



Australian Government

Commonwealth Environmental Water Office

Commonwealth Environmental Water

Portfolio Management Plan

Northern Unregulated Rivers

2018–19



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Commonwealth environmental water portfolio management planning

Commonwealth Environmental Water Holder

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

Commonwealth environmental water

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

There are broadly three options for managing Commonwealth environmental water:

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

Purpose of the document

This document sets out the plans for managing the Commonwealth environmental water portfolio in the Northern Intersecting Streams for 2018–19. Efficient and effective management of Commonwealth environmental water requires the utilisation of all portfolio management options. By taking a multi-year approach to planning, portfolio management tools such as use, carryover and trade can be managed for maximising environmental outcomes.

The portfolio management plans support transparent, coordinated and adaptive management of Commonwealth environmental water, consistent with the Basin-wide environmental watering strategy and having regard to the Basin annual environmental watering priorities. To learn more about the planning approach see *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2017–18* (available at:

<http://www.environment.gov.au/water/cewo/publications> under 'Planning approach').

Delivery partners

Commonwealth environmental water is managed with advice from a range of partners. In the Northern Intersecting Streams, our partners include the Queensland Departments of Natural Resources, Mines and Energy (DNRME), Environment and Science (DES) and Agriculture and Fisheries (DAF), New South Wales Office of Environment and Heritage (NSW OEH), New South Wales Department of Primary Industries – Fisheries (DPI Fisheries), New South Wales Department of Industry – Water (DOI Water), 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 CEWO via: ewater@environment.gov.au.

Table of contents

Commonwealth environmental water portfolio management planning.....	1
Commonwealth Environmental Water Holder.....	1
Commonwealth environmental water.....	1
Purpose of the document	1
Delivery partners	1
Your input.....	1
Table of contents	2
1. Environmental watering in the Northern Intersecting Streams	3
1.1. The Northern Intersecting Streams.....	3
1.2. Environmental objectives and outcomes in the Northern Intersecting Streams.....	6
1.3. Environmental flow requirements	7
1.4. Monitoring and adaptive management	8
2. Portfolio management in 2018–19	9
2.1. Antecedent and current conditions and the demand for environmental water in 2018–19...11	11
2.2. Feasibility of active management by catchment	13
2.3. Priority environmental demands	15
2.4. Active management priorities for 2018–19	18
2.5. Water availability in 2018–19	20
2.6. Stakeholder Feedback.....	20
2.7. Identifying Investment Opportunities	21
3. Next steps	22
3.1. From planning to decision making.....	22
3.2. Further information	22
Bibliography	23
Attachment A – Further detail on environmental assets of the Northern Intersecting Streams.....	27
Lower Balonne	27
Warrego.....	27
Moonie	28
Attachment B – Expected outcomes from the Basin-wide environmental watering strategy	31
Attachment C –Toorale Commonwealth environmental water	35
Attachment D – Long-term water availability	36
Commonwealth environmental water holdings	36
Other sources of environmental water.....	36
Planned environmental water	36

1.Environmental watering in the Northern Intersecting Streams

1.1. The Northern Intersecting Streams

The Northern Intersecting Streams include the Moonie, Condamine–Balonne, Nebine and Warrego river systems (Figure 1). These rivers have many common features, and for planning purposes, are grouped together. Flow in these river systems is dominated by occasional rainfall events rather than being 'controlled' by public dams and other infrastructure as occurs in 'regulated' catchments of much of the Basin to the south. The majority of water use and entitlement is in the form of diversion of river flows and water during periodic unregulated flow events that breaks out of rivers and becomes overland flows across floodplains. 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 water 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 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. Runoff into rivers from lowland areas usually makes only a minor contribution as rain that falls on the flat floodplains tends to evaporate or seep into the ground rather than becoming streamflow. In some northern unregulated systems, no flow periods of several months are common and may extend to several years during prolonged dry conditions. The degree of intermittency varies between rivers. Most of the Lower Balonne system and the Moonie, Warrego, Nebine and Paroo systems are highly intermittent, experiencing no flow for 50 percent or more of the time on a long term basis.

The Northern Intersecting Streams include headwater and slopes zones but for most of their length flow through flat semi-arid rangelands. 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).

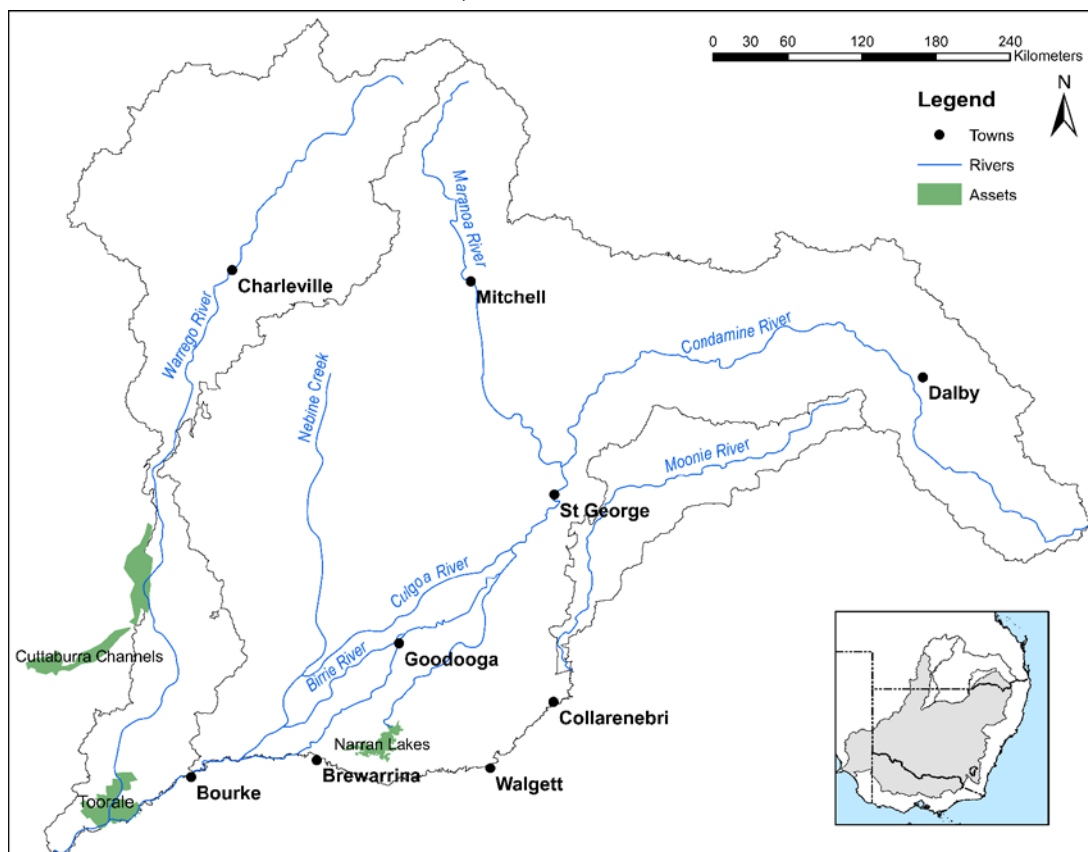


Figure 1: Map of the Northern Intersecting Streams.

Environmental assets of the Northern Intersecting Streams

There are many environmental assets in the Northern Intersecting Streams that are of international and national significance. These environmental assets include species and communities of fish, waterbirds and vegetation, and important habitats such as wetlands and drought refuges.

The Condamine–Balonne and the Warrego catchments supports the largest area of wetlands of any catchment in the Murray-Darling Basin. An important example in the Condamine–Balonne is the Narran Lakes. This terminal wetland complex is of both national and international significance, comprising of the **Narran Lakes Nature Reserve** (28,323 ha) and the **Ramsar listed Narran Lakes site** (8,447 ha) within (Figure 2).

At the time of the Narran Lakes listing as a Wetland of International Importance under the Ramsar Convention, an Ecological Character Description (ECD) was outlined. This ECD describes the ecological character including components, processes and services of the wetland and is a fundamental tool for site managers by outlining threats and limit of acceptable change. Butcher et al. (2011) described the critical components and processes as:

- **Hydrology and productivity:** The Narran River system has highly variable flows driven by summer rainfall in the upper catchment. It is also a losing system because of high evaporation. A range of flood magnitudes are essential to maintain floodplain condition including productivity. Hydrological connectivity and variation in inundation is a key to maintaining floodplain productivity.
- **Vegetation:** A key characteristic of the site is the complex channelised floodplain, which is vegetated with lignum in vast expanses. Three distinct wetland basins are present within the site: Clear Lake, Back Lake and the Long Arm (Figure 2).
- **Fish:** Native fish species dominate the system with 11 species recorded from several surveys.
- **Waterbirds:** supports a significant number of migratory bird species including 14 species listed under international migratory species treaties and a further 26 species which are migratory within Australia. Significant breeding populations of colonial breeding species including great eastern egret (*Ardea modesta*), glossy ibis (*Plegadis falcinellus*), Australian white ibis (*Threskiornis molucca*) straw-necked ibis (*Threskiornis spinicollis*), and royal spoonbill (*Platalea regia*) are supported at the site.

The Narran Lakes also provides critical supporting services, such as near natural wetland system and threatened species:

- Murray cod (*Maccullochella peelii peelii*) listed as vulnerable under the EPBC Act and critically endangered on the IUCN Red List (IUCN 2010).
- Australasian bittern (*Botaurus poiciloptilus*) is listed as endangered under both the EPBC Act and the IUCN Red List (IUCN 2010).
- Winged peppercreep (*Lepidium monoplacoides*) is listed as endangered under the EPBC Act (Butcher et al. 2011).

A key threat to the ecological character of the Narran Lakes is increased upstream water extraction, with potential impacts identified as: reduced vegetation health and loss of habitat for waterbird breeding; and reduced value as drought refuge and support of critical life stages.

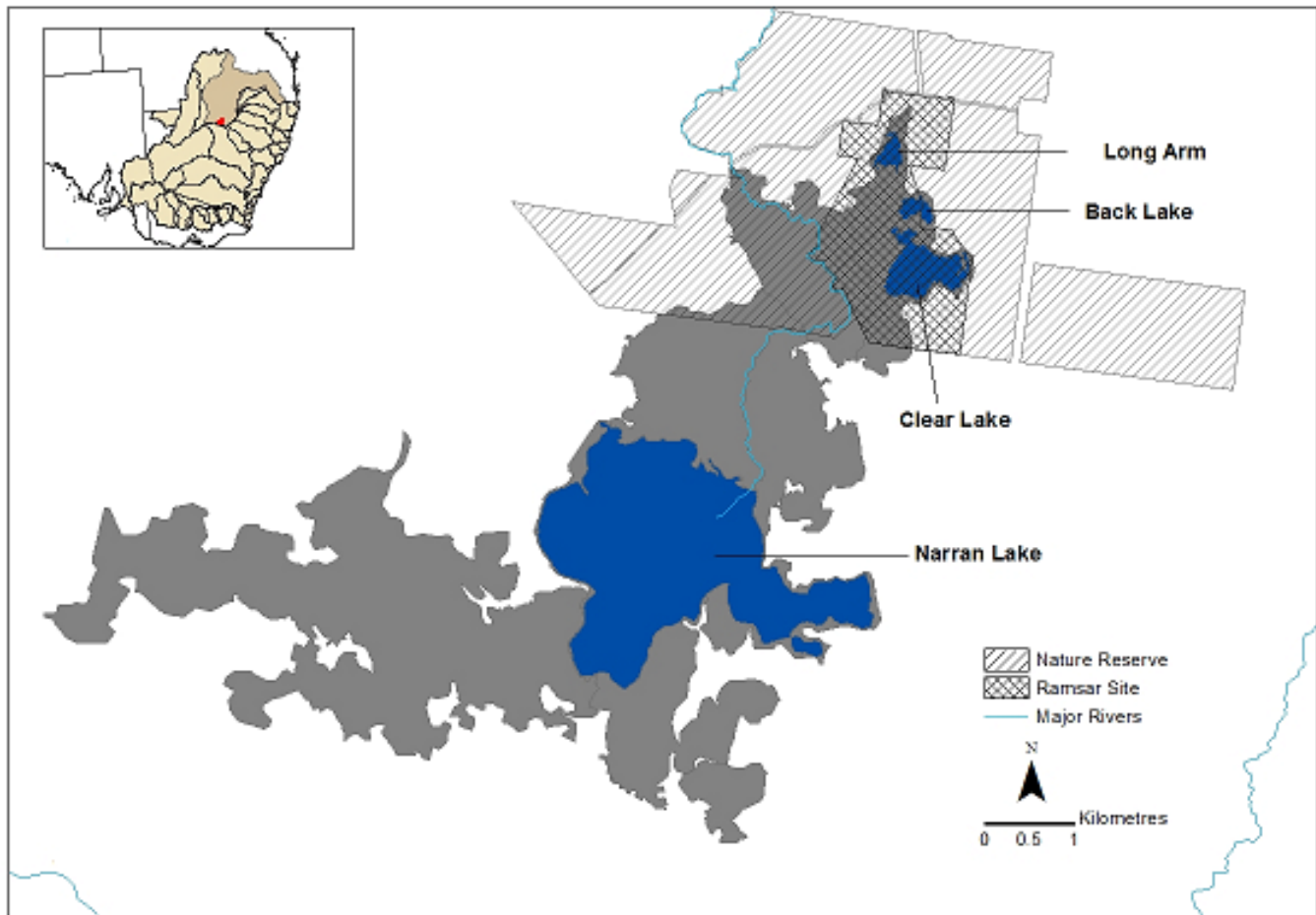


Figure 2. The Narran Lakes

Also of national significance is the Balonne River Floodplain, which includes the **Culgoa National Park** located on the border between New South Wales and Queensland (DES 2018). This park protects both rare vegetation communities, like inland riverine woodlands and open grasslands, as well as important habitat for a number of terrestrial species threatened in New South Wales, including the Australian bustard, grey falcon, painted honeyeater, pink cockatoo, brolga, koala, striped-faced dunnart and little pied bat (DES 2018 as referenced in NPWS 2003).

The Warrego catchment contains the Cuttaburra Channels and nationally significant Yantabulla Swamp, which is a mosaic of channels, floodways and wetlands that consistently supports large numbers and a high diversity of waterbirds and when flooding provides breeding sites for ducks and colonial waterbirds. Another ecologically important wetland is Toorale's Western Floodplain, located at the junction of the Warrego and Darling rivers. In wet conditions this area provides an important feeding and breeding site for fish, birds, frogs, turtles and yabbies. Over 100 species of birds have been seen at Toorale include eastern great egret, pink eared duck and brolgas. Toorale has a high plant diversity including a species listed as threatened in NSW, tiny teeth (*Dentella minutissima*).

These ecological populations and habitats are connected by the Barwon-Darling River, providing a critical drought refuge and movement corridor for fish and waterbirds. These are described below, and in more detail in [Attachment A](#).

Fish species in Northern Intersecting Streams listed as threatened at the state and/or Commonwealth level include Murray cod and silver perch. Additionally, these rivers support important remnant populations of olive perchlet, purple spotted gudgeon, and freshwater catfish that are less prevalent or no longer present in the southern Basin. There are a number of species that only occur in the northern Basin, including Rendahl's and Hyrtl's tandan.

Waterbird species, including international migratory species, visit habitats along Northern Intersecting Streams. These species include the great egret, glossy ibis, and rainbow bee-eater. Additionally, nationally threatened waterbirds (including Australian painted snipe and Australasian bittern) and species listed as threatened in NSW (including the brolga, freckled duck and blue-billed duck) live in habitats along the

Northern Intersecting Streams. Any watering actions that contribute to maintaining waterbird habitat or support waterbird breeding within the Northern Intersecting Streams may also benefit waterbird populations more broadly across the Murray-Darling Basin and beyond, by increasing the opportunity for recruitment and recovery. Additionally, there is increasing evidence of the connection between waterbird populations observed in the Narran Lakes and other wetlands along Northern Intersecting Streams with other important nearby ecological assets such as the Macquarie Marshes and the Gwydir Wetlands. The range of many waterbird species extends further afield from the Macquarie Marshes to key ecological assets including the Booligal Wetlands, Barmah-Millewa Forest, Coorong and Lower Lakes.

Native vegetation along the Northern Intersecting Streams is also highly significant. An example is the ecological community of coolibah-black box woodland on the Culgoa River floodplain which is listed as endangered under Commonwealth legislation. Important riparian and floodplain vegetation in the dryland catchment areas include lignum, river red gum, river cooba black box, and coolibah. There is a high proportion of remnant vegetation in good condition in some areas, including the floodplains of the Warrego and Culgoa rivers.

In between boom periods river channels typically dry to a series of disconnected waterholes, which are **drought refuges** that are reconnected by the next significant flow event. Semi-permanent and permanent waterholes in the main river channels and tributary creeks and anabranch systems are critical to ensuring the survival of species between boom periods and their capacity to recolonise the system in subsequent flow periods. Much of the riverine fauna (e.g. fish, turtles, invertebrates) of the Northern Intersecting Streams is dependent upon the persistence of a network of refugial waterholes during frequent and often prolonged no flow periods.

The Barwon-Darling river channel connects all the rivers, lakes and wetlands in the northern Murray-Darling Basin, providing a critical dry period refuge and movement corridor for fish and waterbirds, as well as habitats for other aquatic species including turtles, mussels, and shrimp. Connectivity between the Barwon-Darling and the Northern Intersecting Streams is particularly important for regional communities of native fish and other aquatic species. A separate Portfolio Management Plan has been developed for the Barwon-Darling.

1.2. Environmental objectives and outcomes in the Northern Intersecting Streams

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 Strategy). The Strategy includes quantified environmental outcomes at both a Basin-scale and for each catchment—outcomes relevant for the Northern Intersecting Streams catchment are described in [Attachment B](#).

Basin state governments are also developing long-term watering plans for each catchment. These plans will identify the priority environmental assets and ecosystem functions in the catchment, the objectives and targets for these assets and functions, and their watering requirements. Once developed, these plans will provide the key information on the long-term environmental water demands in the catchment. Prior to the development of long-term watering plans, the Office will continue to draw on existing documentation on environmental water demands developed by state governments, local natural resource management agencies and the Murray-Darling Basin Authority (MDBA).

Based on these strategies and plans, and in response to best available knowledge drawing on the results of environmental watering monitoring programs, the outcomes being targeted by environmental watering in the Northern Intersecting Streams are summarised in Table 1 below. The objectives for water-dependent ecosystems will continue to be revised as part of the Office's commitment to adaptive management.

Table 1: Summary of long-term expected outcomes from environmental watering in the Northern Intersecting Streams

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

Information sourced from: CEWO (2014), Davie and Mitrovic (2014), Kingsford (1999), McGinness and Arthur (2011), MDBA (2012), NSW DWE (2009a, b), SKM (2009, 2012), Thoms et al. 2005, Australian Wetlands (2009), Eco Logical Australia (2015, 2017a, 2017b, 2018)

1.3. Environmental flow requirements

Occasional flow events are important features of the Northern Intersecting Streams. In some rivers, these flow events may only occur once or several times in a year. Seasonal flow patterns have largely been preserved in the Northern Intersecting Streams. However, diversions during unregulated flow events and flow changes associated with small public regulated water schemes (such as the Condamine–Balonne) and in-stream weirs with diversions to private infrastructure 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 MDBA assessed the environmental flow requirements of streams across the Basin in 2012. In 2016 the MDBA re-assessed the environmental water requirements of the Condamine–Balonne systems, based on an improved science base (MDBA 2016). There are also ongoing research activities contributing to our understanding of environmental water requirements of the Northern Intersecting Streams include the Joint-venture science program and state planning assessments as part of the Long-term watering plans. The Commonwealth also funds the Murray-Darling Basin Environmental Water Knowledge and Research (EWKR) project which is gaining important information, including several research projects in the Lower Balonne, to support managing environmental water in the Basin.

Environmental watering requirements at Toorale and in the Warrego River are being refined informed by local knowledge and Long Term Intervention Monitoring (LTIM) monitoring activities funded by the Office.

The CEWO has worked with water recovery teams of Commonwealth and state government to ensure that unregulated entitlements recovered in the Northern Intersecting Streams provide flows that contribute towards meeting the environmental flow requirements. Where long term outcomes are not being met by natural flows, short-term or urgent environmental demands, if feasible, can be addressed by using event based mechanisms and other active management approaches, which are discussed in Section 2.

1.4. 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. The CEWO monitors stream flows in the northern Basin using real-time data from river gauges, to quantify how Commonwealth unregulated entitlements are enhancing river flows. River flow data in conjunction with official announcements of water harvesting access in Queensland systems (Lower Balonne, and Warrego) are used to estimate the contribution Commonwealth unregulated entitlements make to flows. Water 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 LTIM project at the junction of the Warrego and Darling Rivers Selected Area (at Toorale) 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. Some of the key findings of 2017–18 monitoring of the junction of the Warrego and Darling Rivers LTIM selected area include:

- Birds: over 100 species have been seen at Toorale include eastern great egret, black fronted dotterel, grey teal, pink eared duck, herons, brolgas and Australian grebe. When it is wet, birds breed and feed on the Western Floodplain and the Warrego River. In dry times the birds use the dams as refuges.
- Fish: even small flows in the Warrego River provide breeding opportunities for fish including golden perch and Hyrtl's catfish. When wet, the Western floodplain also provides fish breeding opportunities for Murray-Darling rainbowfish (*Melanotaenia fluviatilis*).
- Vegetation: over 3,800 hectares of key plant communities on the Western Floodplain were inundated in 2016-17. This helped plant diversity and cover, including tiny teeth (*Dentella minutissima*). Lignum also flourished and flowered providing the vegetation required for bird breeding.
- Connectivity: environmental flows increased the connectivity along and between Warrego and Darling Rivers.

A research project in the Lower Balonne was also finalised in 2017–18. This EWKR project has improved our understanding of water availability and use by vegetation of the Lower Balonne floodplain (DSITI and DNRM 2017).

The CEWO also makes use of monitoring undertaken by state partners. For example, our partners provide updates on the condition of important in-channel and riparian habitats, such as refugial waterholes in the Lower Balonne and waterbird breeding habitat in the Narran Lakes. The outcomes from these monitoring activities, and any other available relevant data, are used in adaptive management to inform portfolio planning and decision-making.

Further information on the monitoring activities is available at:

<http://www.environment.gov.au/water/cewo/catchment/northern-unregulated-rivers/monitoring>

2. Portfolio management in 2018–19

The Northern Intersecting Streams has less regulating structures compared with other areas of the basin, particularly the south. This is a positive for the environment but also can limit options for discretionary use of environmental water. Water cannot be ordered from public storages at a particular time – environmental water can only be sourced as a share of an unregulated flow event, determined by entitlement conditions, or possibly in the future, released from private storages. 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.

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 use of existing and future unregulated entitlements in the northern Basin (excluding the Toorale Warrego River entitlements and NSW supplementary water holdings) has been approved by the Commonwealth Environmental Water Holder in 2012. This decision is the default management arrangement for these entitlements but does not preclude alternative uses.

Event based mechanisms are being designed to allow more active management of unregulated entitlements so as to achieve greater ecological outcomes. These mechanisms may include use of in-stream and on-farm infrastructure to store and release water, and temporary purchase, conditional purchase, and forward purchase. 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 increasing the duration of some key flow events due to the lack of public infrastructure in the region for this purpose.

Priorities and intentions for active management in the Northern Intersecting Streams in 2018–19 were determined using the following steps (shown schematically in Figure 3):

1. Antecedent flows and current catchment conditions were reviewed to identify general environmental water requirements across the Northern Intersecting Streams region going into 2018–19 (Section 2.1).
2. Some 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 using an active management approach.
3. For catchments with generally high environmental water requirements (from Step 1) and feasible active management options (Step 2), requirements were examined in detail and ranked by urgency. This step focused on the Lower Balonne where requirements have been comprehensively assessed and long term flow indicators identified (Table 4).
4. Urgent environmental water requirements with feasible active management options were collated to identify regional priorities for 2018–19 (Table 4).

STEP 1: CURRENT CONDITIONS

What are the current general environmental demands in the region based on antecedent and current conditions?

STEP 2: FEASIBILITY OF ACTIVE MANAGEMENT / EVENT BASED MECHANISMS

Environmental need

Have specific requirements (such as long term flow indicators) being identified to reflect these demands at a catchment or key environmental assets?

Is there likely to be a shortfall in meeting specific environmental water requirements and flow indicators with existing in-stream use?

Operational feasibility

Have any event based mechanisms been designed that could be applied in the system?

Could these options significantly improve the likelihood of meeting any of the identified demand(s) compared to existing in-stream use or doing nothing scenario?

Is the active management option(s) operationally feasible?
(feasible to coordinate the action with unregulated flows; infrastructure access and operational arrangement known; protection of additional flows; other risks able to be managed)

Is there a process in place to undertake the required water transactions and access to infrastructure, or one that could be developed in an appropriate timeframe?

STEP 3: ESTABLISHING PRIORITY ENVIRONMENTAL DEMANDS

Which catchments have assets with high environmental demand and feasible active management options?

What is the relative urgency of the demand?
(Environmental water requirements examined in detail and ranked by urgency)

STEP 4: IDENTIFYING REGIONAL PRIORITIES

Considering the regional nature of many ecological communities and the importance of connectivity, what are the priority active management options across the region for development?

Figure 3: Prioritisation process for the Northern Intersecting Streams

2.1. Antecedent and current conditions and the demand for environmental water in 2018–19

For the first half of 2017–18, most of the Northern Interconnecting Streams were experiencing below average to very much below average rainfall conditions, resulting in very low to no flows across all systems (BOM 2018). At the same time, some areas were experiencing record hot temperatures during spring and early summer, including very warm nights, which exacerbated no flow conditions. At the end of February and early March 2018, a deep trough extended from the northwest, through to central and southeastern Queensland producing rainfall across the west and southern inland areas (BOM 2018). This resulted in small flows breaking the cease to flow conditions and providing end of system connectivity across the Northern Interconnecting Streams, with the exception of the Narran River system. By early May 2018, flow patterns in all intersecting streams were again dominated by low to very low flow conditions.

A range of ecological assets in the Northern Intersecting Streams are under stress. For example, the ecological information in the Condamine–Balonne indicates that despite the low to medium flows in 2016–17, ecological assets either remain under stress:

- Large areas of lignum shrubland, which provide waterbird breeding and foraging habitat within the Ramsar wetland site, have not been inundated since April 2013. The last large-scale waterbird breeding event observed in the northern unregulated catchments was in March 2012, at Narran Lakes.
- Several refugial waterholes on the Narran River system, including one waterhole that was previously identified as persistent, went dry in 2017–18, increasing the population extinction risk for native aquatic fauna, including golden perch.
- The Birrie and Bokhara rivers, which are the inner channels of the Lower Balonne distributary system, experienced only short periods of flow in the last five years.
- Woodland communities on the Culgoa River floodplain in the area around the Queensland-NSW border, including the threatened coolibah–blackbox ecological community, have not been inundated from river flows for more than six years.

There are ecological assets in the Northern Intersecting Streams that are in good condition. For example, a recent survey of Toorale's Western Floodplain illustrates how this boom and bust system came to life after rain and environmental watering providing important habitat for native fish, waterbirds, turtles and frogs (Ecological Australia 2017b). While the floodplain is now in a drying phase the soil profile is still wet and the vegetation is in good condition (Hampers comm).

Annual flows at key ecological sites in the Northern Intersecting Streams between 2008 to 2018 are summarised in Table 1.

Table 2: Annual flows at key sites in the Northern Intersecting Streams 2007 to 2018 (updated 21 May 2018)

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	2016–17	2017–18
Moonie	<i>Nindigully (from 1969)</i>	High	Mod	Very High	Highest on record	Very High	High	Low	Very Low	Very Low	High	Mod
Lower Balonne	<i>St George (from 1971)</i>	Mod	Very Low	Very High	Highest on record	Very high	High	Low	Low	Low	Mod	Low
	<i>Wilby Wilby (from 1964)</i>	Mod	Very Low	High	Highest on record	Very high	High	Low	Low	Low	Mod	Very low
Nebine Creek²	<i>Roseleigh Crossing (from 2007)</i>	Very High	Mod	Highest since 2007	High	High	Very Low	Low	Low	High	Mod	Low
Warrego	<i>Wyandra QLD (from 1966)</i>	Very High	Low	Very High	Very High	Very High	Lowest on record	Very Low	Low	Low	Mod	Low
	<i>Ford's Bridge NSW (from 1972)</i>	Very High	Low	Very High	Very High	Very High	Very Low	Very Low	Low	Very Low	Mod	Very low

Notes to Table 2:

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	

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.

2.2. Feasibility of active management by catchment

The *Water Act 2007* provides for the trade of Commonwealth environmental water (allocations and entitlements) and specifies the conditions under which sales may occur. To improve environmental outcomes must be the primary reason for trade of Commonwealth environmental water. In most northern unregulated catchments the trade of water allocations is not an appropriate or available strategy. An alternative strategy is to enter into contracts with water licence holders as part of an event based mechanism to provide additional water to the environment.

The recent work by the Office to develop event based mechanisms has focused on the Narran Lakes. Findings will be extended to other catchments in due course.

Feasibility of active management in Northern Intersecting Streams is described in based on the criteria on operational readiness and the environmental demands listed in Figure 2. Overall:

- The development and implementation of new event based mechanisms in 2018–19 will focus on actions in the Lower Balonne. Further due diligence work will be undertaken to assess effectiveness, risk, feasibility, and whether the regulatory and compliance regime supports the implementation of these measures.
- Active management of the Commonwealth's unregulated holdings on the Warrego River at Toorale will continue in accordance with the management strategy for utilisation of these entitlements at Boera Dam ([Attachment C](#)). Water available after license conditions are triggered will be directed either downstream to enhance low or fresh flows in the lower Warrego and Darling rivers, and/ or to areas on Toorale's Western Floodplain, Where the water is delivered will depend on the relative environmental demand in these areas at the time of the flow. The management strategy includes a decision tree that helps determine environmental priorities and volumes to be used. Factors considered include antecedent flows, current in-stream and wetland conditions, the size and duration of the flow and implications for the use of environmental water in future years.

Table 3: Potential for active management in Northern Intersecting Streams

Catchment	Environmental need			Feasibility				Possible actions <i>[italicised actions are the proposed focus of development in 2018–19]</i>	Key issues	Priority for 2018–19
	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 2018–19			
Moonie (Queensland)	NO	NO	NO	NO	NO	YES	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 (Queensland)	NO	NO	NO	NO	NO	YES	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 (Queensland)	YES	YES	YES	YES	YES	YES	YES	<ul style="list-style-type: none"> - Waterhole filling flow in Lower Balonne rivers - Narran Lakes 25 GL inflow - Narran Lakes 50 GL inflow - Support waterbird breeding event in Narran Lakes - Enhance medium to large fresh in the Narran River for fish migration 	<ul style="list-style-type: none"> - Measurement and compliance measures to ensure additional purchased flows achieved environmental outcomes - Risk of diversion of additional purchased flows and substitution for planned environmental water 	YES
Warrego Queensland	NO	NO	NO	NO	NO	YES	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	YES	YES	<ul style="list-style-type: none"> - Enhance flows to: <i>The Warrego and Darling rivers to improve low or small fresh flows and provide opportunities for native fish (movement, spawning, recruitment)</i> - Toorale Western floodplain for vegetation, waterbird habitat, breeding and recruitment of frogs, fish, birds and turtles 	<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

Note: Contributions to meet Darling environmental requirements may be considered subject to water availability, antecedent conditions, and environmental demands consistent with CEWO's strategy for utilisation of the unregulated entitlements on the Warrego River at Toorale.

2.3. Priority environmental demands

Comprehensive long term environmental water requirements for the Lower Balonne have been identified during development of the Basin Plan and in the Northern Basin Review process (MDBA 2016b). Prioritisation of environmental demands in these catchments is shown in Table 4. High low/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.

Priority demands in the different catchments were collated and ranked qualitatively to obtain a prioritised list of urgent environmental demands in the Northern Intersecting Streams going into 2018–19. This step is shown in Table 5.

Table 4: Environmental demands and priorities for active management of Commonwealth environmental water in the Lower Balonne for 2018–19

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)			Watering history	2018–19	
	Physical and process assets	Flow/volume	Average required frequency (maximum interval)	(from all sources of water)	Environmental demands For water	Potential for <u>active management</u> ^{B,C}
Lower Balonne River channels (Culgoa River, Narran River and inner distributary channels)	Drought refuge (waterholes) ^{1,2}	Flow reaches end of all channels within a three month period, indicated by ¹ :	Annually (no longer than 12 months between last flow) ¹⁸	While a filling flow has recently occurred in the Culgoa (March 2018) and Bokhara (May 2018) river systems, an end of system event did not occur in other systems. This replenishment flow is required for the lower Narran River system where the majority of key refugial waterholes in the Lower Balonne are located ² . Water is required annually to replenish refugial waterholes (contributing to persistence, connectivity and quality).	High	Low to Moderate A low priority for active management in unregulated flows that trigger event management rules ¹⁶⁻¹⁷ . Active management (augmentation of flows through event-based mechanisms) could be a higher priority in other unregulated flows, given that the demand is not likely to be met in the long term.
		30 ML/day Birrie River @ Talawanta for 1 day				
		30 ML/day Bokhara River @ Bokhara for 1 day				
		30 ML/day Culgoa River @ Weilmoringle for 1 day				
		30 ML/d Narran River @ Narran Park for 1 day				
	Culgoa River - longitudinal connectivity ^{3,4}	Small in channel fresh 1 000 ML/day @ Brenda for 7 days	8 to 9 in 10 years	Although small freshes have occurred 9 in 10 years, the recent fresh did not meet the duration requirements. After a year of no flow, basic ecological function could be hampered if dry conditions prevail.	Moderate to High	Potentially out of scope for active management Potential for active management requires further investigation, including operational feasibility in medium flow events, given that the 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) for 14 days	4 to 6 in 10 years	The last in large in-channel fresh that partially met the demand occurred 6 years ago. A small fresh is required this year to maintain existing fish populations and provide for local dispersal and increased recruitment opportunities.	Critical	High A high priority for active management under all water resource availability scenarios. Demand could be met in conjunction with recommended event-based mechanisms (such as seasonal assignments ¹⁵) to also support environmental demands of the Narran Lakes (25 GL inflow)
	Culgoa River – fish migration ^{3,4}	Large in-channel fresh 3 500 ML/day @ Brenda (August - May) for 14 days	4 to 6 in 10 years	The last in large in-channel fresh that met the demand occurred 7 years ago, which exceeds or approaches the lifespan of short lived fish species. A large fresh is required this year to maintain healthy fish populations and provide for dispersal and recruitment.	Critical	Potentially out of scope for active management 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 for 12 days	Every 2 to 3 years	The last flow of this magnitude occurred 7 years ago, exceeds critical interval (3 years) to maintain condition of river red gum forests ^f . Inundation required this year to maintain ecosystem health and function.	Critical	Potentially out of scope for active management Potential for active management requires further investigation, including ecological outcomes from watering
	Connectivity with the inner floodplain ⁵⁻⁹	15 000 ML/day Culgoa River @ Brenda for 10 days	Every 3.5 to 4 years	The last flow of this magnitude occurred 7 years ago, which exceeds the critical interval to maintain condition of river red gum forests and to sustain lignum (3 to 5 years). Inundation required this year to maintain ecosystem health and function.	High	Out of scope for active management Benefit of supplying additional Commonwealth environmental water would be negligible
	Connectivity with the mid floodplain ⁵⁻⁹	24 500 ML/day Culgoa River @ Brenda for 7 days	Every 6 to 8 years	The last flow that met the demand occurred 7 years ago. Inundation required within the next year to maintain ecosystem health and function	Low to Moderate	Out of scope for active management Benefit of supplying additional Commonwealth environmental water would be negligible
	Connectivity with outer floodplain ⁵⁻⁹	38 000 ML/day Culgoa River @ Brenda for 6 days	Every 10 to 20 years	The last flow that met the demand occurred 7 years ago. Critical interval for inundation, since the 2010-11 and 2011-12 floods, will be around 2020	Low	Out of scope for active management Benefit of additional Commonwealth environmental water would be negligible
Narran Lakes	Waterbird breeding habitat in northern lakes (Ramsar site) ^{8,10-14}	25 GL @ Narran Park (Narran River) over 60 days	Every 1 to 1.3 years	This demand was partially met 2 years ago. While the interval since last fully successful event (4.5 years) exceeds interval for vigorous growth and maximum without development spell, an inflow of 24 GL occurred during 2016 -17 water year reducing the urgency of this environmental water requirement. Inflows required this year to sustain core lignum waterbird habitat and ability to support waterbird breeding.	Critical	High A high priority for active management under all water resource availability scenarios ¹⁵ .
	Waterbird breeding and foraging habitat northern lakes zone ^{8,10-14}	50 GL @ Narran Park over 90 days	Every 1.3 to 1.7 years	This demand was met 6 years ago. Inflows are required this year to sustain lignum shrublands and maintain condition of riparian red gum forests.	Critical	

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)			Watering history	2018–19	
	Physical and process assets	Flow/volume	Average required frequency (maximum interval)	(from all sources of water)	Environmental demands For water	Potential for <u>active management</u> ^{B,C}
	Trigger and maintain large scale colonial waterbird breeding ^{8,10-14}	154 GL @ Narran Park over 90 days	Twice in every 8 to 10 years	This demand was met 7 years ago. Last large scale waterbird breeding event was in early 2013. An event is 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	Potentially out of scope for active management Commonwealth water portfolio is likely to contribute during large flow events
	Water all floodplain and wetland habitat in Narran Lakes complex, initiate waterbird breeding, provide long-term refuge	250 GL over 180 days @ Narran Park	Every 10 to 12 years	This demand was met 7 years ago. Following the 2010-11 and 2011-12 floods, the critical interval for inundation will be from 2020 (if not received before then)	Low	Out of scope for active management Benefit of additional CEW would be negligible

Notes to table: 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 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 4:

- Condamine and Balonne Resource Operations Plan (s269): pers comm P. Harding, Consulting Hydrologist Queensland DSTI 20 Feb 2015.
- 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
- 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
- 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).
- MDBA (Murray-Darling Basin Authority) 2016a, Inundation mapping in the Northern Basin review, Murray-Darling Basin Authority, Canberra (in prep.)
- Sims, NC and Thoms, MC 2002, 'What happens when flood plains wet themselves: vegetation response to inundation on the lower Balonne flood plain', *International Association of Hydrological Sciences*, vol.276, pp.195-202
- Casanova, M 2015, Review of Water Requirements for Key Floodplain Vegetation for the Northern Basin: Literature review and expert knowledge assessment, report prepared for the MDBA by Charophyte Services, Lake Bolac
- 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.
- Sims, N 2004, The landscape-scale structure and functioning of floodplains, University of Canberra, Canberra
- 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
- 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
- ANU (Australian National University) Enterprise 2011, 'Decision Support System for the Narran Lakes', final report to the NSW Department of Environment, Sydney
- 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
- 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
- BDA Group (2018), A comparative assessment of event-based mechanisms for providing water to the Narran Lakes, Report prepared for the Commonwealth Environmental Water Office
- DES (In Prep) Review of Water Plan (Condamine and Balonne) 2004 – Ecological Risk Assessment Report. Draft January 2018.
- Water Resource Plan (Condamine and Balonne) 2004, (Subdivision 2 Event management rules for the Lower Balonne)
- DES (Unpublished)

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

2.4. Active management priorities for 2018–19

Based on the assessment in Table 4 and previous sections, the most urgent environmental water requirements for assets in the Northern Intersecting Streams in 2018 -19 are summarised in Table 5.

Table 5: Priority environmental requirements and active management options in 2018 - 19 in the Northern Intersecting Streams

Environmental demand	Urgency	Specific actions to be considered in 2018–19
Inundation of core waterbird breeding habitat at Narran	Critical	Enhance a flow event to achieve 25 GL inflow to Narran Lakes (action development well advanced)
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	Moderate	Enhance overflow from Boera Dam to the Western Floodplain [#]
Fresh in the Narran River for fish migration	Critical	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
Lower Balonne channels drought refuge (waterholes)	High	Enhance flows with purchased unregulated/regulated water to achieve flow through in all channels particularly the Narran and Birrie rivers
Large scale waterbird breeding event at Narran Lakes	High	Support breeding event with additional inflows, if required (action development well advanced)

[#]Active management at Toorale National Park in 2018 - 19 will be in accordance with the approved strategy for utilization of the Commonwealth's unregulated entitlements on the NSW Warrego River based on highest environmental demand.

Note: Contributions to meet Barwon-Darling environmental requirements will be subject to water availability, antecedent conditions, and environmental demands in accordance with the

Delivery in 2018–19

In 2018–19 the development of event based mechanisms to provide additional environmental water in the Northern Intersecting Streams will focus on practical options that are feasible to implement within the next 24 months and which address the most urgent environmental demands (Table 5). There will be an emphasis on the Narran Lakes. Small active deliveries to anabranches in the Lower Border Rivers or flow enhancement in the Culgoa River (Lower Balonne) for fish benefits may also be considered if the associated delivery and contractual arrangements can be progressed sufficiently.

Although a priority order of active management options has been defined based on urgency of the associated environmental requirements (Table 5), each action is appropriate to a specific flow situation, and will only be viable if a suitable unregulated flow event occurs. 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, and provide longitudinal continuity and replenishment of waterholes.

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 2018–19 and beyond. Active management at Toorale National Park, to achieve targeted outcomes in the lower Warrego/Darling Rivers and the Western Floodplain, will continue in 2018–19 in line with the CEWO's strategy for utilisation of the unregulated entitlements on the Warrego River at Toorale.

Murray–Darling Basin Plan environmental watering priorities and the Murray–Darling Basin-wide environmental watering strategy

The Murray–Darling Basin Authority publish the Basin annual environmental watering priorities each year and in 2017–18 also published multi-year priorities. Commonwealth environmental water in the Intersecting Streams will contribute to the following multi-year environmental watering priorities and the 2018–19 Basin annual environmental watering priorities.

Rolling, multi-year priorities

- Support lateral and longitudinal connectivity;
- Maintain and improve the condition and promote recruitment of forests and woodlands;
- Improve the condition and extent of lignum shrublands;
- Improve the abundance and maintain the diversity of the Basin's waterbird population;
- Improve flow regimes and connectivity to maximise the ecological function of the Barwon-Darling river system for native fish;
- Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations.

2018-19 Annual Priorities

- Support opportunities for lateral connectivity between the river and adjacent low-lying floodplains and wetlands to reinstate natural nutrient and carbon cycling processes;
- Coordinate replenishment flows across multiple tributaries to maintain habitat condition and regulate water quality, carbon and nutrients in refuges along the Barwon-Darling watercourse;
- Enable growth and maintain the condition of lignum shrublands;
- Provide flows to improve habitat and support waterbird breeding;
- Maximise availability of productive foraging habitat for shorebirds;
- Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations;
- Improve flow regimes and connectivity to maximise the ecological function of the Barwon-Darling river system for native fish.

In making decisions on the use of Commonwealth environmental water the CEWH will have regard to these priorities while also considering water resource availability and environmental demand. In contributing to these demands, the Commonwealth Environmental Water Office will also be aiming to contribute to the expected outcomes in the Basin-wide environmental watering strategy (see Attachment A).

2.5. Water availability in 2018–19

Water availability depends on the flow events that occur. 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 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 May to July 2018 suggests an equal likelihood of dry or wet conditions. There is a 50% chance (of above average rainfall across the Northern Intersecting Streams and there is a 50% likelihood of above average day time temperatures. However, the short term outlook should not be taken as a reliable predictor of significant unregulated flow events in 2018–19. Unregulated flows cannot be predicted with any certainty. Large flows in Northern Intersecting Streams typically rely on rainfall events in headwater areas of catchments where overall rainfall is much higher than in the semi-arid lowland areas.

At 16 May 2018, Commonwealth unregulated water holdings in the Northern Intersecting Streams comprise around 131 gigalitres expressed as long-term average annual yields. Commonwealth unregulated environmental water holdings across the northern Basin now exceed those of regulated water. Further detail on sources of environmental water in the Northern Intersecting Streams is provided in [Attachment D](#).

The total volume of water that is available (with full activation of all unregulated entitlements in the Northern Intersecting Streams in 2018–19 exceeds 234 gigalitres. 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.

Around 5 to 20 gigalitres per action of additional environmental water could potentially be used in active management options such as temporary purchase to enhance flow events in the Lower Balonne.

Information on 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 Intersecting Streams have been sought during 2017–18 and in previous years. Event based mechanisms have been discussed with Lower Balonne stakeholders and Queensland departments of Natural Resources, Mines and Energy (DNRME) and Environment and Science (DES) over the last few years and will continue in 2018–19. For Toorale, the Joint Management Committee (including NSW National Parks), Eco Logical and NSW DPI Fisheries have provided feedback on the management of the Western Floodplain using Commonwealth environmental water.

Feedback has included:

- There is in-going support and interest in participation in event based mechanisms amongst Lower Balonne water users, community representatives and Queensland agencies.
- Preliminary results from research activities undertaken in the Lower Balonne waterholes has been used to support changes to low flow requirements in this system, particularly to ensure persistence of refugial waterholes in the Narran River system.
- The Western Floodplain at Toorale has high ecological value and should continue to be a high priority for environmental water. The Warrego and Darling rivers also have ecological value for fish and are also a priority for environmental water.

2.7. Identifying Investment Opportunities

Under the Water Act the Commonwealth Environmental Water Holder (CEWH) has the flexibility to use the proceeds from the sale of water allocations to fund environmental activities in the Basin. 'Environmental activities' should improve the capacity of the CEWH to meet the objectives of the Basin Plan environmental watering plan.

Environmental Activities must also be consistent with:

- the CEWH's obligation to exercise its functions to protect and restore environmental assets; and
- the requirement to use Special Account funds (including trade proceeds) to cover costs incurred in the performance of the CEWH's functions.

The CEWH is in the process of developing an Investment Framework to guide decisions on what types of environmental activities may be considered when investing the proceeds from the sale of environmental water allocations.

3. Next steps

3.1. From planning to decision making

It is important to distinguish between planning and operational decision making. As shown in Figure 4, planning allows the Office to manage the environmental water portfolio in a holistic manner and is an exercise in developing a broad approach or intention, based on the key drivers (demand and supply).

Decision making throughout each year builds on the intention by considering in more detail the specific prevailing factors and additional factors such as costs, risks, and constraints to water delivery and market conditions. The conditions and arrangements in the Northern Intersecting Streams will be taken into account by the CEWH at the decision making stage.

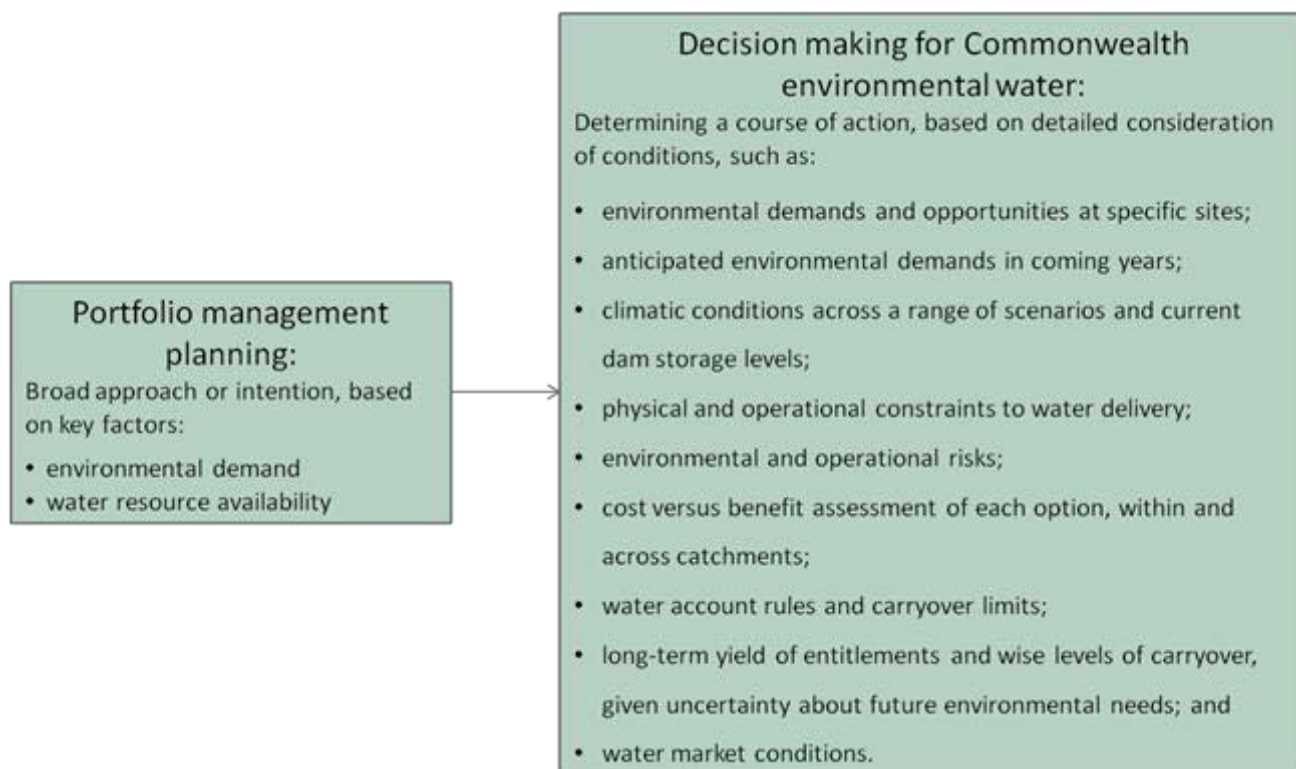


Figure 4: Planning and decision making for Commonwealth environmental water use

3.2. Further information

For further information on how the CEWO 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>

Bibliography

Alluvium (2016). *Toorale Environmental Water Delivery Business Case – Options assessment*. Report for the NSW Office of Environment and Heritage

ANU (Australian National University) Enterprise (2011). *Decision Support System for the Narran Lakes*. Final report to the NSW Department of Environment, Sydney.

Arthington A., and Balcombe S. (2011). Extreme flow variability and the boom and bust ecology of fish in arid-zone floodplain rivers: a case history with implications for environmental flows, conservation and management. *Ecohydrology*, 4(5), 708–720.

Balcombe, S. Arthington, A. Foster, N. Thoms, M. Wilson, G. Bunn, S. (2006). Fish assemblages of an Australian dryland river: abundance, assemblage structure and recruitment in the Warrego River, Murray-Darling Basin. *Marine and Freshwater Research*, 57, 619-633.

Balcombe S., Bunn S., Arthington A., Fawcett J., McKenzie-Smith F. and Wright A. (2007). 'Fish larvae, growth and biomass relationships in an Australian arid zone river: links between floodplains and waterholes', *Freshwater Biology*, 52, 2385–2398.

BDA Group (2018). A comparative assessment of event-based mechanisms for providing water to the Narran Lakes. Report prepared for the Commonwealth Environmental Water Office.

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*. Murray-Darling Basin Authority, Canberra. <https://www.mdba.gov.au/publications/independent-reports/flow-waterbird-ecology>

Brennan S., O'Brien M., Thoms M. and Maher S. (2002). *The Physical Character and Flow Criteria for Wetlands Along the Barwon-Darling River*, CRC for Freshwater Ecology Technical Report to NSW Department of Land and Water Conservation.

Butcher R., Hale J., Capon S., and Thoms M. (2011). *Ecological Character Description for Narran Lake Nature Reserve*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Capon S.J. (2009). Flow-dependent ecosystems of Toorale Station: Ecological character, condition and issues associated with decommissioning water resources infrastructure.

Casanova M. (2015). *Review of Water Requirements for Key Floodplain Vegetation for the Northern Basin: Literature review and expert knowledge assessment*. Report prepared for the MDBA by Charophyte Services, Lake Bolac. <http://www.mdba.gov.au/publications/independent-reports/review-water-requirements-key-floodplain-vegetation-northern-basin>

Commonwealth Science and Industrial Research Organisation (CSIRO) (2007). *Water availability in the Warrego. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project*. CSIRO, Australia.

CSIRO (2008). *Water availability in the Moonie. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project*. CSIRO, Australia. <http://www.clw.csiro.au/publications/waterforahealthycountry/mdbsy/pdf/moonie-report.pdf>

Dick R. (1993). *The Vegetation of the Wombeira Land System on the Floodplains of the Culgoa, Birrie and Narran Rivers in NSW- November 1990*. Occasional Paper No. 13. NSW National Parks and Wildlife Service.

Department of Environment and Resource Management (DERM) (2010). *Waterhole research highlights*, Queensland Government, Brisbane. <http://wetlandinfo.ehp.Queensland.gov.au/resources/static/pdf/ecology/river-conceptual-models/waterholes/waterholes-research-highlights-report-version-2-may-2011.pdf>

Department of Environment and Science (DES) (2018). Review of Water Plan (Condamine and Balonne) 2004 and Resource Operations Plan. Environmental Assessment Report. Department of Environment and Science, Brisbane.

Department of Science, Information Technology and Innovation and Department of Natural Resources and Mines (DSITI and DNRM) (2017). *Improving the understanding of water availability and use by vegetation of the Lower-Balonne Floodplain*, The State of Queensland 2017.

Eco Logical Australia (2015). *Commonwealth Environmental Water Office Long Term Intervention Monitoring Project. Junction of the Warrego and Darling rivers Selected Area; Annual Evaluation Report – Year 1*. Report prepared for the Commonwealth Environmental Water Office, Department of the Environment, Commonwealth of Australia.

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. <http://www.mdba.gov.au/publications/independent-reports/vegetation-barwon-darling-Condamine-Balonne-floodplain-systems-new>

Eco Logical Australia (2017a). *Commonwealth Environmental Water Office Long Term Intervention Monitoring Project. Junction of the Warrego and Darling rivers selected area; 2015-16 Final Evaluation Report*. Report prepared for the Commonwealth Environmental Water Office, Department of the Environment and Energy, Commonwealth of Australia.

Eco Logical Australia (2017b). *Aquatic fauna use of the Warrego River Western Floodplain*. Report prepared for the Commonwealth Environmental Water Office, Department of the Environment and Energy, Commonwealth of Australia.

Eco Logical Australia (2018). *Commonwealth Environmental Water Office Long Term Intervention Monitoring Project. Junction of the Warrego and Darling rivers selected area; 2016-17. Final Evaluation Report*. Report prepared for the Commonwealth Environmental Water Office, Department of the Environment and Energy, Commonwealth of Australia.

Gowans S., Milne R., Westbrooke M. and Palmer G. (2012). *Survey of Vegetation and Vegetation Condition of Toorale*. Prepared for the NSW Government Office for Environment & Heritage, November 2012. Centre for Environmental Management. University of Ballarat, Mt Helen, Victoria

Green D. (1992). *Survey of wetlands of the Warrego River*. Report prepared by the NSW Department of Water Resources for the Australian National Parks and Wildlife Service. 32 pp.

Holz L., Barma D. and Wettin P. (2008). *Warrego River Scoping Study*, WMA Water, Sydney. Prepared for Western CMA and South-Western NRM.

Hunter J. (2005). *Vegetation of Culgoa National Park, central northern New South Wales*. *Cunninghamia* 9:275-284.

King A., Green D. and Brady A. (1995). *Wetlands of the Paroo River and Cuttaburra Creek*. Technical Services Division, NSW Department of Land and Water Conservation. July 1995

Kingsford R.T. (1999). *Aerial survey of waterbirds on wetlands as a measure of river and floodplain health*. *Freshwater Biology* 41(2):425-438.

Kingsford R., Bedward M. and Porter J. (1994). *Waterbirds and Wetlands in Northwestern New South Wales*. National Parks and Wildlife Service Occasional Paper No 19. NSW National Parks and Wildlife Service, Hurstville.

Kingsford R.T., Thomas R.F. and Wong P.S. (1997). *Significant wetlands for waterbirds in the Murray-Darling Basin*. NSW National Parks and Wildlife Service, Hurstville.

Kingsford R.T., Thomas R.F. and Curtin A.L. (2001). *Conservation of wetlands in the Paroo and Warrego River catchments in arid Australia*. *Pacific Conservation Biology* 7, 21-3.

Kingsford R.T., Bino G., Porter J. and Brandis K. (2013). *Waterbird communities in the Murray-Darling Basin (1983-2012)*. Murray-Darling Basin Authority (2014), Canberra. <http://www.mdba.gov.au/sites/default/files/pubs/Waterbird-communities-mdb-aug-2013.pdf>

IUCN (2010). The IUCN Red List of Threatened Species. <http://www.iucnredlist.org/>

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*. January 21, 2016 (online version prior to inclusion in an issue) <http://onlinelibrary.wiley.com/doi/10.1111/fwb.12707/full>.

Murray-Darling Basin Authority (MDBA) (2012a). *Assessment of environmental water requirements for the proposed Basin Plan: Lower Balonne Floodplain*. MDBA Publication No: 24/12. Murray-Darling Basin Authority, Canberra. <http://www.mdba.gov.au/publications/mdba-reports/assessing-environmental-water-requirements-basins-rivers>

MDBA (2012b). *Assessment of environmental water requirements for the proposed Basin Plan: Narran*

Lakes. MDBA Publication No: 27/12. Murray-Darling Basin Authority, Canberra.
<http://www.mdba.gov.au/publications/mdba-reports/assessing-environmental-water-requirements-basins-rivers>

MDBA (2012c). *Assessment of environmental water requirements for the proposed Basin Plan: Lower Border Rivers (in-channel flows)*. Document 40/12. Murray-Darling Basin Authority, Canberra.
<http://www.mdba.gov.au/what-we-do/basin-plan/development/bp-science/assessing-environmental-water-requirements>

MDBA (2012d). *Assessment of environmental water requirements for the proposed Basin Plan: Barwon-Darling River upstream of Menindee Lakes*. MDBA Publication No: 41/12. Murray-Darling Basin Authority, Canberra. <http://www.mdba.gov.au/publications/mdba-reports/assessing-environmental-water-requirements-basins-rivers>

MDBA (2014a). *Basin-wide Environmental Watering Strategy 2014*. MDBA Publication No 20/14. Murray-Darling Basin Authority, Canberra.

MDBA (2016a). *Inundation mapping in the Northern Basin review*. Murray-Darling Basin Authority, Canberra (in prep.).

MDBA (2016b). *The Northern Basin Review: Understanding the economic, social and environmental outcomes from water recovery in the northern Basin*. Murray-Darling Basin Authority, <https://www.mdba.gov.au/sites/default/files/pubs/Northern-basin-review-report-FINAL.pdf>.

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*. Final report prepared for the Murray-Darling Basin Authority, Canberra. May 2016 (in prep.).

Nairn L.C. and Kingsford R.T (2012). *Wetland distribution and land use in the Murray-Darling basin*. A report to the Australian Floodplain Association. Australian Wetlands, Rivers and Landscapes Centre, University of NSW, Sydney. <https://www.ecosystem.unsw.edu.au/content/wetland-distribution-and-land-use-in-the-murray-darling-basin>

NSW Department of Primary Industries (NSW DPI) (2007). *Endangered ecological communities in NSW – Lowland Darling River aquatic ecological community*. Primefact: 173. NSW Department of Primary Industries, Port Stephens, NSW.

NSW DPI (2015a). *Fish and flows in the Northern Basin: responses of fish to changes in flows in the Northern Murray-Darling Basin*. Stage 2 Report prepared for the Murray-Darling Basin Authority by NSW DPI, Tamworth. <http://www.mdba.gov.au/publications/independent-reports/fish-flows-northern-basin-responses-fish-changes-flows-northern>

NSW DPI (2015b). *Fish and Flows in the Northern Basin: responses of fish to changes in flow in the Northern Murray-Darling Basin – Reach Scale Report*. Stage 3 report prepared for the Murray-Darling Basin Authority by NSW DPI, Tamworth. <http://www.mdba.gov.au/publications/independent-reports/fish-flows-northern-basin-responses-fish-changes-flows-northern>

NSW National Parks and Wildlife Service (NSW NPWS) (2000). *Narran Lake Nature Reserve Plan of Management*. NSW National Parks and Wildlife Service.

Queensland Department of Science, Information Technology and Innovation (Queensland DSITI) (2015). *Waterhole refuge mapping and persistence analysis in the Lower Balonne and Barwon-Darling rivers*. Department of Science, Information Technology and Innovation, Brisbane. <http://www.mdba.gov.au/publications/independent-reports/waterhole-refuge-mapping-persistence-analysis-lower-balonne-barwon>

Queensland Department of Natural Resources (Queensland DNR)(1999). *Overview of Water Resources and Related Issues: The Moonie River Catchment*. Department of Natural Resources, Queensland.

Queensland Murray-Darling Basin Inc. (QMDC) & South West Natural Resource Management Group Inc. (SWNRM) (2004). *Regional Natural Resource Management Strategy 2004*.

Sheldon F., Bunn S., Hughes J., Arthington A., Balcombe S. and Fellows C. (2010). 'Ecological roles and threats to aquatic refugia in arid landscapes: dryland river waterholes'. *Marine and Freshwater Research*, 61, 885–895

Sims N. (2004). *The landscape-scale structure and functioning of floodplains*. University of Canberra, Canberra.

Sims N. and Thoms M. (2002). What happens when flood plains wet themselves: vegetation

response to inundation on the lower Balonne flood plain. *International Association of Hydrological Sciences*, 276, 195-202.

Thomas R., 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 (in prep).

Thoms M., Capon S., James C., Padgham M. and Rayburg S. (2008). *Narran Ecosystem Project: the response of a terminal wetland system to variable wetting and drying*. Report prepared for the Murray-Darling Basin Commission, Canberra. http://www.mdba.gov.au/kid/kid-view.php?key=ME6/m*B4xaFwCIWIOraRKJeD2pAOE4E1E5XDUIlvovE=

Attachment A – Further detail on environmental assets of the Northern Intersecting Streams

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 listed 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 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 (Queensland DSITI 2015).

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 that 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 from 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, Thurlgoonia and Tuen Creeks flowing 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).

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 (Queensland 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 (Queensland DERM 2010; Marshall et al. 2016).

Attachment B – 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 Intersecting Streams are described below.

RIVER FLOWS AND CONNECTIVITY

Connectivity outcome	Condamine-Balonne	Nebine	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

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 Intersecting Streams

Environmental asset	Total abundance and diversity	Drought refuge	Colonial waterbird breeding	Shorebird abundance	In scope for Commonwealth e-watering
Narran Lakes	*		*	*	Yes
Cuttaburra channels	*		*	*	Minor in-stream contribution
Yantabulla swamp	*				
Upper Darling River	*	*			

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 in the Northern Intersecting Streams:

Species	Specific outcomes	In-scope for Commonwealth water
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)	*	*		*	*	*
Anabranes connecting Warrego and Paroo Rivers (including Gumholes, Bow, Cuttaburra Ck)	*					
Lower Moonie to Barwon River [Moonie]	*	*		*		*
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 C –Toorale Commonwealth environmental water

Considerations

Expected inflows to Boera Dam:
 - after stock and domestic refill, and flow to Darling (licence) requirements subtracted

Downstream environmental demand:

Darling River in-stream demand:
 - 0-14,000 ML/d peak flow (observed / forecast) of the Darling at Louth
 - Time since flows in above range observed; frequency in recent year(s)
 - Water quality in Darling (e.g. blackwater, blue green algal blooms)
 - Will Warrego flows exacerbate or mitigate Darling water quality issues?

Lower Darling / River Murray demand:
 - High in-stream flow demand
 - Potential to contribute to downstream demands; low Commonwealth environmental water availability in southern-connected Basin

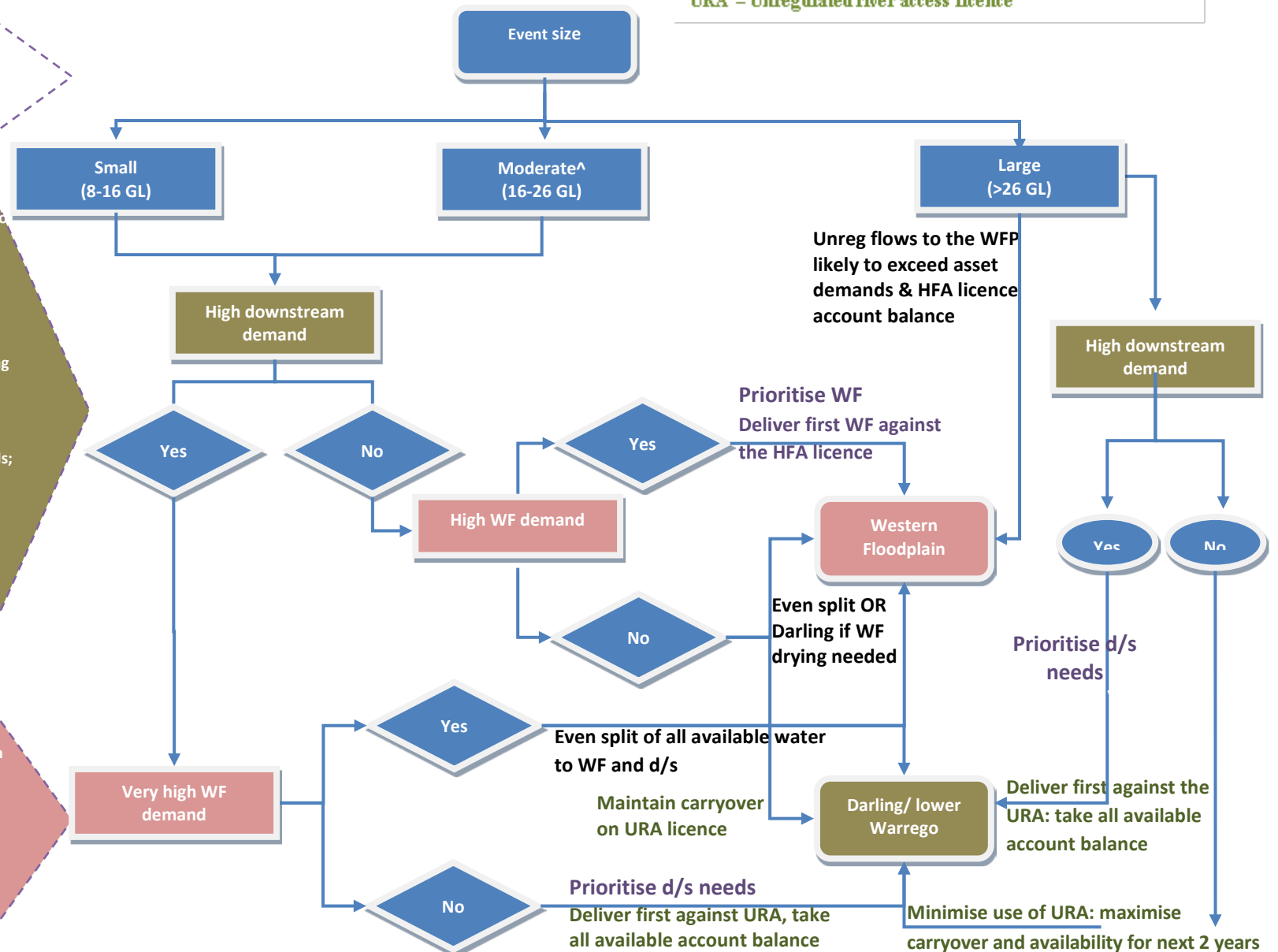
Warrego River (on Toorale) demand:
 - drought refugia replenishment
 - fish passage, riparian vegetation watering requirements
 - water quality in Warrego flows

Western Floodplain (WF) environmental demand:

- time since last significant floodplain wetting event; maintaining average historical floodplain flows
 - frequency, duration of wetting events in recent years
 - drying period required/beneficial
 - wetland vegetation condition
 - Maintain waterbird feeding habitat and/or breeding event

HFA – Special additional high flow access licence

URA – Unregulated river access licence



^ In moderate events residual volumes in excess of ~16 GL Commonwealth environmental water may be available to the WF during high Darling River demand

Attachment D – Long-term water availability

Commonwealth environmental water holdings

The Commonwealth holds a variety of unregulated entitlements in the Northern Intersecting Streams, with majority held in Queensland. Access conditions for entitlements can differ between management areas. For example, Commonwealth unregulated entitlements held in the Lower Balonne, both water harvesting and overland flow entitlements, are accessed through announcement. Whereas unregulated entitlements in the Moonie and Warrego, are accessed when flow conditions are met. For overland flow licences specific to the Lower Balonne in Queensland, there are 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 full list of Commonwealth environmental water holdings can be found at www.environment.gov.au/topics/water/commonwealth-environmental-water-office/about-commonwealth-environmental-water/how-much and is updated monthly.

Other sources of environmental water

There are currently no other sources of held environmental water in the Northern Intersecting Streams.

Planned environmental water

In addition to water entitlements held by the Commonwealth, environmental demands in the Northern Intersecting Streams 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 Intersecting Streams. 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 until after the peak of the flow event has passed, for dry spell (6 months) breaking flows.

While water from entitlements held by the Commonwealth will contribute to environmental demands in the Northern Intersecting Streams, particularly under low flow and conditions where event based mechanisms are triggered, 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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