



Australian Government

Commonwealth Environmental Water Office

Commonwealth Environmental Water

Portfolio Management Plan

Macquarie River Valley

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 and is supported by staff of the Commonwealth Environmental Water Office (CEWO). 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 Macquarie River Valley 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, 2018–19* (available at: <http://www.environment.gov.au/water/cewo/publications> under 'Planning approach').

Delivery partners

Commonwealth environmental water is managed in conjunction with and delivered by a range of partners. This portfolio management plan has been developed in consultation with our delivery partners, including the NSW Office of Environment and Heritage (OEH), the Department of Primary Industries (DPI) – Fisheries, WaterNSW, and the Macquarie Cudgegong Environmental Flows Reference Group (the Macquarie Cudgegong EFRG).

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.

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1. Environmental watering in the Macquarie River Valley

1.1. The Macquarie River Valley

Macquarie River flows are heavily influenced by large rainfall events in the upper catchment and flows in tributary systems. The river is formed when the Campbells and Fish rivers join above Bathurst in Central Western New South Wales followed by tributary flows from the Winburndale River, Turon River and Pyrmul Creek. The Macquarie River then flows into Burrendong Dam, south east of Wellington (Figure 1). Below the dam, tributary flows are provided by the Bell River, which enters at Wellington; Little River and Wambangalong Creek, which enter upstream of Dubbo; and the Talbragar River and Coolbaggie Creek, which enter just downstream of Dubbo. Subsequently, as the land flattens further west of Dubbo, the Macquarie River provides flows to distributary creeks, wetlands and rich alluvial river flats associated with braided channels. At this point, water flows are slow resulting mainly from extensive silt deposits and high attenuation and can connect with the Barwon-Darling River.

Two major storages, Windamere Dam (capacity 368 gegalitres (GL) on the Cudgegong River, and Burrendong Dam on the Macquarie River (storage capacity of 1 188 GL, with additional storage capacity of 489 GL in the flood mitigation zone), regulate catchment water supplies. Commonwealth environmental water delivery is gravity fed from Burrendong Dam into the Macquarie River to downstream environmental assets such as the Macquarie Marshes and distributary creeks. Regulating structures are utilised to manage the diversion of water into distributary creeks at lower rates. At higher flow rates, water may flow overbank or via flood runners onto floodplains and wetlands.

The catchment includes the Macquarie Marshes complex on the lower reaches of the Macquarie River, of which, parts of the northern, southern and eastern Marshes are listed as a Wetland of International Importance under the Ramsar Convention. The Macquarie Marshes were recognised under the Ramsar Convention for being a unique example of a wetland type in the region in terms of their size and their diversity of wetland types, supporting species of conservation significance and biological diversity, providing refuge during adverse conditions, and regularly supporting large numbers of waterbirds. The Ramsar site contains a range of habitats including core areas of semi-permanent wetlands, including forests and woodlands, reed beds, marshes, rushlands and open lagoons, which provide habitat for migratory bird species and large numbers of waterbirds, including colonial nesting birds.

Other assets in the catchment include the Macquarie River channel, the unregulated component of the lower Macquarie River downstream of Warren Town Weir and the distributary creek system to the west of the Marshes. The rivers and wetlands of the Macquarie Valley hold significant spiritual and cultural importance for the Wiradjuri and Ngemba-Wayilwan Aboriginal people.

The Macquarie Marshes and Macquarie River support a number of species listed as endangered or vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*, for example, the Australian painted snipe, Australasian bittern, Murray cod, trout cod and spike rush. The aquatic community of the Macquarie also forms part of the *Lowland Darling River aquatic ecological community*, which is listed as endangered under the *NSW Fisheries Management Act 1994*. This community includes 21 native fish species and hundreds of native invertebrate species that are found within the Darling River and its associated streams, wetlands and anabranches within NSW.

The *Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source (2016)* provides for planned environmental water (refer to Attachment C) and stock and domestic (replenishment) flows. The NSW Government also manages licenced water for the environment. These other water sources offer opportunities to align Commonwealth environmental water deliveries to increase the potential for environmental objectives to be achieved jointly and assist with delivery efficiency and effectiveness.

A number of the rivers and creeks in the Macquarie Valley may contribute water to the Barwon-Darling at various times. The Barwon-Darling connects rivers, lakes and wetlands across the northern Basin, providing critical drought refuge and a movement corridor for fish and waterbirds, and habitat for other aquatic species including turtles, mussels, and shrimp. Flows that connect the Barwon-Darling and the northern tributaries may help to support healthy and diverse populations of native fish and other fauna, including in the Macquarie River. More information about the Barwon-Darling is described in the *Commonwealth Environmental Water Portfolio Management Plan: Barwon-Darling 2018–19*.

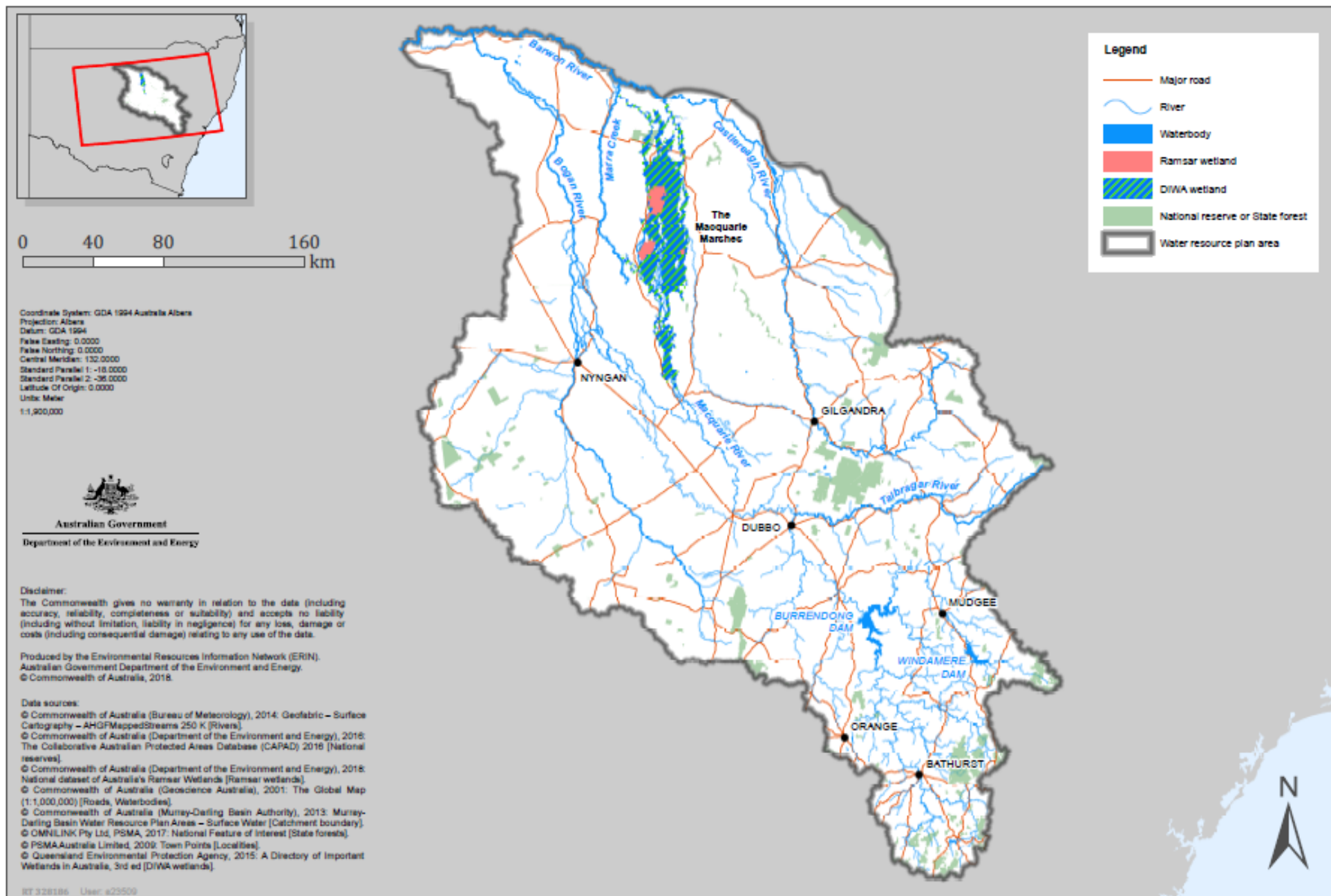


Figure 1: Map of the Macquarie River Valley (produced by the Department of the Environment and Energy, June 2018).

1.2. Environmental objectives in the Macquarie River Valley catchment

The long-term environmental objectives for the Murray-Darling Basin are described in the Basin Plan's environmental watering plan and the Basin-wide environmental watering strategy, which includes 'quantified environmental expected outcomes' at both a Basin-scale and for each catchment. The expected outcomes relevant for the Macquarie River Valley are described in [Attachment A](#).

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

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

Table 1: Summary of objectives being targeted by the Commonwealth Environmental Water Office by environmental watering in the Macquarie-Castlereagh Water Resource Plan Area.

BASIN-WIDE MATTERS (Matters in red link to the Basin-wide Environmental Watering Strategy)	OBJECTIVES FOR MACQUARIE ASSETS		
	IN-CHANNEL ASSETS	OFF-CHANNEL ASSETS	
	Macquarie River	Macquarie Marshes	Distributary creeks
VEGETATION	Maintain riparian and in-channel vegetation condition, growth and survival (extent) by providing in-channel freshes	Maintain, and in some cases improve, floodplain and wetland vegetation condition, growth and recruitment, including for non-woody vegetation, river red gum, black box and coolibah, by contributing to in-channel freshes, bankfull and small overbank flows	Support the condition, growth and survival of riparian and in-channel vegetation by providing in-channel freshes
WATERBIRDS		Support naturally triggered breeding events, increase connectivity, and provide suitable habitat (including drought refuge), to increase waterbird abundance and reproduction, and maintain current species diversity	
FISH	Provide baseflows and freshes to support opportunities for the movement and increased distribution, reproduction and recruitment of native fish, including freshwater catfish, Murray cod, golden perch, silver perch and trout cod, to prevent the loss of native species, and improve the population structure and distribution of key species		Support the movement and habitat requirements of native fish by providing baseflows and freshes
MACROINVERTEBRATES	Support recruitment and maintain macroinvertebrate diversity and habitat		
OTHER VERTEBRATES	Support opportunities for the reproduction and recruitment of other native aquatic species, including frogs and turtles		Support the reproduction of other native aquatic species including frogs

BASIN-WIDE MATTERS (Matters in red link to the Basin-wide Environmental Watering Strategy)	OBJECTIVES FOR MACQUARIE ASSETS		
	IN-CHANNEL ASSETS	OFF-CHANNEL ASSETS	
	Macquarie River	Macquarie Marshes	Distributary creeks
CONNECTIVITY	Support longitudinal connectivity, by providing baseflows and contributing to flows that increase connectivity with the Barwon-Darling	Support connectivity, particularly lateral between the river and floodplain by contributing to freshes and bankfull flows	Support connectivity, particularly with the lower Macquarie River and Barwon River by providing baseflows and small freshes
PROCESSES	Support key ecosystem functions and promote productivity, including on the floodplain		
WATER QUALITY	Maintain water quality within channels and pools		
RESILIENCE	Provide drought refuge habitat (particularly for fish)		

Information sourced from: Murray-Darling Basin Authority (2012); Murray-Darling Basin Authority (2014); Barma Water Resources in association with IRPEC Pty Ltd and Paul Wettin (2011); Torrible et al. (2011); Commonwealth Environmental Water Office (2014); and Jenkins et al. (2012).

1.3. Environmental flow requirements

While environmental water plays an important role in supporting wetlands and rivers, not all environmental demands can and will be met through the use of held environmental water. In the Macquarie Valley, some demands are met by regulated water deliveries for consumptive purposes, while others are met by tributary flows or large unregulated/natural flow events, dam spills or flood mitigation releases. Some environmental demands are beyond what can be delivered within operational constraints.

Figure 2 shows the broad environmental demands that are in scope for Commonwealth environmental water. Importantly, these are broad, indicative demands and individual watering events may contribute to particular opportunities, such as using infrastructure to deliver water to individual wetlands that would otherwise not be possible because of constraints. Also, there may be opportunities for Basin state governments to remove or modify constraints, which will improve the efficiency and/or effectiveness of environmental watering. Further information on delivery constraints are described in [Attachment B](#).

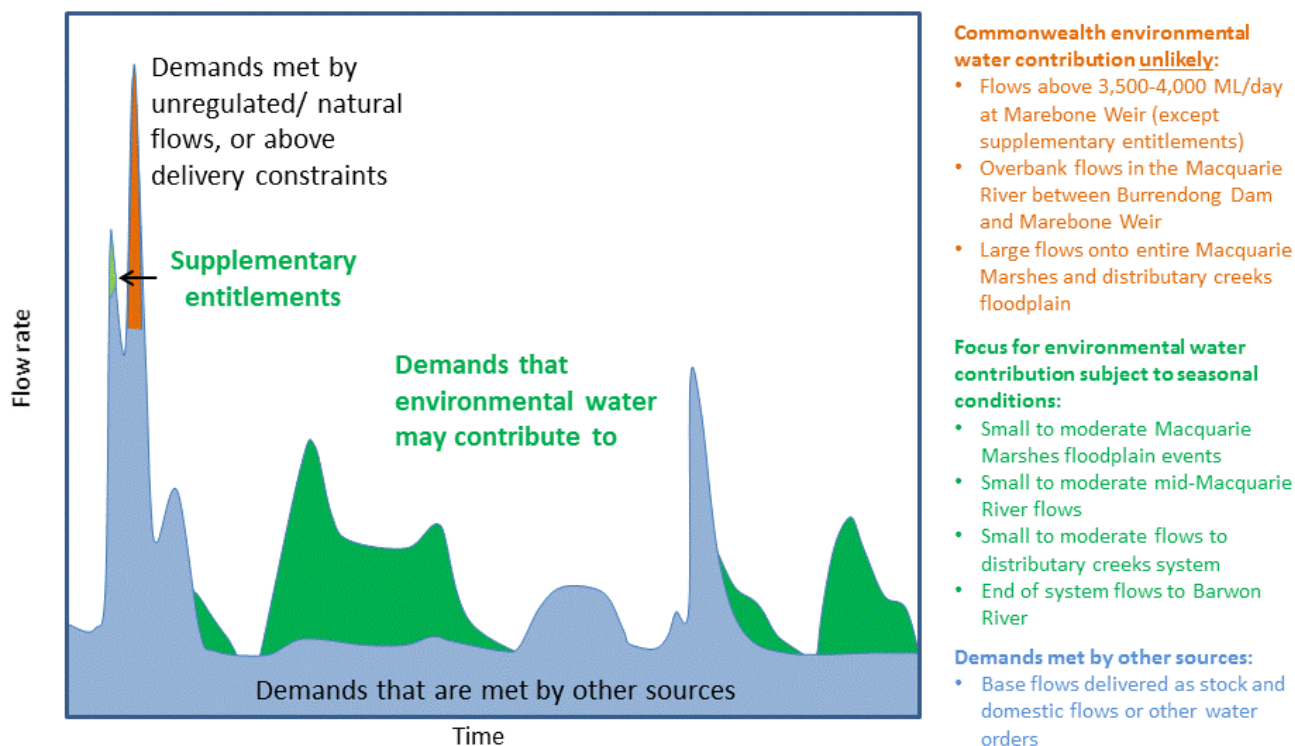


Figure 2: Scope of demands that environmental water may contribute to in the Macquarie River Valley.

Based on the above objectives and delivery constraints, specific watering requirements (flow magnitude, duration, timing and frequency) have been identified as being in scope for Commonwealth environmental water. These water requirements are described in Table 3. As with the objectives, the environmental water requirements will continue to be reviewed and revised in response to new knowledge.

1.4. Monitoring and adaptive management

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

In the Macquarie-Castlereagh catchment, this is primarily achieved by the collaborative efforts and resources of NSW agencies and the CEWO, and includes:

- prioritised environmental monitoring of vegetation, waterbirds and frogs by NSW OEH and native fish by NSW DPI – Fisheries
- hydrology (online flow gauging) and flow delivery data by NSW Department of Industry (DOI) and WaterNSW
- short-term intervention monitoring funded by the CEWO in the Macquarie catchment in 2014–15 (native fish) and 2016–17 (waterbird colonies and native fish). This monitoring aimed to understand the environmental responses to different watering actions, with respect to targeted objectives and expected outcomes.
- operational surveillance of flow events by staff from the CEWO, NSW OEH and WaterNSW
- other aspects such as shallow groundwater and processes/functions by various others including researchers, landholders and agencies.

The Macquarie Marshes has also been identified as a priority research site for the Murray-Darling Basin Environmental Water Knowledge and Research Project (EWKR), which seeks to improve the science available to support environmental water management in the Murray-Darling Basin.

Information on short-term monitoring activities and the EWKR project can be found at <http://www.environment.gov.au/water/cewo/catchment/macquarie/monitoring>.

Key findings and recommendations from fish (Stocks et al. 2015, Davis et al. 2017), flow (WaterNSW 2017), frog (NSW OEH 2017, Ocock and Spencer 2017) and waterbird (Spencer et al. 2016, CSIRO 2017, UNSW 2017) monitoring include:

- Spring/early summer deliveries of environmental water in the Macquarie River have been associated with peaks in hatch date frequencies of some small-bodied opportunistic fish species such as Australian smelt, un-specked hardyhead and Murray-Darling rainbowfish, particularly on the receding tail of flows or during sustained periods of increased flow.
- Environmental water delivered in spring and early summer is likely to support native fish recruitment for species such as Murray cod and freshwater catfish, by increasing flows and boosting primary production in the Macquarie River.
- Local weather conditions influence the activity of some frog species, as well as inundation extent. Increased inundation extent is associated with an increase in the number of sites with good breeding conditions, resulting in greater numbers of calling flow-responsive species breeding. Flooding events are very important for increasing the overall abundance of flow-responsive frog species, by supporting breeding and enabling frogs to move between wetlands, thus connecting isolated populations.

- Environmental water delivery is important to provide habitat and help maintain inundation to complete frog metamorphosis. Maintaining water levels in the Marshes into late November increases frog recruitment.
- Delivery of environmental water over the winter-spring months can provide suitable wetland habitat for nationally threatened and internationally recognised migratory species of waterbirds. Late winter and early spring delivery (maintained into summer if possible) will coincide with warmer temperatures and the peak activity of most waterbird species and their food supplies. A slow, steady contraction of inundated area is preferable.
- Connectivity between the lower Macquarie River (downstream of the Macquarie Marshes) and the Barwon River is important for allowing the movement of native fish between rivers for spawning, movement and recruitment (e.g. for bony bream, golden perch, spangled perch).
- Connectivity between the lower Macquarie and Barwon rivers can be successfully achieved using environmental water, particularly in synchrony with flow events occurring in the Barwon River. Further connectivity events between the Macquarie and Barwon rivers should be considered in the future by environmental water managers.
- Identified and potential barriers to fish movement within the mid-lower Macquarie River and Marshes need to be investigated and remedied, and adequate protection of environmental flow events in the Macquarie catchment is required.
- Long-term flow monitoring in the lower Macquarie River would result in a more accurate understanding of the amount of environmental water that is delivered through this system and into the Barwon River.

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

2. Portfolio management in 2018–19

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

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

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

The Macquarie catchment experienced hot and dry conditions between spring 2012 and autumn 2016, with very much below average rainfall over the period, and above average to very much above average maximum temperatures across the region. A combination of NSW and Commonwealth environmental water was delivered to the Macquarie River and Macquarie Marshes during these dry years to help support native fish in the river channel and the inundation of core wetland areas in the Marshes. Delivering environmental water during dry years such as those experienced between 2012 and 2016 help to build resilience in the system, enabling it to respond well when conditions become wetter.

Conditions began to change in May 2016, with above average to highest on record rainfall across the catchment over winter and spring, with particularly high rainfall in June and September 2016. Maximum temperatures were average to below average over winter. Burrendong Dam filled to 100 per cent of capacity on 4 September 2016 (up from 11 per cent of capacity in early May). Good rainfall, tributary flows and releases under airspace operations of the Flood Mitigation Zone (FMZ) in Burrendong Dam in late 2016 and early 2017 contributed to widespread inundation in the Macquarie Marshes. All areas of river red gum woodland in the Marshes were inundated, improving the condition of wetland vegetation. Flooding triggered large-scale colonial and general waterbird breeding, with at least 21 colonies recorded in the Marshes. Managed environmental water (a mix of NSW and Commonwealth water sources) was delivered immediately following the cessation of Flood Mitigation Zone flows to maintain water levels in key colonial waterbird colonies and foraging areas.

Conditions began to dry again over summer 2016–17, with average to very much below average rainfall, and very much above average to highest on record maximum temperatures. However, rainfall in March 2017 was average to above average across the catchment. Environmental water (Commonwealth and NSW) was delivered in April and May 2017 as part of two separate watering actions to support native fish in response to natural tributary flows. Environmental water was used to: support the post spawning dispersal of native fish in the mid-Macquarie River and Marshes; and to provide connectivity between the lower Macquarie and Barwon rivers to provide opportunities for the movement of native fish between the catchments.

Rainfall has been variable through 2017–18, with below average to very much below average rainfall in the catchment over winter, very much below to above average rainfall in spring and summer, and very much below average to below average rainfall in autumn. Temperatures have been very warm, particularly in winter, with very much above average to highest on record temperatures recorded. Above average to very much above average temperatures persisted through spring, summer and into autumn. Environmental water (Commonwealth and NSW) was delivered between July and November 2017, to support wetland vegetation, waterbirds and native fish in the Macquarie River and Marshes.

As of 11 May 2018, Burrendong Dam had received just 31 500 ML of inflow since July 2017, with storage levels falling from 87 to 37 per cent over the same period. Should dry conditions persist, no new allocations are expected in the Macquarie catchment for the start of the 2018–19 water year. Under very dry conditions, additional water conservation measures may be required, for example block releases for irrigation where feasible.

With the potential for further dry and hot conditions in the Macquarie catchment in future, and the need to build resilience and support further recovery in the system, there are a number of environmental demands that require water in 2018–19.

Environmental water demands for environmental assets in the Macquarie catchment in 2018–19 are represented in Table 3 and are summarised below:

Mid-Macquarie River (Burrendong – Marebone Weir): The level of demand is related to the flow rate. Small flows to maintain refugia for native fish remain a high demand as they are required continuously. However, these flows are often met by other sources of water. There is a moderate demand for water in 2018–19 to contribute to small freshes that will support the movement and breeding of native fish flow generalists (e.g. Australian smelt, Murray-Darling rainbow fish), in-channel specialists (e.g. Murray cod, freshwater catfish), and a moderate to high demand for flows to support the breeding of native fish flow specialists (e.g. golden and silver perch). The demand for large freshes and bankfull flows to drown out weirs and allow for the movement of native fish is considered to be very low (required approximately twice in ten years), after being met by high flows in spring 2016.

Macquarie Marshes 1:1 to 2:3¹ year inundation zones (reed beds, lagoons, mixed marsh, water couch): High demand. Ideally, annual wetting is required to maintain these communities. There have been positive responses in these vegetation communities following good inundation in 2016–17 and in 2017–18. For example, there has been strong growth and expansion of reedbeds, and a good response to inundation by aquatic plants such as primrose and nardoo. However, with very dry conditions, groundcover in autumn 2018 was observed to be in poor condition and low abundance over a large area of the Marshes. Watering in 2018–19 is required for these vegetation communities to continue improving in condition and building resilience for future dry years.

Macquarie Marshes 1:2 to 2:5 year inundation zones (reeds, water couch, mixed marsh, river red gum forest, river cooba): Moderate to high demand. These areas of the Marshes were inundated in 2016–17, and again 2017–18 using environmental water. A positive response was observed in the condition of wetland vegetation which was watered again in 2017–18. In particular, river red gums displayed healthy canopies, fresh growth and flowering. Vegetation was also inundated for sufficient time to set seed. However, conditions were dry between 2013–14 and 2015–16, with demands only being partially or not met during that time, and very dry conditions have returned in 2017–18. These vegetation communities ideally require water eight in ten years, with some species having a maximum dry interval of two to three years. Wetting is required again in 2018–19 to build on the benefits of inundation in 2016–17 and 2017–18, maintain soil moisture and groundwater levels, support vegetation recruitment, and to build resilience to help sustain these communities in the longer term.

Macquarie Marshes 1:3 to 1:4 year inundation zones (river red gum woodland, river cooba, inner coolibah woodland): Low demand. These areas were sufficiently watered in 2012–13 and again in 2016–17. These communities are ideally inundated one in three years, with some species requiring water every three to four years. Some of these communities had been showing signs of stress before being inundated in 2016 (e.g. river red gum woodland in the Northern Marshes). Improvements in tree condition were observed in autumn 2017 and 2018. Water will be required again in the next one to two years to maintain condition.

Macquarie Marshes 1:5 to 1:10 year inundation zones (outer river red gum woodland, coolibah and black box): Low demand. Much of this area was inundated in 2016–17 with the approximate 1:8 year inundation event. Before that time this zone had not been inundated since 2010–11. Some species require water every four to five years and the condition of river red gum trees further away from watercourses had declined during those dry years. Wetting may be required again in the next few years to maintain condition. These areas are difficult to reach with environmental water alone.

¹ For example, 1:1 – inundation required every year; 2:3 – inundation required two years in three; and so on.

Lower Macquarie River (Marshes – Barwon River): The level of demand is related to the flow rate. There is a moderate demand for water in 2018–19 to provide seasonal freshes and a moderate to high demand for a fish connection flow in the lower Macquarie River. This demand was met in 2016–17, however, it was not met between 2012–13 and 2015–16, and was only partially met in 2017–18. In-channel seasonal freshes are ideally provided annually. Connectivity through the system is important for all native fish, which need to move as part of their life cycle to feed, find shelter, and maintain good body condition. The capacity to support connection between the lower Macquarie River and the Barwon River is contingent on suitable conditions in both these systems, water availability and operational feasibility. Following good flows and connectivity in 2016–17, there is a low demand in 2018–19 to provide water to inundate the floodplain in the lower Macquarie River, which is likely required one in every three years.

Distributary creeks: Low to moderate demand. Demands in the distributary creeks are considered to have been met in 2016–17, although they were only partially or not met (depending on the creek) in the preceding three years, which were particularly dry, and in 2017–18. Although the required watering frequencies are not well known for the distributary creeks, they may require further water in the next one to two years to provide benefits for native vegetation and to provide connectivity with the Barwon-Darling system.

Barwon-Darling

There is a growing awareness of the importance of connecting flows across the northern Basin, to support habitat, water quality, native fish and other aquatic species in the Barwon-Darling and its tributary systems, including the Macquarie River. Subject to antecedent conditions, water availability, and urgency of environmental demands, there may be opportunities to coordinate releases across multiple rivers in the northern Basin to meet broader environmental demands. The environmental demands in the Barwon-Darling are described in the *Commonwealth Environmental Water Portfolio Management Plan: Barwon-Darling 2018–19*.

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 Macquarie River Valley 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 process;
- Coordinate replenishment flows across multiple tributaries to maintain habitat condition, and regulate water quality, carbon and nutrients in refuges along the Barwon-Darling watercourse;

- Provide flows to improve habitat and support waterbird breeding;
- Maximise availability of productive foraging habitat for shorebirds;
- 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.

In contributing to these demands, the Office will also be aiming to contribute to the expected outcomes in the Basin-wide environmental watering strategy (see [Attachment A](#)).

2.2. Water availability in 2018–19

Forecasts of Commonwealth water allocations

Allocations against Commonwealth water entitlements in the Macquarie River Valley are determined by NSW government and will vary depending on inflows. The following forecasts in Table 2 are based on the best available information including NSW forecasts and historical inflow scenarios.

Table 2: Forecasts of Commonwealth water allocations (including carryover) in 2018–19 in the Macquarie River Valley as at 30 April 2018.

Entitlement type	Forecasts of Commonwealth water allocations (including carryover) in 2018–19 (GL)					
	Very dry ←————→ Very wet					
	95 percentile	90 percentile	75 percentile	50 percentile	25 percentile	10 percentile
Macquarie (general security)	72	74	81	142	199	199
Macquarie (supplementary)	Up to 8 GL	Up to 8 GL	Up to 8 GL	Up to 8 GL	Up to 8 GL	Up to 8 GL

Notes:

1. Forecasts for regulated catchments are given to the nearest whole gegalitre.
2. Allocation rate scenarios are based on long term average allocation rates.

The volume of Commonwealth environmental water likely to be carried over in the Macquarie River Valley for use in 2018–19 is estimated to be approximately 72 GL.

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

Water resource availability scenarios

Commonwealth environmental water is managed with other water in the system. When considering the available resource to meet environmental demands, it is necessary to also factor in the resources managed by other entities that are available to contribute to environmental objectives. Relevant resources include held environmental water managed by state government agencies, planned environmental water, natural and unregulated flows, conveyance water and consumptive water. Further detail on sources of environmental water in the Macquarie River Valley is provided in [Attachment C](#).

By combining the forecasts of water held by the Commonwealth with streamflow forecasts, as well as taking into account operational considerations, water resource availability scenarios can be developed ranging from very low to very high. Based on available information low to moderate resource availability scenarios are in scope for 2018–19, with high and very high resource availability only possible if conditions become wet (noting that as of 23 May there was a 177 GL shortfall in Burrendong Dam to make up before new allocation can be made).

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

Environmental water needs (demand) and water availability (supply) both influence the overall purpose of Commonwealth environmental water management. Under different combinations, the management purpose can range from 'avoiding damage' to the environment to 'improving' ecological health. This in turn informs the mix of portfolio management options that are suitable for maximising outcomes. Figure 3 shows how current demands and forecasted supply are considered together.

The overall 'purpose' for managing the Commonwealth's water portfolio in the Macquarie River Valley for 2018–19 is to protect, maintain, and where possible improve, the health and resilience of aquatic ecosystems in the Macquarie River and Macquarie Marshes.

Overall environmental water resource availability	Demand for environmental water				
	Critical – water predominantly needed urgently	High – water predominantly needed this year	Moderate – water predominantly needed this year and/or next	Low – water predominantly not needed this year	Very low - water predominantly not needed this year and next
Very low	Avoid damage to environmental assets		Protect and ensure ecological capacity for recovery		Maintain ecological health and resilience
Low					
Moderate					
High					
Very high	Improve the health and resilience of aquatic ecosystems / build future capacity to support ecological health and resilience				

Figure 3: Determining a broad purpose for portfolio management in the Macquarie River Valley for 2018–19. Note: grey lines represent potential range in demand and resource availability.

Further detail on how the overall purpose for portfolio management changes under different supply and demand scenarios is provided in *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2018–19* (available at: <http://www.environment.gov.au/water/cewo/publications>).

2.4. Water Delivery in 2018–19

As in previous years, the use of Commonwealth (and NSW) environmental water will be adaptively managed throughout 2018–19, in response to changing water resource availability and environmental conditions and demands.

Following an increase in available water in 2016, there is sufficient water remaining to provide flows in 2018–19 that will build on natural flooding in 2016–17 and environmental water delivered in 2017–18. Opportunities

to deliver additional follow up flows will become more limited the longer it has been since natural flooding, particularly if dry conditions continue. Therefore, delivering some of the available environmental water in 2018–19 will capitalise on the current opportunity to help maintain, and where possible improve, the condition and resilience of key assets. The delivery of environmental water in 2018–19 also reflects the need to continue building condition and resilience in the system following a number of very dry years during the millennium drought and again between 2013–14 and 2015–16.

Consistent with the demands and purpose described above, the CEWO is considering supplying environmental water to the following watering actions for 2018–19 (see also Table 3 for supporting information regarding the basis for determining these watering intentions).

1. 2018–19 winter/spring inundation event: a portion of the available water may be used (in combination with NSW environmental water) to deliver a flow to the Macquarie Marshes (Action 6 – Appendix 3). Environmental water would target the inundation of up to 19 000 hectares of the Macquarie Marshes to support wetland vegetation (reeds, water couch, mixed marsh, river red gum forest and river cooba), and to provide habitat for waterbirds, fish and frogs.

Delivering environmental water to the Macquarie Marshes is also expected to:

- meet baseflow requirements in the mid-Macquarie River (Action 1 – Appendix 3)
- support native fish condition, movement and spawning opportunities in the mid-Macquarie River by managing the hydrograph to provide suitable flows (Actions 2 and 3 – Appendix 3)
- contribute to seasonal freshes in the lower Macquarie River and support some connectivity with the Barwon River (Action 8 – Appendix 3)
- support values of the Ramsar site within the Marshes, such as maintaining core areas of semi-permanent wetlands (including reeds and red gum forest), providing habitat for migratory waterbirds and native fish, and promoting biological diversity.

The delivery of environmental water to support the Macquarie Marshes is scalable, depending on the volume of water available and catchment conditions (Action 6 – Appendix 3). The volume of water required to meet the demands described may also vary, depending on antecedent conditions.

Should very wet conditions prevail in 2018–19, environmental water may be targeted at broader areas of the Macquarie Marshes, for example to inundate up to 50 000 hectares (requires ~250 GL), or to provide additional water on the recession of larger flows. Additional water may also be delivered as a waterbird breeding contingency to support a naturally triggered colonial waterbird breeding event should one occur (Action 7 – Appendix 3). Delivery of environmental water to the Macquarie Marshes under wetter conditions could also contribute to meeting larger environmental demands in the lower Macquarie River, which would contribute to floodplain inundation and connectivity with the Barwon River (Action 10 – Appendix 3). Additional water could also be used to ensure there is adequate water to meet environmental demands in future, particularly if conditions become drier in future years.

Despite the moderate to high demand for water in 2018–19, it may not be feasible to target the spawning of native fish flow specialists in the Macquarie River using environmental water. The flow rates required to target native fish flow specialists become particularly difficult to operationalise during dry conditions as are currently being experienced. Additionally, monitoring over a number of years has not found evidence that flow specialist fish species have spawned, so there is still some uncertainty about whether this group spawns in the Macquarie. However, providing connection to source populations is important, and large freshes improve productivity and provide opportunities for movement (and can be a trigger for spawning if temperatures are right). Therefore, augmenting natural freshes may be a target this year or next, depending on water availability and the capacity to build on rain triggered events.

When available, supplementary entitlements managed by the Commonwealth may be used to contribute to meeting environmental demands and to build on the benefits of naturally triggered flow events in the system.

Any watering actions that contribute to maintaining waterbird habitat or support waterbird breeding within the Macquarie catchment may also benefit waterbird populations more broadly (e.g. via waterbird flyways across the Lachlan, Murrumbidgee, mid-Murray, Gwydir, Namoi and Border Rivers catchments).

Stakeholder Feedback

The Macquarie Cudgegong EFRG, with NSW OEH and NSW DPI – Fisheries, has provided valuable advice that has informed planning for the management of Commonwealth environmental water in the catchment. In recognition of the antecedent conditions, forecast water availability and environmental demands, the EFRG has recommended that:

- Environmental water be used to deliver a flow of up to 165 GL to inundate up to 20 000 ha in the Macquarie Marshes (including Eastern, Northern and Southern Marshes). This flow would help to maintain the condition and resilience of the pink zone (Figure 4) of the Marshes, including reeds, water couch, mixed marsh, river red gum forest, and river cooba. It would also provide habitat for waterbirds, fish and frogs, and maximise the capacity of the target area to maintain condition should dry conditions persist.
- Delivery could commence in July 2018 and include a pre-wetting component to help prime the wetland system. Environmental water delivered to the Macquarie Marshes can also be delivered in a way to provide movement opportunities in late winter for native fish such as Murray cod, and provide spawning and dispersal opportunities for in-channel specialists and flow generalists when temperatures are warmer.
- Remaining environmental water and any new allocations should be carried over for use in future years.

2.5. Trading water in 2018–19

No specific requirements for sale or purchase of water in the Macquarie Valley have been identified, however, environmental water requirements will be reviewed periodically throughout the water year.

Planning on water trade considers supply and demand within the catchment and across the Basin. As part of the planning process, the CEWO undertakes a Basin-wide analysis to identify opportunities to use allocation trade to better match differing demands across catchments.

Further information will be provided to the market ahead of any trade of Commonwealth environmental water at: <http://www.environment.gov.au/water/cewo/trade/current-trading-actions>.

For more information on the rules and procedures governing the trade of Commonwealth environmental water, see the *Commonwealth environmental water Trading Framework* available at: <http://www.environment.gov.au/water/cewo/publications/water-trading-framework-nov2016>.

2.6. Carrying over water for use in 2019–20

The volume of water carried over for use in 2019–20 will depend upon resource availability and demand throughout the year. As the 2018–19 water year progresses, a carryover target will be determined for the Macquarie catchment, sufficient to meet early season requirements. As documented in Table 3 below, potential demands in 2019–20 include:

- Wetland watering between June and April to the Macquarie Marshes to inundate up to 9 000 ha of the wetlands, which includes the blue/purple inundation zone (reeds, lagoons, water couch, mixed marsh)(Figure 4)
- Flows in the mid-Macquarie River, targeting native fish movement and breeding
- Instream flows in the lower Macquarie River, providing connectivity to the Barwon-Darling

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

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

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

2.7. 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.

Table 3: Environmental demands, priority for watering in 2018–19 and outlook for coming year in the Macquarie River Valley.

Environmental assets	Target values	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2018–19		Implications for future demands
		Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19
Mid-Macquarie River (Burrendong – Marebone Weir) ¹ <ul style="list-style-type: none"> Native fish habitat and spawning Instream aquatic ecosystems Riparian vegetation 	Fish refuge: all guilds Aquatic ecosystems	Baseflows: small very regular flows through to end of system, wetting holes and in-stream storages.	Ideally: continuous flow (Max interval: continuous flow)	Minimum baseflows have been achieved, even during drier years between 2013–14 and 2015–16. However, these are ideally required continuously to maintain instream habitat, and will be required again in 2018–19. Therefore, the environmental demand has been assessed as high.	High	A low priority for CEW except under a very low resource availability scenario (usually met through operational flows).	High
	Fish spawning–flow generalists (e.g. Australian smelt, carp gudgeon) + in-channel specialists (e.g. Murray cod, freshwater catfish)	Small freshes: up to 800–1 000 ML/day for at least 14 days at Baroona in spring (Oct–Nov) through to mid- autumn; and conditioning flow in winter (July to mid-August).	Ideally: annually (Max interval: 3 years for large-bodied generalists; 5 years in-channel specialists; 1 year for small-bodied)	Small freshes have been achieved since 2015–16. These flows are ideally provided annually, so are required again in 2018–19, preferably timed with tributary flows. Therefore, the environmental demand has been assessed as moderate.	Moderate	Potential use under very low to high water resource availability scenarios, subject to natural tributary flows and water temperature.	Moderate
	Flow specialists guild movement and breeding (e.g silver perch, golden perch, spangled perch)	Priming flow: >5 000 ML total flows at Baroona over 3 days with approx. 7 day recession (tributary pulse). Spawning pulse: initial peak ≥ 5 000 ML/day at Baroona for >2 days with event lasting for >7 days. (35–40 day total pulse) Dispersal flow: initial pulse >3 000 ML total flows over 3 days at Baroona. Second pulse min. 2 000 ML/day peak with recession. Approx 10d duration total events. (Oct–March) Water temperature for all pulses ≥19 °C.	Ideally: 1 in 3 years (up to twice per year) (Max interval: 5 years)	Flows for native fish flow specialists were likely last met in 2012–13 (Nov–Jan). Flows in spring 2016 were likely sufficient to meet the flow targets for a spawning pulse, however, the temperatures at the time were not appropriate throughout the river system for native fish spawning. Therefore, this flow has not been adequately achieved for the maximum interval, and the environmental demand has been assessed as moderate to high.	Moderate to High	Water availability to meet this demand likely insufficient under a dry scenario. Possible use of CEW under moderate to high water resource availability scenarios to augment freshes and support movement. Subject to natural tributary flows, water temperature, and significant river rises that will cue movement and possibly spawning of flow specialists.	High to Critical
	Fish movement In stream + riparian vegetation	Large freshes and bankfull: 10 000–20 000 ML/day at Baroona for a minimum of 3 days (to drown out key weirs).	Ideally: 2 in 10 years (Max interval: Unknown)	Large freshes were last achieved in 2016–17, when flows >10 000 ML/day were achieved at Baroona on three occasions, for 6, 3 and 28 days respectively in Sept-Oct 2016. Before this, it was last met in 2011–12 and 2010–11, meeting the desired frequency of 2 in 10 years. Therefore, the environmental demand has been assessed as very low.	Very low	A low priority for CEW in 2018–19 and only able to contribute to this demand when coordinated with major tributary flow event.	Low
Macquarie Marshes ^{3,4†} <ul style="list-style-type: none"> Includes areas of Ramsar listed wetlands 	Blue and Purple inundation zones (4 000 to 9 000 ha)	30–60 GL at Marebone over 3 months between June and April to inundate reed beds, lagoons, mixed marsh, and water couch.	Ideally: annually (Max interval: 2 years)	Demand has been met in past 6 years in all areas of the Marshes except the Northern Marshes in 2014–15, and the Eastern Marshes in 2015–16. Watering is required to maintain wetland vegetation with annual watering requirements and build on benefits of good inundation in 2016–17 and 2017–18. Therefore, the environmental demand has been assessed as high.	High	A high priority for CEW under very low to high water resource availability scenarios.	High

[†] Volume required to meet demands may vary depending on antecedent conditions.

Environmental assets	Target values	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2018–19		Implications for future demands
		Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19
<ul style="list-style-type: none"> Nationally significant wetlands Waterbird breeding and habitat Habitat and breeding ground for frogs Native fish habitat 	Pink inundation zone (19 000 ha)	Minimum 100 GL at Marebone over 3 months between June and April to inundate reeds, water couch, mixed marsh, river red gum forest, river cooba.	Ideally: 8 in 10 years (Max interval: Groundcover – 2 years; trees 4–7 years)	Demand met in 2012–13, 2016–17 and again in 2017–18 in all areas of the Marshes, excluding the Eastern Marshes in 2017–18, which was not inundated for the target duration. Demand either partially met or not met in years in between. Requires water again in 2018–19 to contribute to 8 in 10 year frequency, and to support further recovery of vegetation and build resilience, including in the Ramsar site. Therefore, the environmental demand has been assessed as moderate to high.	Moderate to High	A high priority for CEW under low to high water resource availability scenarios.	Moderate
	Red inundation zone (50 000 ha)	250 GL at Marebone over 3–5 months between June and April to inundate river red gum woodland, river cooba, inner coolibah woodland	Ideally: 1 in 3 years (Max interval: 4–7 years)	Demand met in 2016–17 and 2012–13 in all areas of the Marshes. Based on having been met once in the last three years, the demand is considered low for 2018–19, but may require water the following year. Therefore, the environmental demand has been assessed as low.	Low	Low priority for CEW in 2018–19.	Moderate
	Orange and green inundation zones (81 000 to 145 000 ha)	400–700 GL at Marebone over 5 months between June and April to inundate outer river red gum (RRG) woodland, coolibah, and black box	Ideally: 1 in 4 years (RRG), or 1 in 8 years (other veg) (Max interval: 7 years (RRG) 20 years (other veg))	Demand last met in 2016–17 in all areas of the Marshes. Before that this demand was met in 2010–11, although some minor inundation occurred in 2011–12 and 2012–13. May require water in the next 1–2 years. Therefore, the environmental demand has been assessed as low.	Low	Low priority for CEW in 2018–19.	Moderate
Lower Macquarie River (Marshes – Barwon River) ^{1,2} <ul style="list-style-type: none"> Native fish habitat and dispersal Provides connectivity between Macquarie and Barwon catchments Instream aquatic ecosystems and floodplain vegetation 	Instream aquatic ecosystems Fish Connectivity	Seasonal freshes: in-channel flows Minimum 20 ML/day at Bells Bridge for 45 days.	Ideally: annually (Max interval: Unknown, possibly 2 years)	Seasonal freshes were met in the lower Macquarie in both 2016–17 (between Aug and Jan) and 2017–18 (between Aug and Dec). These flows preferably occur annually and are required again in 2018–19. Therefore, the environmental demand has been assessed as moderate.	Moderate	Possible use under low to moderate water resource availability scenarios, subject to tributary flows. Needs may be partially met by other flows.	Moderate
	Fish Connectivity	System connectivity between the Macquarie and Barwon catchments: † for example in-channel flow targeting rates of 125–140 ML/day at Bells Bridge (minimum depth of 50 cm) to connect the lower Macquarie River and the Barwon River for a minimum of 10 days.	Opportunistic (Max interval unknown, possibly 1 in 5 years)	Based on flows at Bells Bridge, suitable connection was achieved in spring 2016, autumn 2017, and again in spring/summer 2017. Note that these flows in 2016–17 occurred during wetter conditions and the autumn flow was specifically targeting connectivity to the Barwon River. However, flows in 2017–18 occurred in drier conditions and were likely subject to extraction downstream of Bells Bridge, meaning suitable connection may not have been achieved. Therefore, the environmental demand has been assessed as moderate to high.	Moderate to High	Unlikely to be a priority under continuing dry conditions. Possible use under high to very high water resource availability scenarios only, subject to suitable conditions and operational feasibility.	Moderate to High
	Floodplain vegetation Connectivity	15–30 GL at Bells Bridge to inundate floodplain and lower reach of Macquarie River.	Ideally: 1 in 3 years (Max interval: 7 years)	Good connectivity was achieved with the lower reach and floodplain of the Macquarie River in 2016–17 and previously in 2012–13. ~15.3 GL of flow also passed Bells Bridge between July and mid-Dec 2017. However, this water was likely subject to unregulated flow extraction in the lower Macquarie, so this demand may not have been fully met. The environmental demand has been assessed as low.	Low	A low priority for CEW in 2018–19.	Moderate

† Broader system connectivity may be achieved by other flows in the system and operational management of environmental/other water (e.g. via the Bogan River, Gunningbar Creek, the Castlereagh River, and Marthaguy Creek (including through the Gum Cowal).

Environmental assets	Target values	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2018–19		Implications for future demands			
		Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2019–20 if watering occurred as planned in 2018–19			
Unregulated Distributary creeks⁵ Marra Creek Lower Crooked Creek[‡] • Native fish habitat • In-channel and riparian habitat • Connectivity with Barwon-Darling catchment	Fish In channel and riparian vegetation Increased frequency and duration of connectivity to Barwon-Darling	Baseflows and freshes to Marra Creek and/or the lower Crooked Creek. Volumes required dependent on which creeks are targeted. Some connectivity may be provided by replenishment flows.	Required frequency unknown (1 in 1–3 years based on key vegetation)	Demand met in 2016–17 and 2012–13, with stock and domestic replenishment flows partially contributing to demand in some creeks in years in between and in 2017–18. Therefore, the environmental demand has been assessed as low to moderate.	Low to Moderate	Possible use under moderate to very high water resource availability scenarios, subject to suitable water availability and operational feasibility.	Moderate			
<p>Note: contributions to meet Barwon-Darling environmental requirements may be considered subject to water availability, antecedent conditions, and environmental demands. Refer to <i>Commonwealth Environmental Water Portfolio Management Plan: Barwon-Darling 2018–19</i>.</p> <p>References:</p> <p>1. Sourced from information and advice provided by NSW DPI Fisheries (Sam Davis, pers. comm. 2015– 2018)</p> <p>2. Sourced from Barma Water Resources et al. (2011)</p> <p>3. Sourced from advice from NSW Office of Environment and Heritage (Tim Hosking, Paul Keyte and Debbie Love, pers. comm. 2015–2018), NSW Department of Environment, Climate Change and Water (2010), and MDBA (2012)</p> <p>4. Based on inundation zones as mapped by Thomas et al. (2015).</p> <p>5. Sourced from Torrible et al. (2011)</p> <p>6. All watering history sourced from advice from NSW Office of Environment and Heritage (Tim Hosking, Paul Keyte and Debbie Love, pers. comm. 2015–2018), NSW OEH Statement of annual environmental watering priorities, WaterNSW Water Balance Reports, and data from the following gauges (NSW Department of Industry, 2018):</p> <table><tr><td><ul style="list-style-type: none">421090: Macquarie River at d/s Marebone Weir421001: Macquarie River at Dubbo (in the absence of available data at Wellington)421147: Macquarie River at Pillicawarrina</td><td><ul style="list-style-type: none">421088: Marebone Break at d/s regulator421107: Marra Creek at Billybongbone Bridge421097: Marra Creek at Carinda Road421146: Gum Cowal at Bifurcation</td><td><ul style="list-style-type: none">421127: Macquarie River at Baroona421016: Crooked Creek at Profile421012: Macquarie River at Carinda (Bells Bridge)421022: Macquarie River at Oxley Station421152: Gum Cowal at Oxley</td></tr></table>					<ul style="list-style-type: none">421090: Macquarie River at d/s Marebone Weir421001: Macquarie River at Dubbo (in the absence of available data at Wellington)421147: Macquarie River at Pillicawarrina	<ul style="list-style-type: none">421088: Marebone Break at d/s regulator421107: Marra Creek at Billybongbone Bridge421097: Marra Creek at Carinda Road421146: Gum Cowal at Bifurcation	<ul style="list-style-type: none">421127: Macquarie River at Baroona421016: Crooked Creek at Profile421012: Macquarie River at Carinda (Bells Bridge)421022: Macquarie River at Oxley Station421152: Gum Cowal at Oxley	Carryover potential	Available allocations to be carried into 2018–19 will be identified in Macquarie environmental water holdings at https://www.environment.gov.au/water/cewo/about/water-holdings .	Low proportion of available allocations expected to be carried into 2019–20, subject to Commonwealth Environmental Water Holdings at 30 June 2019, water resource availability and environmental watering actions undertaken in 2018–19.
					<ul style="list-style-type: none">421090: Macquarie River at d/s Marebone Weir421001: Macquarie River at Dubbo (in the absence of available data at Wellington)421147: Macquarie River at Pillicawarrina	<ul style="list-style-type: none">421088: Marebone Break at d/s regulator421107: Marra Creek at Billybongbone Bridge421097: Marra Creek at Carinda Road421146: Gum Cowal at Bifurcation	<ul style="list-style-type: none">421127: Macquarie River at Baroona421016: Crooked Creek at Profile421012: Macquarie River at Carinda (Bells Bridge)421022: Macquarie River at Oxley Station421152: Gum Cowal at Oxley			
Trade potential	No urgency to augment available allocations, therefore limited potential for allocation purchase. Moderate to high environmental demands means allocation sale unlikely.	No expected urgency to augment available allocations, therefore limited potential for allocation purchase. Potential to trade will depend on environmental demands and resource availability.								

Key - potential watering in 2018–19

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

Key - environmental demands

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

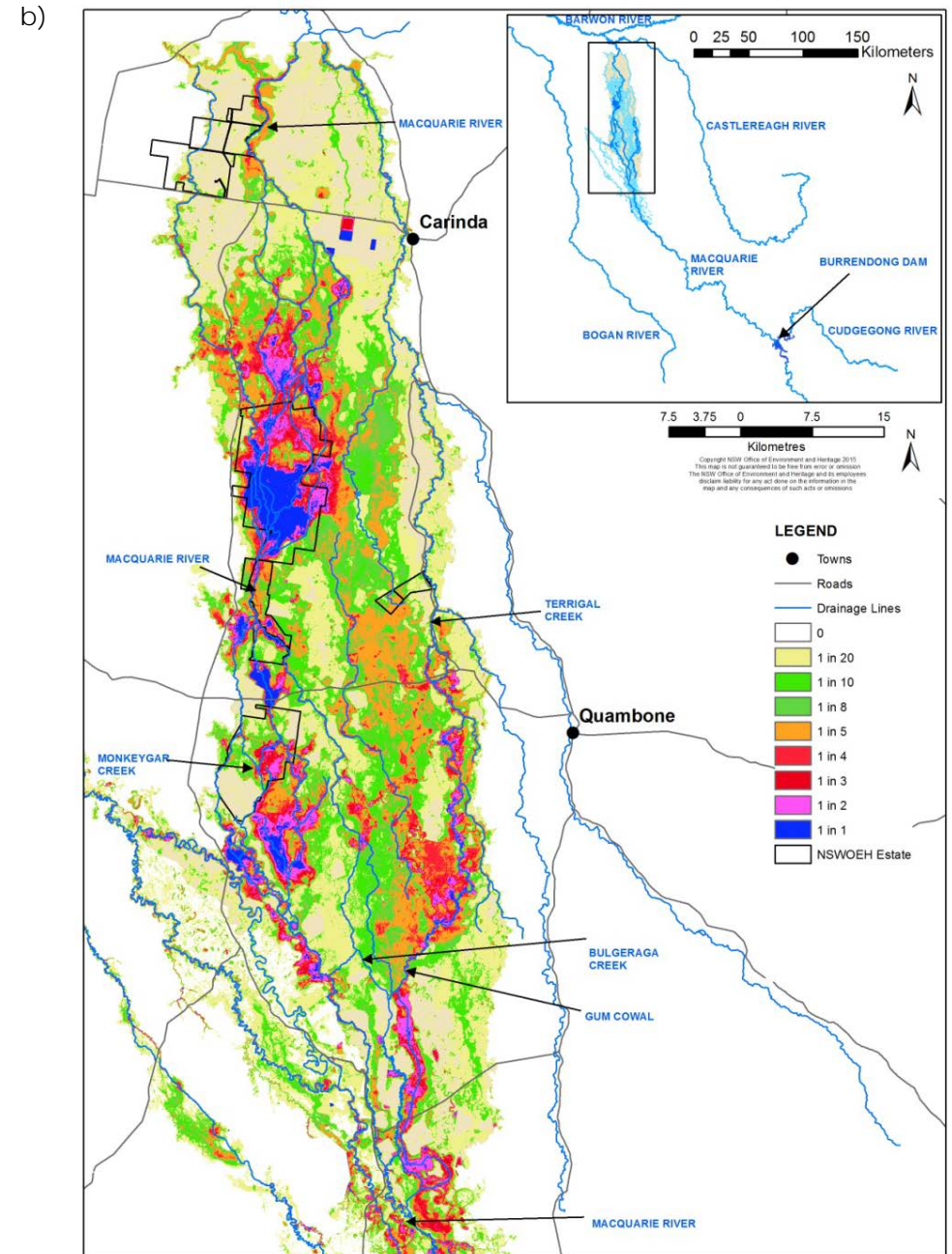
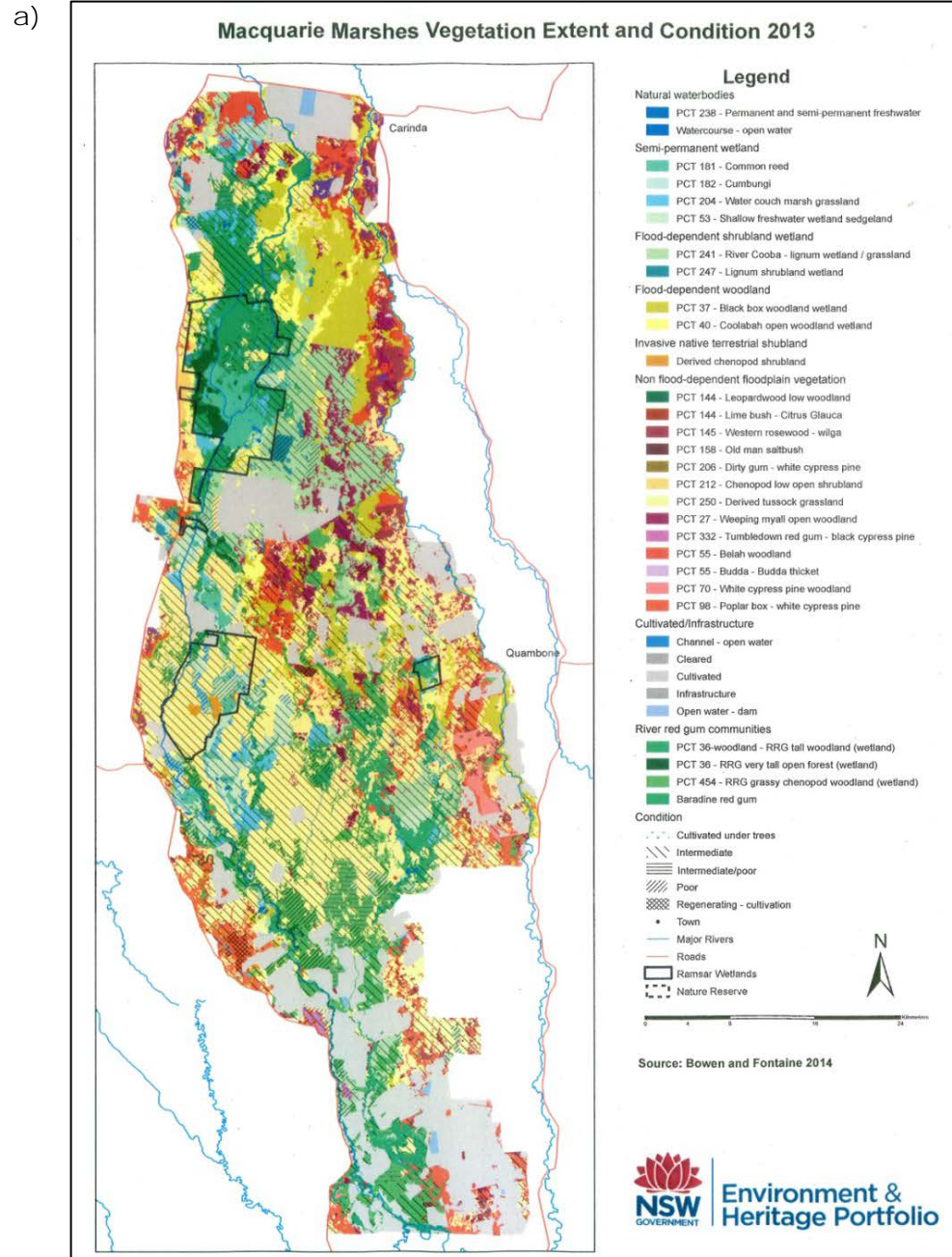


Figure 4: a) Macquarie Marshes vegetation mapping (Bowen & Fontaine 2015); b) Inundation frequencies: Macquarie Marshes 1988–2008 (Thomas et al. 2015)

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 5, planning allows the CEWO to manage the environmental water portfolio in a holistic manner and is an exercise in developing a broad approach or intention, based on the key drivers (demand and supply).

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

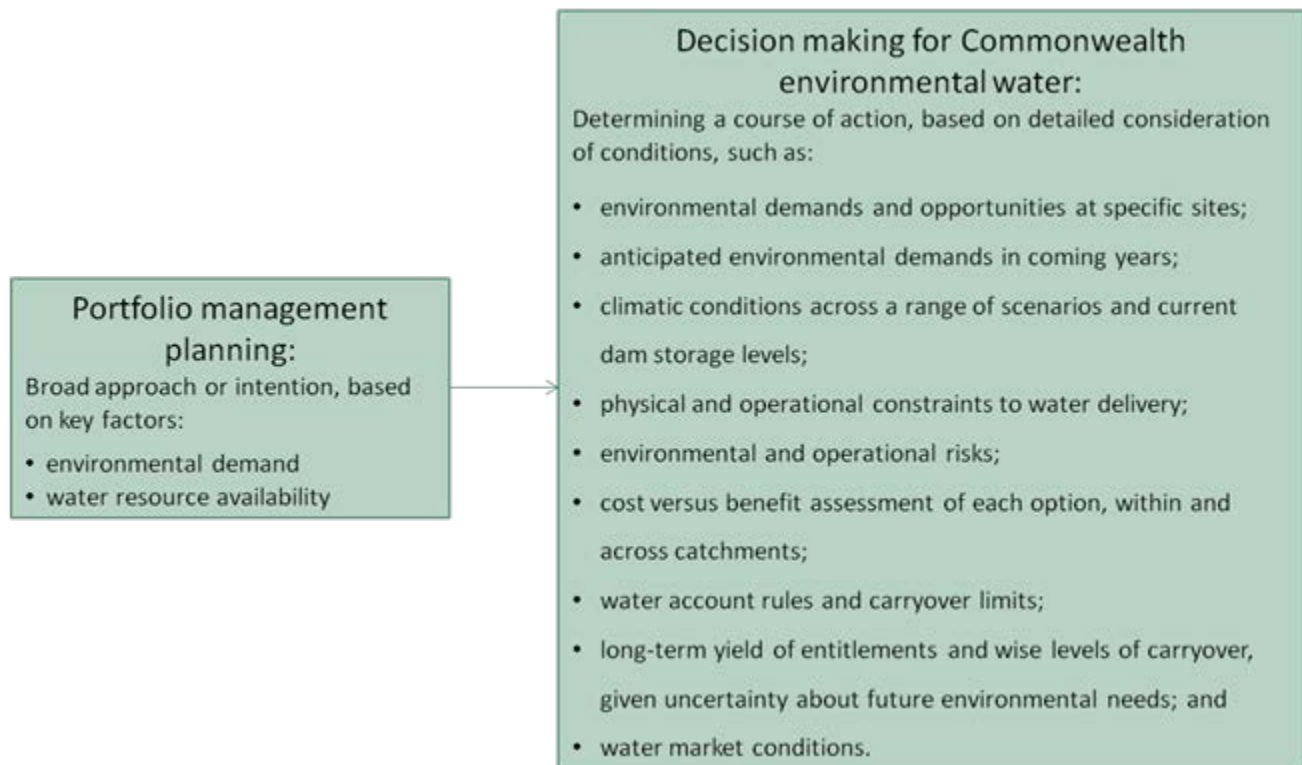


Figure 5: Planning and decision making for Commonwealth environmental water use

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>

or the sites below:

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

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

Expected outcomes from the Basin-wide environmental watering strategy (MDBA 2014) that are relevant to the Macquarie River Valley are described below.

RIVER FLOWS AND CONNECTIVITY

Baseflows are at least 60 per cent of the natural level

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

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

VEGETATION

Maintain the current extent of water-dependent vegetation near river channels and on low-lying areas of the floodplain.

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

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

Improve condition of lignum shrublands in the Macquarie Marshes

Increased periods of growth for non-woody vegetation communities that closely fringe or occur within the river and creek channels, and for common reed and cumbungi in the Macquarie Marshes.

Vegetation extent

Area of river red gum (ha)	Area of black box (ha)	Area of coolibah (ha)	Shrublands	Non-woody water dependent vegetation
58 200	57 100	32 200	Lignum in the Macquarie Marshes	Closely fringing or occurring within the Bogan, Castlereagh, Macquarie and Talbragar rivers; and common reed, cumbungi and water couch in the Macquarie Marshes

WATERBIRDS

Maintain current species diversity

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

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

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

Important Basin environmental assets for waterbirds in the Macquarie

Environmental asset	Total abundance and diversity	Drought refuge	Colonial waterbird breeding	Shorebird abundance	In scope for Cth e-watering
Macquarie Marshes	Yes	Yes	Yes	Yes	Yes

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 one to two 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 species for the Macquarie include:

Species	Specific outcomes	In-scope for Cth e-water in the Macquarie?
Flathead galaxias (<i>Galaxias rostratus</i>)	Considered extinct. Reintroduction using southern populations may be an option in the longer term, with the Macquarie a potential candidate site.	Possibly (Once widespread. Current extent unknown in Macquarie. Potential for re-introduction)
Freshwater catfish (<i>Tandanus tandanus</i>)	Expand the core range of existing populations in the Macquarie	Yes
Golden Perch (<i>Macquaria ambigua</i>)	A 10–15 per cent increase of mature fish (of legal take size) in key populations	Yes
Murray cod (<i>Maccullochella peelii</i>)	A 10–15 per cent increase of mature fish (of legal take size) in key populations	Yes
Olive perchlet (<i>Ambassis agassizii</i>)	Establish additional populations in the Macquarie	Possibly (Once widespread. Current extent unknown in Macquarie. Potential for re-introduction)
Silver perch (<i>Bidyanus bidyanus</i>)	Expand the core range in the Macquarie catchments	Yes
Southern purple-spotted gudgeon (<i>Mogurnda adspersa</i>)	Expand the range (or core range) of populations in the Macquarie. Establish additional populations	Yes
Trout cod (<i>Maccullochella macquariensis</i>)	The distribution of trout cod in the Northern Basin is limited to the Macquarie catchment downstream of Burrendong Dam. Range expansion of the current population is a priority. Establish additional populations	Yes

Important Basin environmental assets for native fish in the Macquarie

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge	In-scope for Cth e-water
Macquarie River – below Burrendong Dam to Warren	Yes	Yes			Yes	Yes	Yes
Macquarie Marshes to Barwon, including lateral connectivity at the Marshes	Yes				Yes	Yes	Yes
Lower Bogan River to junction with the Darling River	Yes				Yes	Yes	Yes

Attachment B – Operational details for watering

Operational considerations in the Macquarie River Valley

The delivery of environmental water in the Macquarie River Valley is currently constrained by the release capacities from storages, channel capacities, and system constraints.

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

- Burrendong Dam storage capacity of 1 188 000 ML and outlet capacity of 8 200 ML/day (WaterNSW 2018; Department of Infrastructure, Planning and Natural Resources 2004)
- South Dubbo weir drown out at > 14 385 ML/day
- Marebone Choke – third party impact at prolonged flows > 4 000 ML/day
- Crooked Creek off take capacity of 100 ML/day
- structures such as banks, weirs, regulators and diversion channels in the Macquarie Marshes.

The Office will develop watering options within existing water delivery and channel capacity constraints unless the agreement of all affected parties has been obtained for an alternative delivery approach.

Potential watering actions under different levels of water resource availability

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

Table 4: Summary of potential watering actions for the Macquarie River Valley

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
Mid-Macquarie River	Baseflows: small, very regular flows through to end of system, wetting holes and instream storages.	1. <i>Minimum baseflows</i> : contribute to flows to maintain connectivity during extreme dry conditions to provide native fish refuge if regulated flows cease				
	Small freshes: up to 800–1 000 ML/day for at least 14 days at Baroona in spring (Oct-Nov) to mid-autumn; and conditioning flow in winter (July to mid-August).	2. <i>Native fish maintenance flow</i> : contribute to flows (baseflows and freshes) in the mid-Macquarie River for the maintenance and conditioning of native fish (flow generalists and in-channel specialists) (July to mid-August)*				
		3. <i>Native fish flow (flow generalists + in-channel specialists)</i> : contribute to river flows (baseflows and freshes) in the mid-Macquarie River to provide habitat for native fish (all guilds) and to provide spawning opportunities for flow generalists and in-channel specialists (spring)*				
	Priming flow: >5 000 ML total flows at Baroona over 3 days with approx. 7 day recession (tributary pulse). Spawning pulse: initial peak ≥ 5 000 ML/day at Baroona for >2 days with event lasting for >7 days. (35–40 day total pulse) Dispersal flow: Initial pulse >3 000 ML total flows over 3 days at Baroona. Second pulse min. 2 000 ML/day peak with recession. Approx 10d duration total events. (Oct–March) Water temperature for all pulses ≥19 °C.			4. <i>Native fish flow (flow specialists)</i> : contribute to river flows (freshes) in the mid-Macquarie River to support native fish populations (flow specialists), including movement, reproduction and recruitment*		

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
	Large freshes and bankfull: 10 000–20 000 ML/day at Barooka for a minimum of 3 days (to drown out key weirs).				5. <i>Native fish passage flow</i> : contribute to river flows (freshes) in the mid-Macquarie River to drown key weirs and provide movement, spawning and recruitment opportunities for flow specialists and generalists*	
Macquarie Marshes	Flows between 60 and 700 GL at Marebone over three–five months between June and April (wetland inundation action scalable depending on water resource availability scenario and target extent)	6. <i>Wetland inundation</i> : contribute to flows to the Macquarie Marshes to inundate wetland vegetation and provide habitat and recruitment opportunities for waterbirds, fish and frogs				
				7. <i>Waterbird breeding contingency</i> : contribute to flows to the Macquarie Marshes to maintain inundation in key waterbird reproduction areas to support a naturally triggered breeding event		
Lower Macquarie River	Seasonal freshes: in-channel flows Minimum 20 ML/day at Bells Bridge for 45 days.		8. <i>Lower Macquarie in-channel freshes</i> : contribute to flows (seasonal freshes) to provide connectivity to the lower Macquarie River and through to the Barwon-Darling, maintain aquatic ecosystems, and provide opportunities for native fish**			
	System connectivity between Macquarie and Barwon catchments: 120–140 ML/day at Bells Bridge (minimum depth of 50 cm) to connect the lower Macquarie and Barwon rivers for a minimum of 10 days			9. <i>Native fish system connection flow</i> : contribute to river flows in the lower Macquarie River system to provide connection with the Barwon River, allowing opportunities for the movement of native fish**		
	15–30 GL at Bells Bridge to inundate floodplain and lower reach of Macquarie River				10. <i>Lower Macquarie floodplain inundation</i> : contribute to flows to inundate floodplain and the lower reach of the lower Macquarie River through to the Barwon-	

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
					Darling, provide connectivity, and support floodplain vegetation*	
Distributary creeks	Baseflows and freshes targeting fish, vegetation and connectivity with the Barwon River			11. <i>Restoring natural flow variability:</i> contribute to flows (baseflows and freshes) in Marra Creek and/or lower Crooked Creek to support hydrological connectivity, vegetation and native fish populations		

Note: Under certain resource availabilities, options may not be pursued for a variety of reasons including that environmental demand may be met by unregulated flows and that constraints and/or risks may limit the ability to deliver environmental water.

* Could be coordinated with environmental water delivery to the Macquarie Marshes, depending on timing and/or volumes. Providing connectivity via Marthaguy Creek may be achieved by coordinating with water delivered to the Eastern Marshes.

Targeted connection to the Barwon may be subject to conditions such as fish spawning/recruitment in the Barwon, tributary inflows, water availability and protection of environmental water.

Potential watering actions – standard operating arrangements

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

Watering Action 1: Mid-Macquarie River minimum baseflows

Watering action: Contribute to flows to maintain connectivity during extreme dry conditions to provide native fish refuge if regulated flow releases from Burrendong Dam cease.

Standard operational considerations: Target flow rates would be dependent on conditions in the system, the volume of water available to be delivered and operational considerations.

Typical extent: This watering action would contribute flows to the mid-Macquarie River downstream of Burrendong Dam to downstream of Warren.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action.

Watering Action 2: Native fish maintenance flow

Watering action: Contribute to flows (small freshes) in the mid-Macquarie River for the maintenance and conditioning of native fish (flow generalists and in-channel specialists) (July to mid-August).

Standard operational considerations:

- The flow limit for this action is 4 000 ML/day at Marebone Weir
- The timing of the flow is very important. Conditioning flows would ideally be delivered before mid-August to avoid favouring carp and providing a competitive advantage over native fish species. However, late winter pulses may be beneficial for movement of species such as Murray cod.
- This action would take advantage of in-stream flows by supplementing tributary flows and/or consumptive orders to create the desired flow increase and recession.
- This action could be coordinated with environmental water delivery to the Macquarie Marshes, depending on appropriate timing and volumes.
- All Macquarie River fishways are required to be open and functioning for this action.

Typical extent: This watering action would be targeted at contributing flows to the mid-Macquarie River downstream of Burrendong Dam, but would also provide flows into the Macquarie Marshes.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action.

Watering Action 3: Native fish flow (flow generalists and in-channel specialists)

Watering action: Contribute to river flows (small freshes) in the mid-Macquarie River to provide habitat for native fish (all guilds) and to provide spawning opportunities for flow generalists and in-channel specialists.

Standard operational considerations:

- The flow limit for this action is 4 000 ML/day at Marebone Weir (excluding supplementary water).

- This action would take advantage of in-stream flows by supplementing tributary flows and/or consumptive orders to create the desired flow increase and recession.
- All Macquarie River fishways are required to be open and functioning for this action.
- Commonwealth supplementary entitlements could contribute to meeting this demand.
- This action could be coordinated with environmental water delivery to the Macquarie Marshes, depending on appropriate timing and volumes.
- If a small to medium sized fresh is moving through Marthaguy Creek, environmental water could be directed down Gum Cowal and the Eastern Marshes to support connectivity (targeting 5–7 days of connection of at least 0.5 m depth, with the Gum Cowal regulator fully open to ensure fish passage). Flows in the unregulated Marthaguy may be at risk of extraction.
- If Marthaguy Creek is not flowing, environmental water could be directed down the mainstem Macquarie River into the Macquarie Marshes to benefit and maintain other downstream assets.
- All Macquarie River fishways are required to be open and functioning for this action.

Typical extent: This watering action would be targeted at contributing flows to the mid-Macquarie River downstream of Burrendong Dam, but would also provide flows into the Macquarie Marshes. Additional areas may be targeted in the Marshes and Marthaguy Creek depending on conditions to support connectivity.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action.

Watering Action 4: Native fish flow (flow specialists)

Watering action: Contribute to river flows (freshes) in the mid-Macquarie River to support native fish populations (flow specialists), including movement, reproduction and recruitment.

Standard operational considerations:

- The flow limit for this action is 4 000 ML/day at Marebone Weir (excluding supplementary water).
- Triggers are based on tributary inputs, flow rates at Baroona and water temperatures of at least 19 degrees celsius.
- Two pulses consisting of a priming flow and then a spawning pulse may be required. This action would take advantage of in-stream flows by supplementing tributary flows and other water in the system to create the desired flow pulses and recessions.
- This action may include a dispersal/recruitment flow consisting of an initial pulse from tributary flows meeting required triggers, followed by a second peak with an appropriate recession.
- This action could be coordinated with environmental water delivery to the Macquarie Marshes, depending on appropriate timing and volumes.
- All Macquarie River fishways are required to be open and functioning for this action.
- Commonwealth supplementary entitlements could contribute to meeting this demand by protecting some of the flow pulse.

Typical extent: This watering action would be targeted at contributing flows to the mid-Macquarie River downstream of Burrendong Dam, but would also provide flows into the Macquarie Marshes.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action.

Watering Action 5: Native fish passage flow

Watering action: Contribute to river flows (large freshes and bankfull) in the mid-Macquarie River to drown out key weirs and provide movement, spawning and recruitment opportunities for flow specialists and generalists.

Standard operational considerations:

- The flow limit for this action is 4 000 ML/day at Marebone Weir (excluding supplementary water).
- A total of 15 000 ML/day at Dubbo is required to drown out weirs on the Macquarie River at Dubbo and Narromine.
- This action would take advantage of in-stream flows by supplementing tributary flows and/or consumptive orders to create the desired flow increase and recession .
- This action could be coordinated with environmental water delivery to the Macquarie Marshes, depending on appropriate timing and volumes.
- All Macquarie River fishways are required to be open and functioning for this action.
- Commonwealth supplementary entitlements could contribute to meeting this demand.

Typical extent: This watering action would be targeted at contributing flows to the mid-Macquarie River downstream of Burrendong Dam, particularly at major weirs at Dubbo and Narromine to enable fish passage. The action would also provide flows into the Macquarie Marshes and possibly downstream to the lower Macquarie River.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action.

Watering Action 6: Wetland inundation

Watering action: Contribute to flows to the Macquarie Marshes to inundate wetland vegetation, and provide habitat and recruitment opportunities for waterbirds, fish and frogs.

Standard operational considerations:

- The flow limit for this action is 4 000 ML/day at Marebone Weir (excluding supplementary water).
- Commonwealth environmental water would be delivered via river flows from Burrendong Dam to Marebone Weir (accounting point), taking up to 11 days to reach the weir.
- Commonwealth supplementary entitlements could contribute to meeting this demand.
- Use of particular channels (e.g. Bulgeraga, Gum Cowal) will depend on assets and outcomes being targeted.
- All Macquarie River fishways are required to be open and functioning for this action.

Typical extent:

- Depending on water availability, specific areas of the Marshes system may be targeted (e.g. within the Northern, Southern and/or Eastern Marshes) rather than the entire inundation zone.

- The extent targeted varies across demands and water resource availability scenarios and will vary depending on delivery design and flow rates. Approximate inundation extents are provided below:
 - Contribute to inundating up to 9 000 ha of reed beds, lagoons and water couch in the Macquarie Marshes (30–60 GL: Very Low to Low scenario).
 - Contribute to inundating up to 19 000 ha of reeds, water couch, mixed marsh, river red gum forest and river cooba in the Macquarie Marshes (≥ 100 GL: Very Low to Moderate scenario).
 - Contribute to inundating up to 50 000 ha of river red gum woodland, mixed marsh and river cooba in the Macquarie Marshes (250 GL: Low to High scenario).
 - Contribute to inundating between 81 000 and 145 000 ha of outer river red gum forest, coolibah, myall and black box in the Macquarie Marshes (400–700 GL: Moderate to High scenario).

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action.

Watering Action 7: Waterbird breeding contingency

Watering action: Contribute to flows to the Macquarie Marshes to maintain inundation in key waterbird reproduction areas to support a naturally triggered breeding event.

Standard operational considerations:

- The flow limit for this action is 4 000 ML/day at Marebone Weir.
- Delivery of Commonwealth environmental water will be triggered by a shared recognition with NSW OEH and other key agencies that catchment conditions and short term future flows into the Marshes will be insufficient to maintain the conditions required to successfully complete a bird breeding event.
- Delivery of Commonwealth environmental water will be adaptively managed to maintain inundation at an appropriate depth and duration, and to avoid a rapid flow recession in known breeding areas.
- This action may not be operationalised if other flows (e.g. irrigation, unregulated, replenishment flows, flood mitigation zone releases) are deemed sufficient to support the breeding event to completion.
- Commonwealth environmental water would be delivered via rivers flows from Burrendong Dam to Marebone Weir (accounting point), taking up to 11 days to reach the weir.
- All fishways and regulators are required to be open and functioning for this action.

Typical extent: Key waterbird breeding sites across the Macquarie Marshes. Specific sites will depend on where the waterbird breeding event takes place at that time.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action. In particular, to determine whether environmental water can be delivered to the precise location of the bird breeding event.

Watering Action 8: Lower Macquarie River in-channel freshes

Watering action: Contribute to flows (baseflows and freshes) to provide connectivity to the lower Macquarie River and Barwon-Darling, maintain aquatic ecosystems and riparian vegetation, and provide opportunities for native fish. This action would help support floodplain vegetation along the lower Macquarie River during periods of higher resource availability.

Standard operational considerations:

- The flow limit for this action is 4 000 ML/day at Marebone Weir.
- Target flow rates would be dependent on conditions in the system, the volume of water available to be delivered and operational considerations.
- This action could be coordinated with environmental water delivery to the Macquarie Marshes or other flows, depending on appropriate timing and volumes.
- Flows above 50 ML/day at Carinda may be at risk of extraction.
- All Macquarie River fishways are required to be open and functioning for this action.

Typical extent: This watering action would be targeted at contributing to flows to the lower Macquarie River downstream of the Macquarie Marshes and the Barwon-Darling. It is expected that this action would provide connectivity to the Barwon-Darling system. This action would provide additional benefits to the mid-Macquarie River and Marshes en route to the lower Macquarie.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action. This action may require close collaboration with relevant landholders. Protection mechanisms would require consultation with WaterNSW and NSW DOI.

Watering Action 9: Native fish system connection flow

Watering action: Contribute to river flows in the lower Macquarie River system to provide connection with the Barwon River, allowing opportunities for the movement of native fish. The action would also provide secondary benefits to the mid-Macquarie and Macquarie Marshes.

System connectivity flows to the Barwon River may be opportunistic and subject to the following considerations:

- Potential for a fresh flow in the Barwon River of flows greater than 1 000 ML/day upstream of the confluence with the Macquarie River (contributed from any water source).
- Coordination of travel times between the Barwon and Macquarie flow pulses.
- Would ideally build on tributary pulses in the Macquarie to increase productivity and provide cues from the catchment, however, this is not critical.
- Need for protection mechanisms for environmental water.
- Lack of barriers for fish movement in the lower Macquarie River.
- Brewarrina fishway should be open (flow trigger for opening is 120 ML/day and rising at Geera, and 75 ML/day and rising at Boorooma on the Barwon River).
- All Macquarie River fishways are required to be open and functioning for this action.
- Flows should be delivered down routes with the fewest fish barriers to maximise the environmental outcomes. The use of Bulgeraga Creek should be limited until fish passage is addressed at the dropbox regulator at the Gum Cowal bifurcation. The Northern Bypass Channel should be used only to prime the system quickly if flows need to catch up through the Northern Marshes.
- Flows would need to be delivered at a rate that does not cause high flow velocities at the Miralwyn pipe culverts, to a depth of at least 0.5 m. Connection with the Barwon River would be targeted for a minimum of 10 days at a flow of 120–140 ML/day.

- Water availability and antecedent conditions in the Macquarie River system. The action may be more likely to occur during wetter conditions or when larger actions have been undertaken beforehand. Providing connection to the Barwon at a minimum depth of 0.5 m for a minimum of 10 days is unlikely to be feasible during periods of low water availability and dry conditions.

Typical extent: This watering action would be targeted at contributing flows to the lower Macquarie River downstream of the Macquarie Marshes, with benefits provided to the whole Macquarie River downstream of Burrendong Dam, and the Macquarie Marshes. If water is being provided to the Eastern Marshes it may also be possible to deliver additional water to the lower Macquarie River via Marthaguy Creek. Depending on water availability, this action would also provide flows to the Barwon-Darling system.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action. The flow would need to be protected in the lower Macquarie, which would require consultation with WaterNSW and NSW DOI.

Watering Action 10: Lower Macquarie floodplain inundation

Watering action: Contribute to flows to inundate floodplain and the lower reach of the lower Macquarie River through to the Barwon-Darling, provide connectivity, and support floodplain vegetation.

Standard operational considerations:

- The flow limit for this action is 4 000 ML/day at Marebone Weir.
- Target flow rates would be dependent on conditions in the system, the volume of water available to be delivered and operational considerations.
- This action could be coordinated with environmental water deliveries to the Macquarie Marshes or other flows, depending on appropriate timing and volumes.
- Flows above 50 ML/day at Carinda may be at risk of extraction, so consideration is required as to how environmental water would be protected to the end of system.
- All Macquarie River fishways are required to be open and functioning for this action.

Typical extent: This watering action would be targeted at contributing to flows to the lower Macquarie River and floodplain downstream of the Macquarie Marshes. It is expected that this action would provide connectivity to the Barwon-Darling system. This action would provide additional benefits to the mid-Macquarie River and Marshes en route to the lower Macquarie.

Approvals: Consult with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) before implementing this action. This action would also require close collaboration with relevant landholders to manage any potential third party impacts. The flow would need to be protected in the lower Macquarie, which would require consultation with WaterNSW and NSW DOI.

Watering Action 11: Restoring natural flow variability

Watering action: Contribute to flows (baseflows and freshes) in Marra Creek and/or lower Crooked Creek to support hydrological connectivity, vegetation and native fish populations.

Standard operational considerations:

- Target flow rates will be dependent on prevailing flow conditions, target assets and operational considerations.

- Commonwealth environmental water would be delivered as in-stream flows, which are gravity fed from Burrendong Dam and diverted from the Macquarie River channel into the distributary creeks system.
- Commonwealth environmental water could be provided to the distributary creeks using either General Security or Supplementary entitlements, depending on conditions and water availability. Flows may be provided in addition to replenishment or unregulated flows, depending on conditions.
- Delivery to the lower Crooked Creek is constrained by the capacity of the Crooked Creek channel, regulator and Mumblebone Weir.
- Commonwealth Supplementary entitlements could contribute to meeting this demand.

Typical extent: The likely target of this action would be the unregulated parts of the distributary creeks system such as Marra Creek and the lower Crooked Creek. Flows may also contribute to achieving connectivity with the Bogan River and/or Barwon-Darling. Other distributary creeks such as Duck and Gunningbar creeks are not likely to be targeted for the delivery of Commonwealth environmental water. Further investigation and consultation regarding the regulated distributary creeks may be undertaken in the future.

Approvals: Close collaboration with landholders in the distributary creeks system would be required to deliver environmental water to the system. Consultation with NSW agencies (WaterNSW, NSW OEH and NSW DPI – Fisheries) would be required before implementing this action.

Attachment C – Long-term water availability

Commonwealth environmental water holdings

The Commonwealth holds the following entitlements in the Macquarie River Valley:

- General Security
- Supplementary

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

Other sources of environmental water

Other potential sources of held environmental water that may be used to complement Commonwealth environmental water delivery in the Macquarie River Valley include:

- General Security (NSW Office of Environment and Heritage)
- Supplementary (NSW of Environment and Heritage)

Planned environmental water

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

There are many sources of Planned Environmental water in the catchment including:

- 1) a 160 GL General Security Allowance ('Environmental Water Allowance' – EWA) that is partly active and partly translucent, explicitly targeted in the Water Sharing Plan to the Macquarie Marshes.
- 2) other protected flow components, such as triggers on supplementary event declarations and the 'first 500 ML/day rule' for translucent releases under the EWA.
- 3) a translucent allocation of 10 GL is stored in the Windamere Dam for the Cudgegong system, available only when dam inflow triggers are reached and dam storage levels are above a minimum level.
- 4) a variety of other non-extracted water that is not easily accounted for, including surplus flows, tributary flows, rainfall irrigation rejections, local rainfall effects, conveyance water and base flows.



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