 days	N/A	Every 1.3 to 1.7 years	Met											<u>Critical</u> Inflows are required this year to sustain lignum shrublands and maintain condition of riparian red gum forests. Interval since last inflow (3.5 years) exceeds the maximum modelled without development spell		
	Trigger and maintain large scale colonial waterbird breeding ^{8,10-14}	154 GL @ Narran Park over 90 days	N/A	Twice in every 8 to 10 years	Not Met			large scale breeding		minor breeding	minor breeding	large scale breeding				<u>Moderate to High</u> 4+ years since last large scale waterbird breeding event. Event required this year or next to provide ibis populations (with Narran site fidelity) with 2 breeding opportunities in their lifetime. An acute and chronic shortage of waterbird breeding across the Basin and the likelihood of this demand not being met in the long term, increases its urgency.	High Additional water from private storage could be provided to support a waterbird breeding event after initiation if required Consistent with 2016–17 Basin Environmental Watering Priority: <i>In moderate conditions, capitalise on opportunities to support waterbird breeding</i>	
	Water all floodplain and wetland habitat in Narran Lakes complex, initiate waterbird breeding, provide long-term refuge	250 GL over 180 days @ Narran Park	N/A	Every 10 to 12 years	May be Met											<u>Very low</u> Following the 2010-11 and 2011-12 floods, the critical interval for inundation will be from 2020 (if not received before then)	Out of scope for active management Benefit of additional CEW would be negligible	

Notes to table: Table 3

- A. As indicated by hydrological modelling undertaken by the Murray Darling Basin Authority (northern Basin review and in developing the Basin Plan) testing outcomes for flow indicators under a number of different water recovery scenarios to meet tributary catchment targets and the shared reduction for the Barwon-Darling system
- B. Ongoing in-stream use of unregulated Commonwealth entitlements ('passive management') will contribute to all listed demands. Contributions from unregulated entitlements are subject to suitable flow events and are determined by the characteristics of each particular flow (peak, duration, losses) and the access conditions of held entitlements.
- C. Potential for active management is based on demand (antecedent conditions, required frequencies of flows) and whether active management is in scope for the particular demand. The larger volume demands are generally out of scope because it is unlikely to be feasible to obtain the additional volume and/or funding required to make a significant contribution to these demands. Potential does not relate to the likelihood of a suitable flow event occurring in 2016-17, which cannot be predicted. Implementation will always be subject to a suitable unregulated trigger flow.

References for Table 3:

1 Condamine and Balonne Resource Operations Plan (s269); pers comm P. Harding, Consulting Hydrologist QLD DSTI 20 Feb 2015 .

2 DSITI (Department of Science, Information Technology and Innovation) 2015, *Waterhole refuge mapping and persistence analysis in the Lower Balonne and Barwon-Darling rivers*. Queensland Department of Science, Information Technology and Innovation, Brisbane

3 NSW DPI (NSW Department of Primary Industries) 2015, '*Fish and flows in the Northern Basin: responses of fish to changes in flows in the Northern Murray-Darling Basin – reach scale report*', Final report prepared for the MDBA by NSW DPI, Tamworth

4 Marshall, J, Menke, N, Crook, D, Lobegeiger, J, Balcombe, S, Huey, J, Fawcett, J, Bond, N, Starkey, A and Sternberg, D 2016, 'Go with the flow: the movement behaviour of fish from isolated waterhole refugia during connecting flow events in an intermittent dryland river', *Freshwater Biology*, 21 January 2016 (date online version prior to inclusion in an issue).

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10 Thomas, RF, Karunaratne, S, Heath, J and Kuo, W 2016, Assessment of site-specific flow indicator inundated areas in vegetation of Narran Lakes, report prepared for MDBA by the NSW Office of Environment and Heritage, Sydney

11 Thoms, M, Capon, S, James, C, Padgham, M and Rayburg, S 2007, Narran Ecosystem Project: the response of a terminal wetland system to variable wetting and drying, report prepared for the MDBC, Canberra

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13 Merritt, W, Spencer, J, Brandis, K, Bino, G, Harding, P and Thomas, R 2016, Review of the science behind the waterbird breeding indicator for Narran Lakes, report prepared for the MDBA, Canberra

14 Brandis, K and Bino, G 2016, A review of the relationships between flow and waterbird ecology in the Condamine-Balonne and Barwon-Darling River Systems, report prepared for the MDBA by Centre for Ecosystem Science, UNSW, Sydney

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 4: Environmental demands and priorities for active management of Commonwealth environmental water in the Barwon-Darling for 2016–17

Environmental assets	Specific site /ecological process	Flow/volume, stream gauge	Duration (Days)	Average required frequency (maximum interval)	Long term expected outcomes ^A	Watering history (from all sources of water)											2016 -17			
						2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Predominant urgency of environmental demand for water	Potential for <u>active management</u> of environmental water? ^{B,C}		
								Moderate	Low	High	Very High	Very High	Moderate	Very Low	Very Low	Very Low				
Dry spell breaking low flow pulse over extended river reach	Dry period refuge (waterholes), basic fish habitat	10-20 GL tributary inflow Indicative trigger: > 40 days nil flow @ Bourke > 60 days nil flow @ Wilcannia	10 to 20 days (inflow)	As required to offset an unusually long nil flow spell	Not likely to be met			Max spell 332 days (Wilcannia)	Max spell 88 days	Max spell 84 days					Max spell 101 days	Max spell 139 days	Max spell 77 days	High	Moderate End of system regulated delivery from Gwydir and/or Border Rivers, Namoi if water availability improves	
Small in channel freshes – Longitudinal connectivity (1)	Small scale fish movement/ access to habitat (snags, in channel benches Brewarrina to Bourke)	6,000 ML/day Darling River @ Bourke	14	8 to 9 in 10 years	May be Met													Critical	Low (as not ready for implementation) High (in future) Flows near this level could potentially be enhanced by additional B/C class access in the Barwon-Darling, unregulated access in tributaries and/or end of system regulated deliveries. Low immediate priority because trade and operational requirements need further investigation.	
	Access to snags and benches, some fish recruitment (Brewarrina to Tilpa)	6,000 ML/day Darling River @ Louth (Aug to May)	20	7 in 10 years	Not met													High	High Flows could be enhanced (up to 16 GL @ 600 ML/day) by directing Commonwealth environmental water from entitlements on the NSW Warrego (Toorale) to the Darling. Subject to trigger flows in the Warrego River and use in the Darling being the priority under CEWO's use strategy for the Toorale entitlements. In future additional B/C class access around Bourke could also contribute to meeting this demand	
	Inundation of benches for primary productivity (Tilpa to Wilcannia)	6,000 ML/day Darling River @ Wilcannia twice in a year	7	4.5 to 6 in 10 years	Met													Moderate	Out of scope for active management Benefit of supplying additional CEW would be negligible; sources of additional water are too far upstream	
Large in channel freshes (1) Longitudinal connectivity	Large scale fish migration Walgett to Wilcannia (weir drown out)	10,000 ML/day Darling River @ Bourke (Aug to May)	14	6 to 8 in 10 years	Met													High	Low Potential for active management requires further investigation. Uncertain if sufficient additional flows could be obtained - potentially unregulated access in Border, Namoi, Gwydir, Macquarie and B & C access in the Darling.	
	Fish recruitment - flow dependent and in-channel specialists eg Murray cod	10,000 ML/day Darling River @ Bourke twice in a year (Aug to May)	20	2.5 to 3.5 in 10 years	May be Met													High		
	Fish recruitment - in-channel specialists eg Murray cod; access to anabranches and wetlands	21,000 ML/day Darling River @ Louth (Aug to May)	20	4 in 10 years	Not Met														High	Out of scope for active management Benefit of supplying additional CEW would be negligible
	Inundation of benches for primary productivity (Tilpa to Wilcannia)	20,000 ML/day Darling River @ Wilcannia	7	4.5 to 6 in 10 years	May be Met														Critical	Out of scope for active management Benefit of supplying additional CEW would be negligible
Lateral Connectivity (2-4)	Connectivity with riparian zone including forests	30,000 ML/day Darling @ Bourke	24	Every 2 to 3 years	Not Met													Critical	Out of scope for active management Benefit of supplying additional CEW would be negligible	
	Connectivity with inner floodplain including wetlands	45,000 ML/day Darling @ Bourke	22	Every 3.5 to 4 years	Not Met													High	Out of scope for active management Benefit of supplying additional CEW would be negligible	
	Connectivity with mid floodplain including woodlands	65,000 ML/day Darling @ Bourke	18	Every 6 to 8 years	Not Met													Low	Out of scope for active management Benefit of supplying additional CEW would be negligible	
	Connectivity with outer floodplain including grasslands, fill Talyawalka Anabranch system	Total volume 2 350 ML Darling @Wilcannia	60	Every 10 to 12 years	May be Met													Very Low	Out of scope for active management Benefit of supplying additional CEW would be negligible	

Notes to Table 4:

- A. As indicated by hydrological modelling undertaken by the Murray Darling Basin Authority (northern Basin review and in developing the Basin Plan) testing outcomes for flow indicators under a number of different water recovery scenarios to meet tributary catchment targets and the shared reduction for the Barwon-Darling system
- B. Ongoing in-stream use of unregulated Commonwealth entitlements ('passive management') will contribute to all listed demands. Contributions from unregulated entitlements are subject to suitable flow events and are determined by the characteristics of each particular flow (peak, duration, losses) and the access conditions of held entitlements.
- C. Potential for active management is based on demand (antecedent conditions, required frequencies of flows) and whether active management is in scope for the demand. The larger volume demands are generally out of scope because it is unlikely to be feasible to obtain the additional volume and/or funding to make a significant contribution to these demands. Potential does not relate to the likelihood of a suitable flow event occurring in 2016-17, which cannot be predicted. Implementation will always be subject to a suitable unregulated trigger flow.

References for Error! Reference source not found.

- 1 NSW DPI (New South Wales Department of Primary Industries) 2015, *Fish and flows in the Northern Basin: responses of fish to changes in flows in the Northern Murray-Darling Basin*, Tamworth, NSW
- 2 MDBA (Murray-Darling Basin Authority) 2016d, *Inundation mapping in the Northern Basin review*, Murray-Darling Basin Authority, Canberra (in prep.)
- 3 Eco Logical Australia 2016 'Vegetation of the Barwon-Darling and Condamine-Balonne floodplain systems of New South Wales: Mapping and survey of plant community types' prepared for the Murray-Darling Basin Authority.
- 4 Brandis, K and Bino, G 2016, *A review of the relationships between flow and waterbird ecology in the Condamine-Balonne and Barwon-Darling river system Systems*, Murray-Darling Basin Authority, Canberra (in prep)

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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

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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

2.4. Active management priorities for 2016–17

Based on the assessment in Table 3 and Table 4 and previous sections, the most urgent environmental water demands for assets in the northern unregulated rivers in 2016–17 are summarised in Table 5.

Table 5: Priority environmental demands and active management options in 2016–17 in the northern unregulated rivers

Environmental demand	Urgency	(✓) Specific actions for development in 2016-17	
		Actions to be developed in next few years	
Inundation of core waterbird breeding habitat at Narran Lakes	Critical	✓	Enhance a flow event to achieve 25 GL inflow to Narran Lakes (action development well advanced)
Fresh in Darling River for small scale fish migration	Critical		Enhance flows to achieve 6 000 ML/day on the Darling at Bourke (actions may be developed within 2 years)
Fresh in the Culgoa River for fish migration	Critical	✓	Targeted flow enhancement to achieve 3 500 ML/day at Brenda for 14 days
Connectivity with the riparian zone in Barwon-Darling	Critical		No action – out of scope for active management (30,000 ML/day at Bourke)
Connectivity with riparian zone in the Lower Balonne channels	Critical		No action – out of scope for active management (9,200 ML/day in lower Culgoa)
Large pulse to inundate benches along Darling for primary productivity	Critical		No action – out of scope for active management (20,000 ML/day @ Wilcannia)
Inundation of waterbird breeding and foraging habitat in northern zone of Narran Lakes	Critical	✓	Enhance a flow event to achieve 50 GL inflow to Narran Lakes (action development well advanced)
Toorale Western Floodplain wetland inundation	High	✓	Enhance overflow from Boera Dam to the Western Floodplain [#]
Fresh in the Narran River for fish migration	High	✓	Enhance flows to achieve 1,000 ML/day for 14 days at Wilby Wilby. (Likely to overlap with 25 GL Narran inflow option, action development well advanced)
Fresh to inundate snags and benches, enable some fish recruitment along the Barwon-Darling	High	✓	Use Toorale Warrego entitlements to help enhance Darling flows to 6 000 ML/day at Louth for 20 days [#]
Lower Balonne channels drought refuge (waterholes)	High	✓	Enhance flows with purchased unregulated/regulated water to achieve flow through in all channels particularly Bokhara and Birrie
Dry spell breaking small pulse along extended reach of Barwon-Darling	High	✓	End of system regulated delivery in a tributary catchment to restart flow in the Barwon-Darling
Large fresh for large scale fish migration and recruitment along Barwon-Darling	High		Enhance flows to achieve 10 000 ML/day at Bourke for up to 20 days (action may be developed within 2 years)
Lower Macintyre River low level wetland connectivity for fish reproduction and recruitment	High	✓	Obtain additional unregulated access in the lower Macintyre to achieve sustained flow between 4,000 and 6,000 ML/day at Terrewah (well advanced)
Large fresh for fish recruitment throughout Barwon Darling	High		No action – out of scope for active management (21,000 ML/day at Louth)
Connectivity with inner floodplain including wetlands in Barwon-Darling	High		No action – out of scope for active management (45,000 ML/day at Bourke)
Large scale waterbird breeding event at Narran Lakes	High	✓	Support breeding event with additional inflows if required (action development well advanced)
Provide water to a wetland or anabranch in the lower Border Rivers for wetland vegetation, nutrient and carbon cycling	Moderate	✓	Infrastructure assisted watering of a targeted site(s) potentially including a trade component (action development well advanced)

[#] active management at Toorale National Park in 2016–17 will be in accordance with the approved 5-year strategy for utilisation of the Commonwealth's unregulated entitlements on the NSW Warrego River.

Delivery in 2016–17

In 2016–17 development of new active management options in the northern unregulated rivers will focus on options that are feasible to implement within the next 12 months and which address the most urgent environmental demands (Table 5). Consequently, development will focus on actions in the Lower Balonne system to enhance inflows to Narran Lakes and small flows in the distributary channels, and actions in the Border Rivers to enhance wetland connectivity in the lower Macintyre River. Small active deliveries to targeted wetlands or anabranches in the Lower Border Rivers and flow enhancement in the Culgoa River (Lower Balonne) for fish benefits may also be considered if the associated delivery and water purchase arrangements, which are currently at a preliminary stage, can be progressed sufficiently.

Although a priority order of active management options has been defined based on urgency of the associated environmental demand (Table 5), each action is appropriate to a specific flow situation, and will only be viable if there is suitable trigger unregulated flow event. For example, a medium flood at St George is needed to trigger Narran Lakes 25 GL inflow action, while the Lower Balonne distributaries action is applicable to a very small flow pulse that otherwise may not reach to the end of the system. The Lower Macintyre wetland connectivity action requires a large in-channel pulse.

The likelihood in any given year of there being a suitable trigger for any active management option based on achieving a target river or end of system flows, is low. Consequently, in practice opportunity, in the form of a suitable trigger unregulated flow event, will be a strong driver for implementation of active management in 2016–17 and beyond. Due to uncertainties around operational details and risks, new actions will be developed in 2016–17 on a trial basis to test implementation and monitoring requirements.

Active management at Toorale National Park, to achieve targeted outcomes in the lower Warrego/Darling Rivers or the Western Floodplain, will continue in 2016–17 in line with the Office's existing strategy for utilisation of the unregulated entitlements on the Warrego River at Toorale.

2.5. Water availability in 2016–17

Unregulated entitlements provide opportunistic access to unregulated river flows and overland flows when a flow event reaches levels specified in entitlement conditions and/or water resource plan triggers at which a period of access may be announced are met. Each entitlement will make a distinctive contribution to restoring in-stream flows reflecting its particular flow access windows, take rates and location. Daily, instantaneous, annual or multi-year limits cap overall diversions in any given year or flow event, and likewise the in-stream contributions that can be attributed to unregulated Commonwealth entitlements.

The outlook for the early season (June to August 2016) suggests an easing of the dry conditions. There is a high chance (75 to 80 per cent) of above average rainfall across the northern unregulated rivers and milder than average day time temperatures. However, forecasting skill at this time of year is low and winter is typically a low rainfall and streamflow period in the north, so the short term outlook should not be taken as a predictor of significant unregulated flow events in 2016–17. Unregulated flows cannot be predicted with any certainty. Large flows in northern unregulated rivers typically rely on rainfall events in headwater areas of catchments where overall rainfall is much higher than in the semi-arid lowland areas.

At 30 April May 2016, Commonwealth unregulated water holdings in the northern Basin comprise around 121 gigalitres expressed as long term average annual yield (Figure 3). This total includes supplementary water in the Gwydir and Macquarie catchments (about 5 gigalitres long term average annual yield). Commonwealth unregulated environmental water holdings in the northern Basin now exceed those of regulated water.

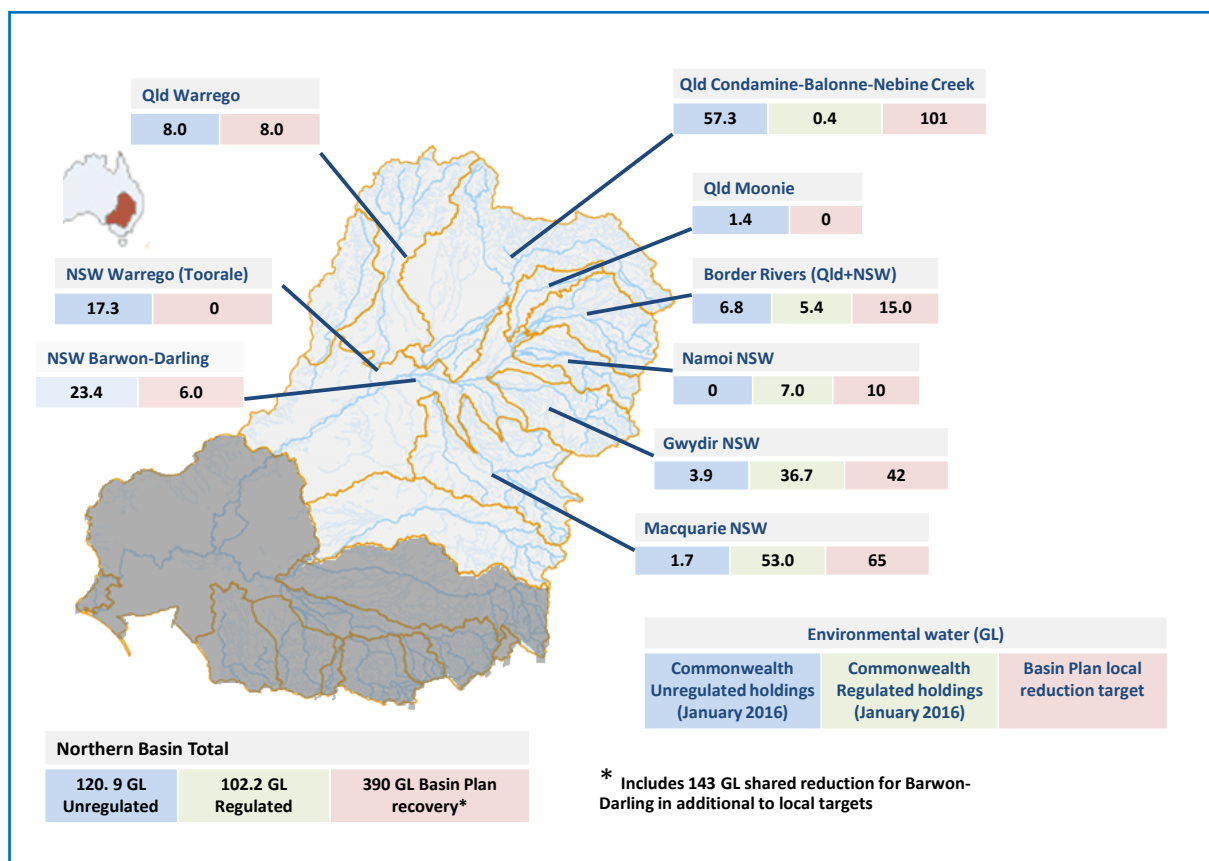


Figure 3: Comparison of Commonwealth ‘unregulated’ (blue shaded cells) and ‘regulated’ (green shaded cells) holdings in the northern Basin (as at 31 May 2016) in long-term average annual yield (LTAAAY).

The total volume of water that is available (with full activation of all unregulated entitlements in the northern unregulated rivers in 2016–17 exceeds 270 gigalitres (excluding supplementary water). However, this upper limit would rarely, if ever be realised and high utilisation is only likely in very wet years. For example, total utilisation of Commonwealth environmental water across all northern unregulated catchments in 2015–16 (to May 2016), a dry year, was only around 20 gigalitres. In the Lower Balonne in a medium flood leading to some low level floodplain inundation, around 100 gigalitres total opportunity for take could be expected from current Commonwealth unregulated holdings in the system; in small to medium flows total opportunity of around 50 gigalitres is likely, with up to about 25 gigalitres in very small flow events.

Around 10 to 20 gigalitres per action of existing or additional environmental water is expected to be used in active management options such as temporary purchase to enhance flow events in the lower Balonne or lower Macintyre rivers or actively managed inflows to the Barwon-Darling.

Information on actual volumes accessed for in-stream use or used actively from Commonwealth unregulated environmental water holdings during the water year can be found at <http://www.environment.gov.au/water/cewo/portfolio-mgt/holdings-catchment> and is updated monthly.

2.6. Stakeholder Feedback

Input on environmental demands and active management options for the northern unregulated rivers have been sought during 2015–16 and in previous years. Operational and water purchase aspects of flow augmentation options in the Lower Balonne system have been discussed in meetings of the Lower Balonne Working Group (convened by the Murray-Darling Basin Authority) over the last two years and in detail at a forum attended by most water users in the region held in Dirranbandi in February 2015.

The Queensland departments of Natural Resources and Mines (DNRM) and Science, Information Technology and Innovation (DSITI) have worked closely with the Office to scope Lower Balonne flow augmentation options, including undertaking initial hydrological modelling of several end of system target flow options.

A joint project between the CEWO, DNRM and the Queensland Department of Environment and Heritage Protection is underway to establish a Code of Practice for the release of water from off-river storages in accordance with Queensland environmental protection law. This project was established when it emerged that potential water quality impacts of discharges made from on-farm storages was an impediment to implementing flow augmentation through purchase of stored water. It is expected that the Code of Practice will be finalised in late 2016 for consideration by the relevant Queensland Minister.

The above agencies, along with the NSW Office of Environment and Heritage, NSW Department of Primary Industries (Water and Fisheries divisions), Border Rivers Environmental Water Network, Water NSW and the Queensland Murray Darling Committee Inc. and Eco Logical Australia (consultants) also provided input and feedback on the active management options in Lower Macintyre River. Local land and water holders have also provided significant input on technical and environmental aspects into the development of active watering options for anabranches and wetlands in the lower Border Rivers.

Feedback has included:

- There is high level of support and interest in participation in water purchase options amongst Lower Balonne water users, community representatives and Queensland agencies.
- Queensland agencies, community organisations and representatives of the fisheries departments in both states support a trial watering action in the lower Macintyre River targeting near channel wetlands and fish outcomes through enhancing an unregulated flow event. The proposal to use additional unregulated water rather than regulated deliveries (by trading or swapping these types of holdings) was considered ecologically sound. Further consultation with NSW environmental and river management agencies will be undertaken.
- Whilst most parties would like trial actions to be undertaken as soon as possible, there is a recognition that developing water trading processes, the requirement for a suitable unregulated trigger flow event/conditions and resolution of water quality issues (for options that include a release from private storage) may delay or constrain implementation of active flow augmentation in the short-term.

2.7. Trading water in 2016–17

Planning for water trade considers supply and demand within the catchment, and across the Basin. As part of the planning process, the Commonwealth Environmental Water Office undertakes a Basin-wide analysis to identify opportunities to use allocation trade to better match differing environmental demands across catchments (see *Commonwealth Environmental Water Portfolio Management: Basin-wide analysis 2016–17* available at: <http://www.environment.gov.au/water/cewo/publications>).

The Commonwealth Environmental Water Office is also investigating the potential for purchases to augment water for the environment in a number of catchments in the northern Basin to meet high environmental water demands (particularly in the Macquarie Marshes, Lower Balonne/Narran Lakes and Border Rivers). Further information will be provided to the market ahead of any trade of Commonwealth environmental water at: <http://www.environment.gov.au/water/cewo/trade/current-trading-actions>.

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

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, constraints to water delivery and market conditions.

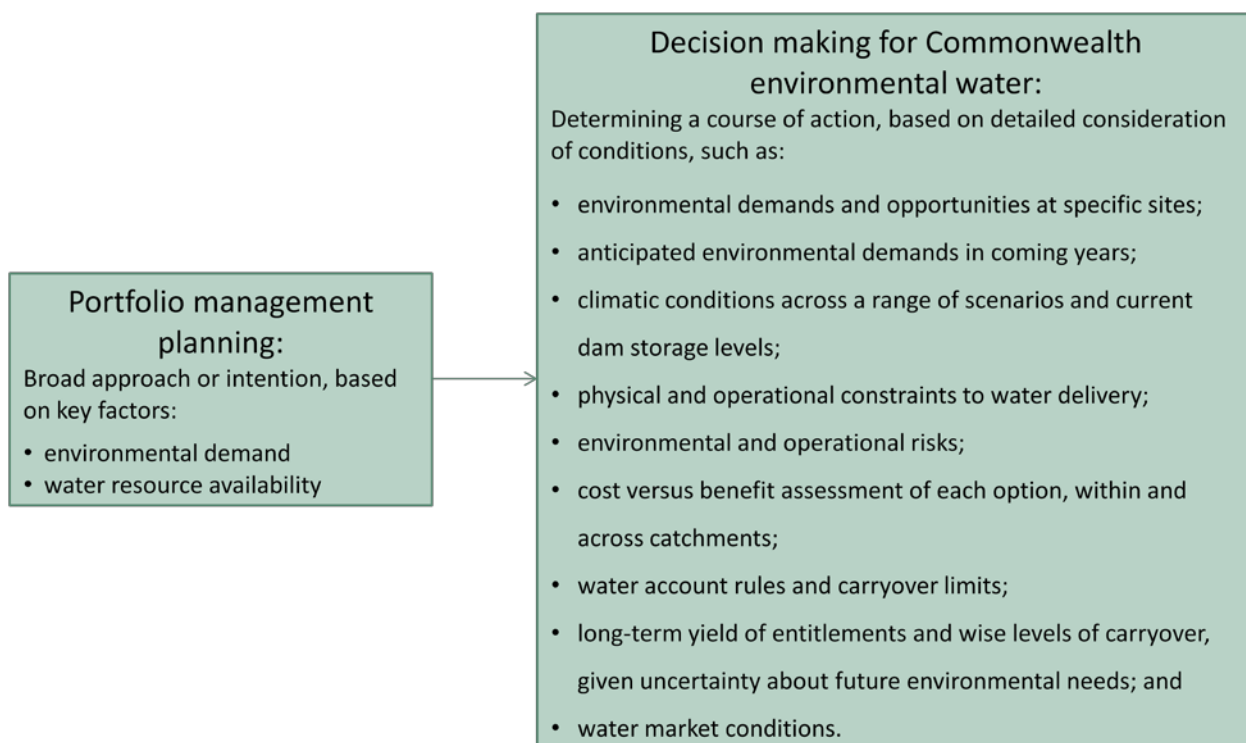


Figure 4: Planning and decision making for Commonwealth environmental water use

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

Expected outcomes from the Basin-wide environmental watering strategy (MDBA 2014) that are relevant to the northern unregulated rivers are described below.

RIVER FLOWS AND CONNECTIVITY

Connectivity outcome	Barwon-Darling	Condamine-Balonne	Nebine	Border Rivers	Moonie	Warrego & Paroo
Baseflows are at least 60% of natural levels	*	*	*	*	*	*
10 percent overall increase inflows to the Barwon-Darling	*	*		*		
30 to 60% increase in the frequency of freshes, bankfull and lowland floodplain flows		*				
10 to 20% increase of freshes and bank-full events	*			*		
Maintain current levels of connectivity			*		*	*

VEGETATION

Maintain current extent of river red gum, black box, coolibah forest and woodlands; existing large communities of lignum and non-woody vegetation

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

Improved recruitment of trees within river red gum, black box and coolibah communities by 2024

Improved condition of lignum shrublands (Lower Balonne including Narran Lakes, Lower Border Rivers) by 2024

Vegetation extent

Catchment	Area of river red gum (ha)*	Area of black box (ha)*	Area of coolibah (ha)*	Shrublands	Non-woody water dependent vegetation
Warrego	7,300	80,400	121,400		Fringing/within the Warrego, Langlo, Ward & Nive rivers
Nebine	200	28,800	15,400		Fringing/within Nebine Creek
Condamine Balonne (lower Balonne)	11,500#	36,100#	62,900#	Lignum in Narran Lakes	Fringing/within the Condamine, Balonne, Birrie, Bokhara, Culgoa, Maranoa, Merivale & Narran rivers
Moonie	2,200	2,500	7,900		Fringing/within Moonie River
Border Rivers	10,700	3,800	35,200	Lignum in the lower Border rivers region	Fringing/within the Barwon, Dumaresq, Macintyre rivers & Macintyre Brook
Barwon Darling	7,800#	11,700#	14,900#		Fringing/within the Barwon and Darling rivers

Area estimates (ha) are from: Cunningham SC, White M, Griffioen P, Newell G and MacNally R 2013, 'Mapping vegetation types across the Murray-Darling Basin', Murray-Darling Basin Authority, Canberra

considered to be an underestimate due to technical limitations in determining the lateral extent of floodplain inundation achieved through Basin Plan implementation

WATERBIRDS

Maintain current species diversity

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

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

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

Important Basin environmental assets for waterbirds in the northern unregulated rivers

Environmental asset	Total abundance and diversity	Drought refuge	Colonial waterbird breeding	Shorebird abundance	In scope for Commonwealth watering
Narran Lakes	*		*	*	Yes
Cuttaburra channels	*		*	*	Minor in-stream contribution
Yantabulla swamp	*				
Upper Darling River	*	*			
Talyawalka system	*				No

NATIVE 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	Specific outcomes	In-scope for Commonwealth water in the northern unregulated rivers?
Silver perch (<i>Galaxias rostratus</i>)	Expand the core range of at least 2 existing populations (Barwon–Darling is a candidate site) improve core range (candidate sites are the Warrego, Paroo and Condamine catchment (including Oakey Creek).	Limited, through improved in-stream flows in unregulated flow events
Freshwater catfish (<i>Tandanus tandanus</i>)	Expand the core range of at least 3–5 existing populations (Border Rivers, Warrego, Condamine and Paroo Rivers are amongst candidate sites)	
Olive perchlet (<i>Ambassis agassizii</i>)	Expand the range of at least 3 existing populations (the Border Rivers and middle Condamine are amongst candidate sites) Establish or improve the core range of 2–4 additional populations (Gowrie and Oakey creeks in the Condamine candidate sites)	
Southern purple-spotted gudgeon (<i>Mogurnda adspersa</i>)	Expand the range (or core range) of at least 3 existing populations (the Border Rivers/Gwydir and Condamine are amongst priority sites) Establish or improve the core range of 2–5 additional populations – (the Border Rivers/Gwydir, Barwon– Darling and Oakey Creek are amongst priority sites).	
Murray cod (<i>Maccullochella peelii</i>)	A 10–15 per cent increase of mature fish in key populations	
Golden perch (<i>Macquaria ambigua</i>)	A 10–15 per cent increase of mature fish in key populations	

Important environmental assets for native fish in the northern unregulated river catchments

Key site/ environmental asset	Key movement corridor	High biodiversity	Site of other significance	Hydrodynamic diversity	Threatened species	Dry period refuge
Warrego River (Ward River to Darling confluence)	*	*		*	*	*
Anabranches connecting Warrego and Paroo Rivers (including Gumholes, Bow, Cuttaburra Ck)	*					
Barwon-Darling River (Mungindi to Menindee)	*	*		*	*	*
Talyawalka anabranch [Darling]	*			*		*
Lower Moonie to Barwon River [Moonie]	*	*		*		*
Macintyre River floodplain lagoons Goondiwindi to Boomi [Border]	*	*	*		*	*
Macintyre River – Mungindi to Severn in NSW [Border]	*	*		*	*	*
Severn River within Sundown National Park (Qld) [Border]		*		*	*	*
Condamine headwaters and Spring Creek upstream of Killarney				*	*	*
Condamine River - Oakey Ck to Surat, including Lower Oakey Creek	*	*		*	*	*
Charley's Ck and tributaries upstream Chinchilla [Condamine]		*	*	*	*	*
Condamine River – floodplain lagoons between Condamine and Surat	*	*	*		*	*
Balonne River and Culgoa Rivers from St George to Barwon-Darling confluence	*	*			*	*

Attachment B – Long-term water availability

Commonwealth environmental water holdings

The Commonwealth holds a variety of unregulated entitlements in northern Basin catchments. In Queensland, the main type of unregulated entitlement is called an unsupplemented water allocation. In the Barwon-Darling River and other unregulated streams in northern NSW they are unregulated river access licences. NSW supplementary water access licences in the 'regulated' reaches of the Border Rivers, Gwydir, Namoi and Macquarie valleys also provide access to unregulated flows in the lower reaches of these river systems.

Overland flow licences, specific to the Lower Balonne in Queensland, set rules for the diversion of overland flow. This is the water that breaks out of rivers onto the floodplain or flows over the floodplain during floods. Diversion of overland flow ('floodplain harvesting') is to some extent provided for under most unregulated entitlements. The NSW government is also working towards issuing explicit volumetric 'floodplain harvesting licences' in the Gwydir, Border, Namoi, Macquarie and Barwon-Darling that reflect existing authorised diversion infrastructure.

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

Other than a small entitlement recovered by the NSW Government in the Barwon-Darling (1 448 ML), there are currently no other sources of held environmental water in the northern unregulated rivers. This small entitlement can be used to further a number of environmental objectives as well as Aboriginal, cultural and heritage outcomes.

Planned environmental water

In addition to water entitlements held by the Commonwealth, environmental demands in the northern unregulated rivers may be met via water provided for the environment under rules in state water plans (referred to as 'planned environmental water').

Rules limiting extraction of unregulated flows by users, such as commence/cease to take flow thresholds and instantaneous, daily, annual and multi-year use limits, form the basis of 'planned environmental water' in the northern unregulated rivers. They are complemented by rules in state water plans in a few areas which defer or reduce extraction during specific types of unregulated flows. Event based rules are triggered by antecedent conditions such as the time since the last flow in a target range or occurrence of a flow that is close to the magnitude required to meet specified ecological outcomes but may not do so unless extraction is limited.

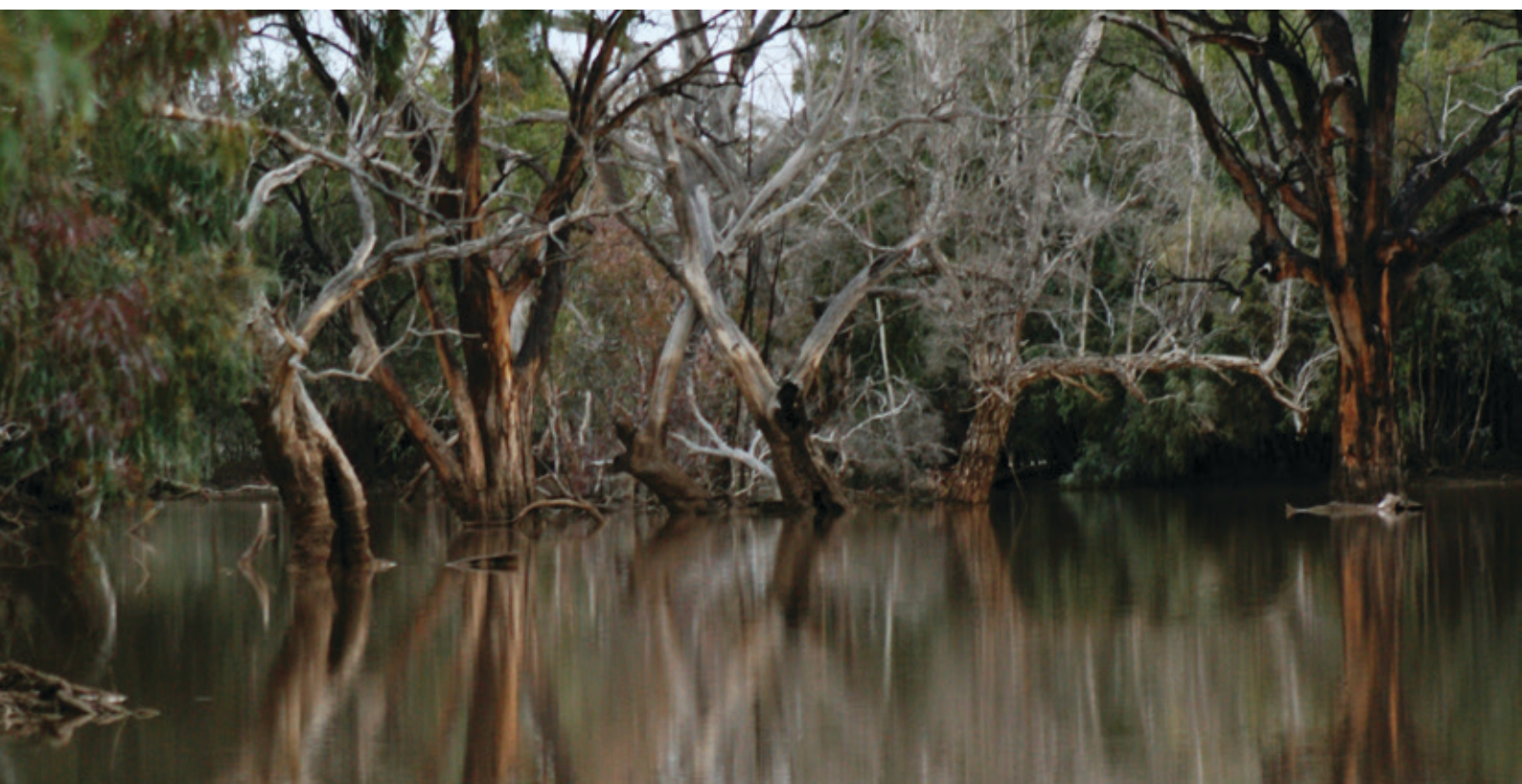
Key flow event protection rules in the region are:

- Lower Balonne – water harvesting may be reduced to assist a low flow to reach the end of all the distributary channels when this has not occurred for more than a year; in the case of a flow likely to fill Narran Lakes and the during the first medium flow (60–100,000 ML/day at St George) after a spell of 2 or 3 years. Inflows into Beardmore Dam up to 730 ML/day outside water harvesting periods are also passed downstream as environmental, stock and domestic (ESD) releases. There are several real time provisions in the resources operations plan to further manage/augment low flow events to achieve flow through if this outcome is looking unlikely.
- Warrego – deferral of water harvesting till after the peak of the flow event has passed, for dry spell (6 months) breaking flows.

- Barwon-Darling – B and C class access in the Barwon-Darling and supplementary access in northern NSW tributaries (Border Rivers, Gwydir, Namoi and Macquarie valleys) may be restricted in response to prolonged dry conditions in order to maintain flows in the Barwon-Darling for algal suppression, fish passage and to meet critical town water supply needs. Application of these provisions is at the discretion of the NSW Water Minister.
- Border Rivers – 25 per cent of unregulated flows in main trunk system and the Macintyre River in NSW protected from point of inflow to the end of system (Mungindi).

The Border Rivers and Barwon-Darling embargo rules in particular can have a significant benefit in enhancing environmentally important in-stream flows. The impact of flow protection rules in the Lower Balonne is limited due to the small reduction in extraction achieved (10 percent for a maximum of 10 days) and limited alignment between the window when the Narran Lakes inflow rule can be activated and the peak season for waterbird breeding (December to March).

While water from entitlements held by the Commonwealth will contribute to environmental demands in the northern unregulated rivers, particularly under low flow and active management conditions, environmental demands will primarily be met by unregulated flows (portion of natural events that is unallocated/not diverted under state water plans, supplemented by additional flows from episodic flow protection rules in certain conditions).



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