



Australian Government

Commonwealth Environmental Water Office

**Commonwealth Environmental Water**

Portfolio Management Plan

# Mid-Murray Region

2017–18



Front cover image credit: Reed Beds Lagoon, Barmah-Millewa Forest. Photo by Commonwealth Environmental Water Office.

Back cover image credit: Native aquatic vegetation in Gunbower Creek. Photo by Commonwealth Environmental Water Office.

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

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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. Mr David Papps is the current Commonwealth Environmental Water Holder. He is supported by staff of the Commonwealth Environmental Water Office. The Office employs six local engagement officers who live and work in regional centres across the Murray-Darling Basin.

## Commonwealth environmental water

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

There are broadly three options for managing Commonwealth environmental water:

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

## Purpose of the document

This document sets out the plans for managing the Commonwealth environmental water portfolio in the Mid Murray for 2017–18. Efficient and effective management of Commonwealth environmental water requires the utilisation of all portfolio management options. By taking a multi-year approach to planning, portfolio management tools such as use, carryover and trade can be managed for maximising environmental outcomes. The portfolio management plans support transparent, coordinated and adaptive management of Commonwealth environmental water, consistent with the Basin-wide environmental watering strategy and having regard to the Basin annual environmental watering priorities. To learn more about the planning approach see *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2017–18* (available at: <http://www.environment.gov.au/water/cewo/publications> (under 'Planning approach'))

## Delivery partners

Commonwealth environmental water is managed in conjunction with and delivered by a range of partners. This portfolio management plan has been developed in consultation with our delivery partners, including NSW Office of Environment and Heritage, Victorian Environmental Water Holder, Victoria Catchment Management Authorities, NSW Local Land Services, NSW Department of Primary Industries, Water NSW, NSW Parks and Wildlife, the Murray–Darling Basin Authority, the Murray–Darling Wetlands Working Group, Murray Irrigation Ltd., scientists engaged in monitoring the outcomes of Commonwealth environmental water use, the Murray-Lower Darling Environmental Water Advisory Group, the Edward-Wakool Environmental Water Reference Group and various community groups and individuals.

## Your input

The management of Commonwealth environmental water relies on considerable advice and assistance from local organisations, state governments and others. Individuals and groups within the Murray-Darling Basin community are encouraged to submit suggestions for the management of Commonwealth environmental water. Please contact the Office via: [ewater@environment.gov.au](mailto:ewater@environment.gov.au).

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# 1. Environmental watering in the Mid Murray Region

## 1.1. The Mid Murray Region

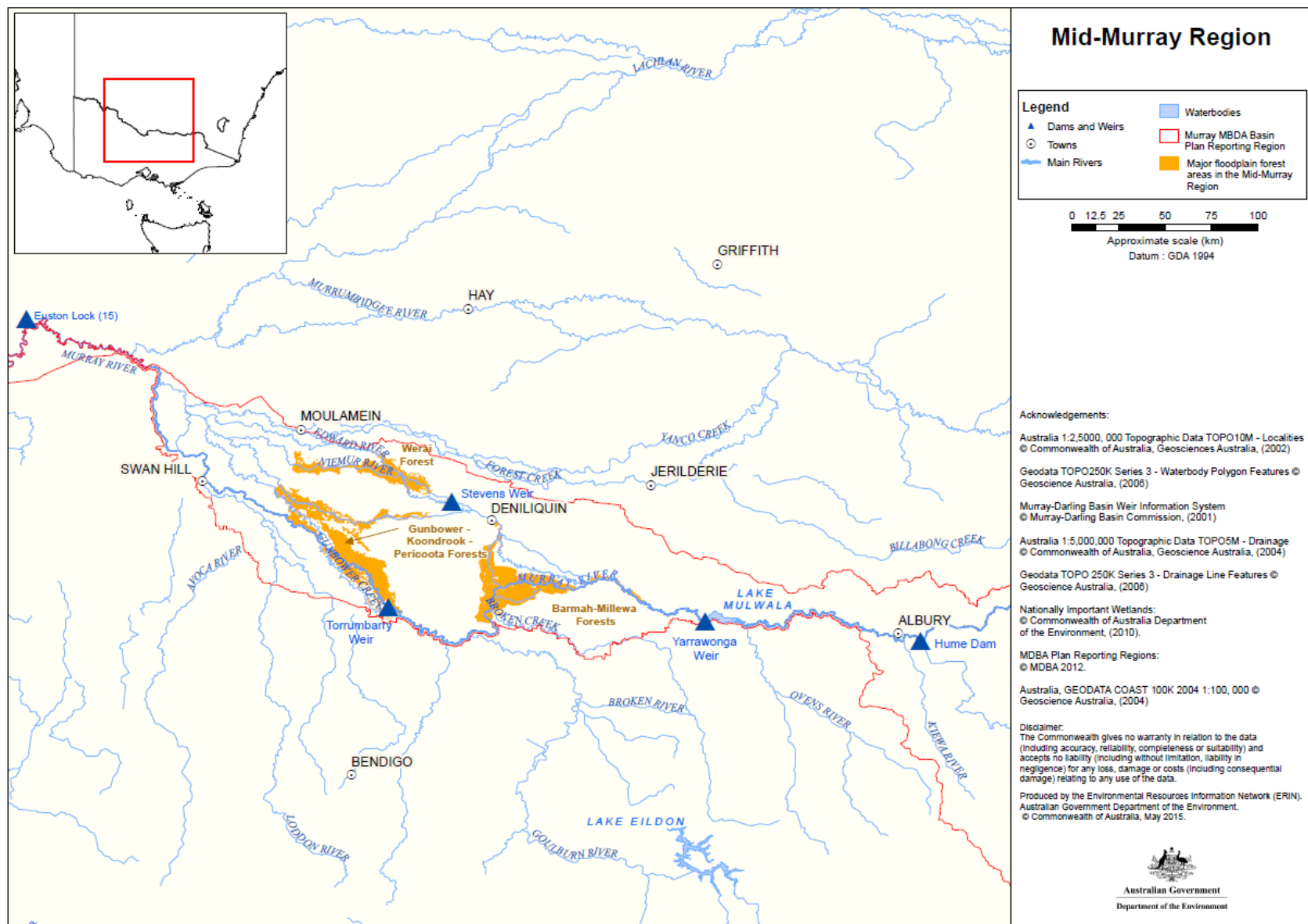
The Mid Murray planning area extends from Hume Dam to Euston (Figure 1). The region contains a number of wetlands of national and international importance including the Ramsar listed Barmah-Millewa, Gunbower and New South Wales Central Murray forests. River Murray flows in this region are strongly influenced by the Goulburn, Ovens, Kiewa, Loddon and Campaspe Rivers.

The delivery of Commonwealth environmental water to the Mid Murray Region differs depending on which part of the region water is being delivered to. Where possible, environmental water will be managed to benefit multiple sites en route, thereby maximising the efficient and effective use of environmental water. The day to day delivery of environmental water along the main stem of the River Murray is managed by the Murray–Darling Basin Authority's River Murray Operations, in close cooperation with state government agencies and state water authorities.

For the New South Wales portion of the Mid Murray Region, Commonwealth environmental water use is coordinated with other environmental water deliveries by the NSW Office of Environment and Heritage. Water delivery is managed by WaterNSW and/or Murray–Darling Basin Authority River Murray Operations. In some instances Murray Irrigation Limited and landholder infrastructure may also deliver environmental water, subject to separate agreements.

For the Victorian portion of the Mid Murray Region, Commonwealth environmental water use is coordinated with other environmental water deliveries by the Victorian Environmental Water Holder. Water delivery is managed by the state water authority, Goulburn-Murray Water, and regional waterway managers including the North-Central Catchment Management Authority, Goulburn-Broken Catchment Management Authority, North-East Catchment Management Authority and the Mallee Catchment Management Authority.

Environmental water is managed by a number of water holders in the Murray, including the Commonwealth Environmental Water Holder, The Living Murray, the Victorian Environmental Water Holder and NSW Office of Environment and Heritage. Environmental water portfolios are coordinated to maximise the effectiveness of water delivery for achieving environmental outcomes. For example, the Southern Connected Basin Environmental Watering Committee was established by the Murray–Darling Basin Ministerial Council in October 2014 to coordinate the efficient and effective delivery of all environmental water in the southern-connected Basin.



**Figure 1:** Map of the Mid Murray Region

## 1.2. Environmental objectives in the Mid Murray Region

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 Mid Murray Region are described in Attachment A.

The Victorian state government has developed a long-term watering plan for the Victorian Murray region (DELWP 2015). The plan identifies the priority environmental assets and ecosystem functions in the catchment, the objectives and targets for these assets and functions, and their watering requirements. The long-term environmental watering plan for the Victorian Murray water resource plan area is available at: [https://www.water.vic.gov.au/\\_data/assets/pdf\\_file/0023/53168/Victorian-Murray-LTWP\\_17-11-2015-FINAL.pdf](https://www.water.vic.gov.au/_data/assets/pdf_file/0023/53168/Victorian-Murray-LTWP_17-11-2015-FINAL.pdf).

Once developed, the New South Wales Murray and Lower Darling plans will also provide key information on the long-term environmental water demands in the catchment. In addition to the long-term watering plans, the Office will continue to draw on existing documentation on environmental water demands developed by state governments, local natural resource management agencies and the Murray–Darling Basin Authority.

Based on these strategies and plans, and in response to the results of environmental watering monitoring programs, the objectives being targeted by environmental watering in the Mid Murray Region are summarised in Table 1 below. The objectives for water-dependent ecosystems will continue to be revised as part of the Commonwealth Environmental Water Office's commitment to adaptive management.



**Table 1:** Summary of objectives being targeted by environmental watering in the Mid Murray Region

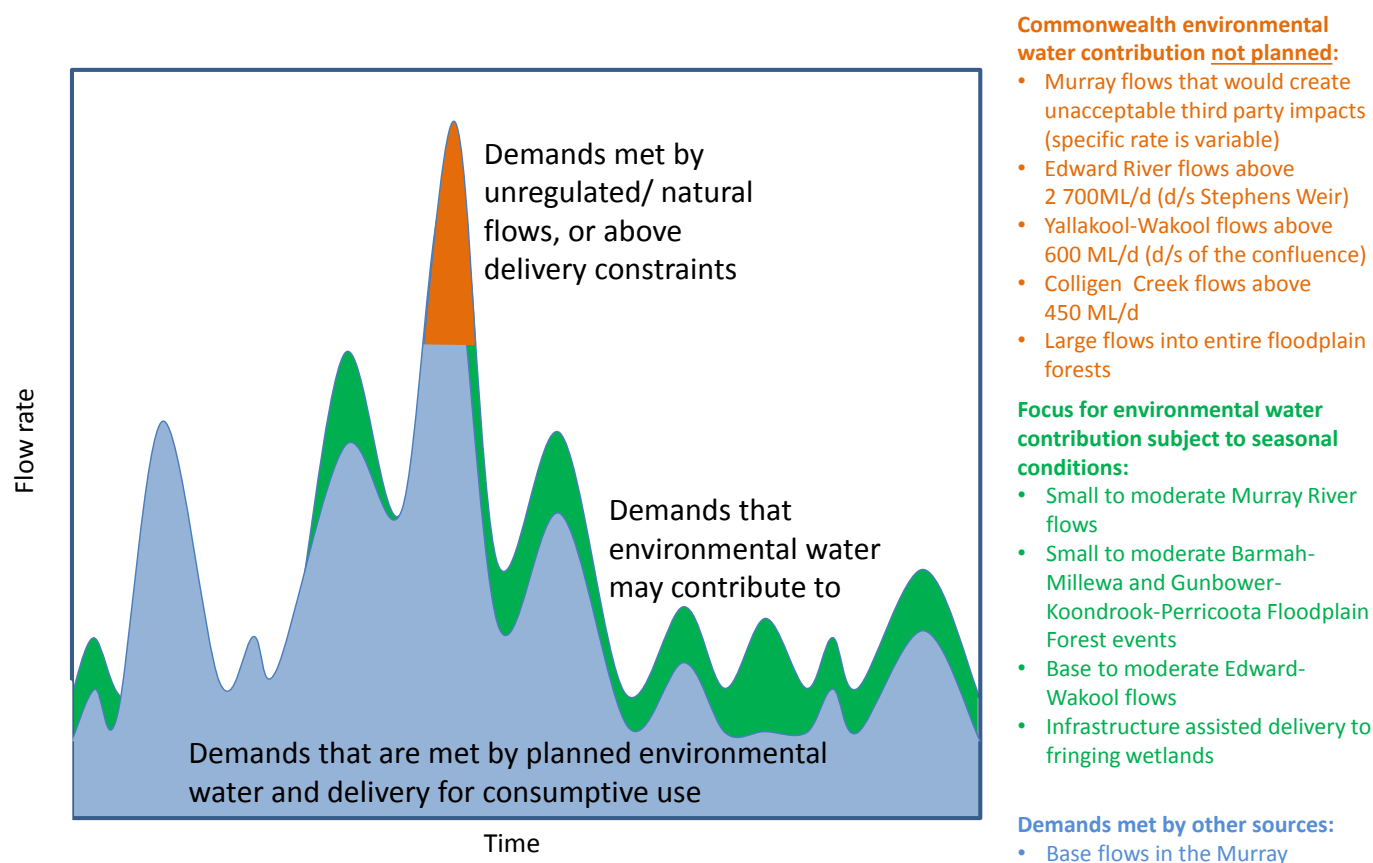
BASIN-WIDE OUTCOMES (Matters in red link to the Basin-wide environmental watering strategy, MDBA 2014)	OBJECTIVES FOR MID MURRAY ASSETS						
	IN-CHANNEL ASSETS			OFF-CHANNEL ASSETS			
	River Murray (Hume Dam to Euston)	Edward-Wakool River System	Gunbower Creek	Barmah-Millewa Forest	Gunbower-Koondrook-Perricoota Forest	Edward-Wakool Forests (e.g. Werai, Neimur)	Off-channel wetlands and ephemeral creeks
VEGETATION	Maintain riparian and in-channel vegetation condition. Increase periods of growth for non-woody vegetation communities that closely fringe or occur within river channels.			Maintain the current extent of floodplain vegetation near river channels and on low-lying areas of the floodplain. Improve condition of black box, river red gum and lignum shrublands. Improve recruitment of black box and river red gum communities. Increased periods of growth for non-woody vegetation communities that closely fringe or occur within the creek channels, and those that form extensive stands within wetlands and low-lying floodplains including Moira grasslands in Barmah-Millewa Forest.			Maintain and improve condition of wetland vegetation.
WATERBIRDS	Provide habitat and food sources to support waterbird survival and recruitment, and maintain condition and current species diversity.						
				Support naturally triggered colonial bird breeding events.			
FISH	Provide flows to support habitat (including longitudinal connectivity and bench inundation) and food sources and promote increased movement/dispersal, recruitment and survival/condition of native fish.			Provide flows to support habitat and cues for increased movement, recruitment and survival/condition of native fish (particularly for floodplain specialists).			
INVERTEBRATES	Provide habitat to support increased microinvertebrate and macroinvertebrate survival, diversity, abundance and condition.						
OTHER VERTEBRATES	Provide habitat to support survival, maintain condition and provide recruitment opportunities for frogs and turtles.						
CONNECTIVITY	Maintain lateral connectivity by contributing to an increase in the frequency of freshes, bankfull and lowland floodplain flows.						
	Maintain baseflows and increase overall flows in the River Murray. Maintain longitudinal connectivity along the River Murray to fulfil important environmental functions such as nutrient and sediment transport, organism dispersal and water quality.			Maintain connectivity through creeks and anabranches, thereby enhancing connectivity and functioning through the length of the River Murray.			
PROCESSES	Increase primary productivity, nutrient and carbon cycling, biotic dispersal and movement. Increase transport of organic matter, salt and nutrients downstream.						
WATER QUALITY	Maintain water quality and provide refuge habitat from adverse water quality events. Increase mobilisation and export of salt from the River Murray system.						
RESILIENCE	Provide drought refuge habitat and maintenance/condition of native biota.						

Information sourced from: MDBA (2014); Department of the Environment (2014); Department of the Environment (2011a-d); MDBA (2012a-f); DELWP (2015).



### 1.3. Environmental flow requirements

Not all environmental demands can and will be met through the use of held environmental water. Some demands are met by regulated water deliveries for consumptive purposes and inter-valley transfers, while others are met by large unregulated/natural flows events or are beyond what can be delivered within operational constraints. Figure 2 shows the broad environmental demands that are in scope for Commonwealth environmental water. Importantly, these are broad, indicative demands and individual watering events may contribute to particular opportunities, such as using infrastructure to deliver water to individual wetlands that would otherwise not be possible due to constraints. Also, there may be opportunities for Basin State governments to remove or modify constraints, which will improve the efficiency and/or effectiveness of environmental watering. Further information on delivery constraints are described in [Attachment B](#).



**Figure 2:** Scope of demands that environmental water may contribute to in the Mid Murray Region

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.

The Long Term Intervention Monitoring (LTIM) Project is also being undertaken in the Edward-Wakool system. It aims to understand the environmental response from Commonwealth environmental watering with respect to the targeted objectives. Information on the monitoring activities is available at: <http://www.environment.gov.au/water/cewo/catchment/mid-murray/monitoring>. Monitoring information is also provided by state governments and The Living Murray program.

Key findings and recommendations from the first two years (2014–16) of Long-Term Intervention Monitoring and previous Short Term Intervention Monitoring in the Edward-Wakool system include:

- Murray cod require stable flows of sufficient depth for spawning. Monitoring in parts of the Edward-Wakool system (e.g. Yallakool Creek) has shown that providing higher flows with the aim of inundating additional spawning habitat (such as timber/snags) did not result in increased spawning. Mapping of fish habitat in this system, especially in sites being monitored, would assist with determining what relationship, if any, may exist between flow, habitat and outcomes being targeted such as spawning and recruitment.
- Rather than being affected by flow, Murray cod recruitment may be constrained by food availability for young/juvenile fish (which is linked in turn to productivity – see point below). However, this has not been tested with very low flows (<200 ML/d) or very high (>600 ML/d) flows in this system.
- Increased flow variability is desirable, however system constraints are preventing a larger total range of flow.
- In-stream aquatic vegetation is responding well to the current flow regime, primarily due to slower recession rates. This is leading to other potential benefits to aquatic habitat.
- Due to a lack of bankfull and overbank flows that cycle nutrients and carbon through the system, primary productivity is limited in the Edward-Wakool system under current system constraints. However, flows through Barmah-Millewa, Koondrook-Pericoota and Weraí during the cooler months could provide productivity benefits.

The outcomes from these monitoring activities are used to inform portfolio management planning and adaptive management decision-making as outlined in Section 2. Our understanding of the role that the Edward-Wakool region plays in achieving outcomes for native fish continues to grow, especially in relation to the broader southern-connected Basin. For example, golden and silver perch may be using the Edward-Wakool system as a place to move into as young/juvenile fish, grow up and then move back into the Murray system to spawn elsewhere.

## 2. Portfolio management in 2017–18

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

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

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

The demand for environmental water is a reflection of the health of rivers, wetlands and floodplains, and the plants and animals they support. Ecological health is influenced by flows and conditions in the past—in some cases, this can date back many years, with parts of the environmental still showing the effects of the millennium drought.

During the 2010 to 2012 period, natural flow events and environmental watering actions resulted in improvements in the condition of many sites in the Mid Murray and promoted ecological recovery following the millennium drought. Drier conditions from 2013 to early 2016 saw some floodplain and wetland sites enter into a natural drying phase, while river flows also reduced in scale.

In 2016–17, the Mid Murray experienced widescale natural inundation. This was of benefit to wetland and floodplain vegetation and waterbird populations. However, the natural floods also caused a significant hypoxic blackwater event. While environmental water was used to mitigate the impacts on native fish populations, the hypoxic blackwater still resulted in large-scale fish kills.

For 2017–18 the demands for environmental water in the Mid Murray are represented in Table 3 and summarised below:

*River Murray Channel:* There is a moderate demand for environmental water to contribute to greater variability, and a more natural seasonality of in-channel flows for a range of outcomes (including the recovery of native fish by providing habitat, food and opportunities for spawning and movement) and to connect the river with low-lying wetlands.

*Edward-Wakool system:* There is a moderate to high demand for environmental water in the Edward-Wakool system, particularly to maintain and consolidate the benefits of previous environmental watering and natural flood events, and to support the recovery of large bodied native fish after the 2016 system wide hypoxic blackwater event. This includes winter base flows over June–August 2017 to assist with improving populations of native fish.

*Barmah-Millewa Forest:* There is a high demand in Barmah-Millewa Forest for flows to support floodplain marsh, which includes Moira grass. Moira grass has suffered long-term declines in extent. While monitoring results from 2016–17 are not yet available, advice from forest managers is that the extensive flooding of the forest generally improved the condition of existing Moira grass including some flowering and increased the extent (pers. comm. Keith Ward, Goulburn Broken CMA; Ali Borrell, NSW National Parks and Wildlife Service, 4 April 2017). Follow-up watering will be important to consolidate these results. Environmental water demands for the rest of the forest's vegetation is moderate. Elsewhere in Barmah-Millewa Forest there is a moderate demand for environmental water to provide greater connectivity between forest creeks and the main River Murray to support the recovery of large-bodied native fish populations such as Murray and trout cod. Meeting all the above demands will also support waterbird outcomes such as the provision of foraging habitat for a range of species. If a naturally-triggered colonial bird breeding event occurs there will be a high demand for environmental water to support inundation of the nesting sites through to fledging stage.

*Gunbower Creek:* There is a moderate to high demand for environmental water to contribute to variable base flows and freshes to support the survival of native fish, encourage movement of large-bodied native

fish and aquatic invertebrates, and support the mobilisation of carbon between Gunbower Creek and Gunbower Forest.

*Gunbower-Koondrook-Perricoota Forest:* Following significant environmental watering actions in 2014–15 and 2015–16, and natural overbank flooding in 2016–17 that supported floodplain fish spawning and bird breeding, there is a low demand for environmental water in Gunbower Forest. Only high value, permanent wetlands are likely to require environmental water in 2017–18. In Koondrook-Perricoota Forest there is a moderate demand for environmental water to build on the outcomes from recent natural inundation.

*Mid Murray off-channel wetlands and ephemeral creeks – Hume to Euston:* There is a moderate-high demand for environmental water in permanent wetlands along this reach, with a particular focus for environmental water use in wetlands that contain Murray hardyhead or other threatened species. In the semi-permanent wetlands, there is a moderate need to maintain aquatic vegetation and waterbird habitat, and to maintain and/or improve the condition of mature river red gum trees. There is a low demand for environmental water in the ephemeral wetlands as water has recently inundated many of these assets.

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

In contributing to these demands, the Commonwealth Environmental Water Office will also be aiming to contribute to the expected outcomes in the Basin-wide environmental watering strategy (see [Attachment A](#)) and the following 2017–18 Basin annual environmental watering priorities relevant to the Mid Murray Region.

- Support Basin-scale population recovery of native fish by reinstating flows that promote key ecological processes across local, regional and system scales for the southern connected Basin
- Support viable populations of threatened native fish and maximise opportunities for range expansion and the establishment of new populations
- Improve the abundance and diversity of the Basin's waterbird population
- Improve the condition and extent of Moira grass in Barmah-Millewa Forest
- Enable recruitment of trees and support growth of understorey species within river red gum, black box and coolibah communities on floodplains that received overbank flooding during 2016 by inundating the floodplains again

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

## **2.2. Water availability in 2017–18**

### **Forecasts of Commonwealth water allocations**

The volume of Commonwealth environmental water likely to be carried over in the Mid Murray Region for use in 2017–18 is estimated to be 182.1 GL. Total carryover in the southern-connected Basin is estimated to be 300–310 GL.

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

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

Entitlement type	Forecasts of Commonwealth water allocations (including carryover) in 2017–18 (GL) <sup>2</sup>					
	Very dry ←————→					Very wet
	95 percentile	90 percentile	75 percentile	50 percentile	25 percentile	10 percentile
NSW Murray (High/Conveyance /General security) (includes lower Darling)	68	179	211	409	409	408
Murray <sup>3</sup> (Victorian High/ low reliability)	309	410	410	411	385	346
Murray (South Australian High security)	152	152	152	152	152	152
<b>Total – Murray</b>	<b>529</b>	<b>741</b>	<b>773</b>	<b>972</b>	<b>946</b>	<b>906</b>
<b>Total – Southern- connected Basin<sup>1</sup></b>	<b>861</b>	<b>1273</b>	<b>1376</b>	<b>1614</b>	<b>1577</b>	<b>1526</b>

Notes:

1. The southern-connected Basin includes the Murrumbidgee, Murray, Lower Darling, Goulburn, Campaspe (excluding Coliban) and Loddon entitlements.
2. Forecasts for regulated catchments are given to the nearest whole gigalitre except where the entitlement held by the Commonwealth is below 1 GL.
3. Total forecast water available in the southern-connected Basin assumes that in Victoria 100 per cent of water held in spillable accounts becomes available under a median or dry scenario and 50 per cent or less becomes available under wetter scenarios. These figures do not include supplementary, unregulated or ground water accruals in the southern-connected Basin.

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

## Water resource availability scenarios

Commonwealth environmental water is not managed in isolation. When considering the available resource to meet environmental demands, it is necessary to also factor in the resources managed by other entities which are available to contribute to environmental objectives. Relevant resources include portfolios held by the NSW Office of Environment and Heritage, Victorian Environmental Water Holder, The Living Murray program, the River Murray Increased Flows program, planned environmental water, natural and unregulated flows, conveyance water and consumptive water. Further detail on sources of environmental water in the Mid Murray Region is provided in Attachment C.

By combining the forecasts of water held by the Commonwealth with streamflow forecasts, as well as taking into account operational considerations, water resource availability scenarios can be developed ranging from very low to very high. Based on available information moderate to very high resource availability scenarios are in scope for 2017–18.

## 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 Mid Murray Region for 2017–18 is to maintain and/or improve the condition of environmental assets.

Overall environmental water resource availability	Demand for environmental water				
	Very High – 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		
Low					
Moderate				Maintain ecological health and resilience	
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 Mid Murray Region for 2017–18. Note: grey lines represent potential range in demand and resource availability.

Further detail on how the overall purpose for portfolio management changes under different supply and demand scenarios is provided in *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2017–18* (available at: <http://www.environment.gov.au/water/cewo/publications>).

## 2.4. Water Delivery in 2017–18

Consistent with the demands and purpose described above, the Office is considering supplying environmental water to the following watering actions for 2017–18 (see also Table 3 for supporting information regarding the basis for determining these watering intentions). Specific information on the operational arrangements are provided in [Attachment B](#).

### **River Murray Channel and Barmah-Millewa Forest 2017–18 (See [Attachment B](#), Table 4 options 1a, 1b and 2)**

Environmental water is expected to be delivered as a River Murray ‘whole of system’ flows in 2017–18. Similar to the approach followed in 2016–17, watering will be guided by natural hydrological triggers (rainfall and inflows) in order to reinstate a portion of the entire flow regime throughout the year. The ‘whole of system’ flows will be scalable so that the environmental watering is responsive to seasonal and operational conditions, the scale of hydrological cues and water availability.

This means that if conditions are wet, environmental water may be used for modest floodplain watering events (limited to flow rates that avoid adverse third party impacts) for outcomes such as floodplain fish breeding and recruitment, full reproductive cycles of important floodplain vegetation species, such as Moira grass, and completion of waterbird breeding events. Floodplain watering may also promote productivity and nutrient cycling processes. If conditions are dry and inflow triggers are small, environmental watering will be focused on in-stream watering, such as in-channel flow variability and periodic connectivity with low-lying anabranches and wetlands (to support fish habitat, movement and condition and riparian and wetland floodplain vegetation, and ecological productivity).

Following natural cues is also likely to see water being delivered most of the year. Maintaining year-round variable base flows is important for providing habitat and food for native fish.

Environmental flows moving through the system will be able to be used to support other actions that are considered seasonally appropriate, such as weir pool raising or drawdown or delivery to off-channel wetland sites. River Murray ‘whole of system’ flows are also planned to be co-ordinated with watering actions occurring in the Edward-Wakool, Goulburn, Murrumbidgee and lower Darling catchments to target system-wide environmental benefits.

### **Edward-Wakool System 2017–18 (Table 4 options 3a – 3c)**

*Permanent Waterways:* The purpose of watering events would be to maintain in-stream habitat, particularly aquatic vegetation and areas supporting the various life stages of native fish. Environmental water use is most likely to contribute to in-channel base flows and freshes. It may also be used to provide a more gradual recession following periods of high flow (e.g. rain rejection flows) and improve water quality to provide refuges for aquatic plants and animals if required and where feasible to do so.

*Ephemeral waterways and wetlands:* The purpose of watering events would be to maintain ephemeral in-stream and wetland habitat, particularly water quality, aquatic vegetation and areas supporting the various life stages of native frogs, birds and aquatic invertebrates.

*Edward-Wakool forests:* The purpose of watering events would be to protect or maintain vegetation health and to contribute to hydrological connectivity and nutrient/carbon cycling processes.

### **Gunbower Creek 2017–18 (Table 4 option 4)**

Environmental water will contribute to year-round variable base flows and freshes to support the survival of juvenile native fish, and encourage movement of large-bodied native fish, aquatic invertebrates and, support the mobilisation of carbon between Gunbower Creek, Gunbower Forest and the River Murray. Consumptive water will be used to provide some of the flows, with environmental water accounting for any losses associated with the delivery of consumptive water en route in Gunbower Creek.



## Gunbower-Koondrook-Perricoota Forest 2017–18 (Table 4 options 5-6)

Given the low demands in Gunbower Forest, it is unlikely that Commonwealth environmental water will be delivered to this site in 2017–18. Any water needed to support permanent wetland sites will likely be met by other water holders.

While there is a moderate demand for water in Koondrook-Perricoota Forest, Commonwealth environmental water is unlikely to be used at the site unless issues regarding potential third party impacts are resolved.

## Mid Murray off-channel wetlands and ephemeral creeks 2017–18 (Table 4 option 7)

It is anticipated that demands will be met by a number of water holders in 2017–18. Commonwealth environmental water may be provided to several wetlands, consistent with local planning processes managed by state delivery partners.

## Stakeholder Feedback

The demands and watering actions have been developed based on input from and/or consultation with key partners including: NSW Office of Environment and Heritage, Victorian Environmental Water Holder, Victorian Catchment Management Authorities, WaterNSW, NSW Department of Primary Industries – Fisheries, NSW National Parks and Wildlife, the Murray–Darling Basin Authority, the Murray–Darling Wetlands Working Group, scientists engaged in monitoring the outcomes of Commonwealth environmental water use, the Edward-Wakool Environmental Water Reference Group, the Murray-Lower Darling Environmental Water Advisory Group, and various community groups and individuals. A number of comments were received, with stakeholders supportive overall of the proposed approach. Feedback will be sought on an ongoing basis as planning transitions to implementation phase.

## 2.5. Trading water in 2017–18

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

As part of the portfolio management process, the Commonwealth Environmental Water Office regularly assesses environmental demand and supply throughout the year, considering factors such as environmental condition and demand, current and forecast climate conditions and water availability, carryover capacity and market conditions.

Where the need arises to adjust the availability of allocations in any valley in the southern-connected Basin for environmental use, the transfer of allocations from another southern connected catchment would be explored as the preferred and more efficient option to allocation purchase or sale. The transfer would be undertaken consistent with the rules identified in state water resource plans that apply to all water users. Possible third party impacts from portfolio transfers are considered when trade limits apply.

The Mid-Murray Region includes trade zones 6, 6B, 7, 10A, 10B and 11. In 2017–18, possible administrative transfers between environmental water accounts to enable environmental water delivery include:

- large (> 100 GL) **within** trade zones, due to the large size of environmental watering activities;
- small (~30 GL) **within** trade zones for smaller environmental watering activities;
- moderate (~50 GL) **through the Barmah choke** from trade zones 6, 10A or 10B, if required and allowable given Barmah Choke trade limit.

In the southern Basin, water allocation outlook statements are forecasting high allocations early in the season, and opportunities to sell allocation may arise in 2017–18. The issue of whether to sell will be considered once there is greater certainty regarding environmental use during the peak winter-spring demand period, most likely from October 2017 onwards. Should a decision be made to sell allocation,

further information will be made available at: <http://www.environment.gov.au/water/cewo/trade/current-trading-actions>

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

## **2.6. Carrying over water for use in 2018–19**

The volume of water carried over for use in 2018–19 will depend upon resource availability and demand throughout the year. A carryover volume of 300–310 GL across the southern-connected Basin is being targeted to help meet early season water requirements and as a risk management strategy should low inflows result in low allocations in 2018–19. As documented in Table 3 below, potential demands early in 2018–19 that may require carryover to support include small contributions to winter or early spring flows through the River Murray, Gunbower Creek and/or Edward-Wakool River systems.

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 the best information available at the time.

Given the connected nature of southern Murray-Darling Basin catchments and the varying carryover, account and use limits, carryover is considered at a broader scale than just the Mid Murray Region. 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**

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

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

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

**Table 3a:** Environmental demands, priority for watering in 2017–18 and outlook for coming years in the Mid Murray Region – **MODERATE WATER RESOURCE AVAILABILITY (HIGH ALLOCATION, LOW INFLOW) IN 2017–18**

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history (from all sources of water)			2017–18			Implications for future demands		
						Predominant urgency of environmental demand for water	Purpose under <u>moderate</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19
	Flow/volume	Required frequency (maximum dry interval)	2014–15 (drying)	2015–16 (dry)	2016–17 (wet)						Not met in 2018–19
River Murray from Hume Dam to Euston and Barmah-Millewa Forest <sup>1</sup>	2,000-4,000 ML/d @ Yarrawonga Weir throughout year for fish habitat and water quality in main river channel and Barmah-Millewa creeks.	Continuous requirement.				Moderate	Maintain	High likelihood of being met via a combination of natural flows, consumptive deliveries and environmental water throughout most months of the year.	Moderate	Moderate	
										High	
	12,000 ML/day @ Yarrawonga Weir for at least 7 days and up to 70 days in winter/spring targeting in-channel outcomes and anabranches.	4 in 5 years (4 years).				Moderate	Maintain	High likelihood of being met via a combination of natural flows, consumptive deliveries and environmental water. Even without overbank flows, some Commonwealth environmental water may be delivered to low-lying creeks and anabranches for drought refuge.	Low	Low	
										Moderate	
	16,000 ML/day @ Yarrawonga Weir for at least 7 days and up to 100-150 days in winter/spring targeting in-channel outcomes and giant rush wetlands.	1 in 2-3 years (5-6 years).				Moderate	Maintain	Moderate likelihood of being met via a combination of natural flows, consumptive deliveries and environmental water (Commonwealth environmental water deliveries limited to flow rates that manage third party impacts).	Low	Low	
										Moderate	
Edward-Wakool River System <sup>5</sup>  (further detail on Edward-Wakool sites is provided at Attachment D)	Permanent waterways.	Annually.				Moderate	Maintain	A high potential for environmental water to contribute to this action to continue system recovery and support native fish communities.	Moderate	Moderate	
										High	
	Ephemeral waterways and wetlands.	1 in 2 years (3 years) for aquatic vegetation and water quality.				Moderate	Maintain	Likely to be watered in partnership with NSW OEH to contribute to improving riparian health and water quality.	Moderate	Moderate	
										Moderate	
	Forests.	2-3 in 5 years (6 years) for river red gums.				Moderate Weraí Forest, which, unlike Barmah-Millewa or Koondrook-Perricoota forests, had not received environmental water or significant inundation until the 2016 flood.	Maintain	More extensive watering could be considered in future years, subject to operational delivery infrastructure, third party impacts and return flows being addressed.	Moderate	Low	
										High	
Gunbower Creek <sup>2</sup>	Winter low flow and summer ramp down to support juvenile fish and maintain habitat connectivity during off-irrigation season: • Winter base flow (up to 400 ML/day @ Gunbower weir for 90 days). Net use ~8,000 ML.	Annually (1 year).		Magnitude reached but not for full duration.		High Base flow of sufficient magnitude and duration required for maintaining Murray cod population.	Protect	A high potential to support native fish communities.	High	High	
										High	
	Spring pulse and stable summer flows for fish breeding: • Base-flow of up to 550 ML/day in spring. • High flow to 700 ML/day for 120 days in spring/summer. • Summer low flow up to 300 ML/day for 60 days in summer/autumn. Net use ~ 17,000 ML.	Fish spawning fresh 2 in 3 years.		Base flow met. Fresh magnitude reached but not for full duration.		Moderate Elevated flows within the creek are required in most years to support native fish spawning to maintain the diversity and condition of small and large-bodied native fish populations.	Maintain	A high potential to support native fish communities.	Moderate	Moderate	
										High	

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history (from all sources of water)			2017–18			Implications for future demands				
						Predominant urgency of environmental demand for water	Purpose under <u>moderate</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19		
	Flow/volume	Required frequency (maximum dry interval)	2014–15 (drying)	2015–16 (dry)	2016–17 (wet)						Not met in 2018–19		
Gunbower-Koondrook-Perricoota Forest <sup>3</sup>	Small-moderate action (25,000 ML/day @ Torrumbarry Weir for at least 20 days and up to 150 days in winter/spring) targeting permanent and semi-permanent wetlands, or targeted infrastructure use at the sites.	~3,000 ha via Gunbower Forest infrastructure.	6-9 in 10 years (2 years)	Gunbower	Gunbower – ~3,000 ha inundated		Low Significant watering action in 2014–15 and 2015–16 and natural flood event in 2016–17 inundated various wetlands in Gunbower Forest. A drying phase across the majority of the floodplain is planned for 2017-18, with the exception of high value, permanent wetlands.	Maintain	A drying phase across the majority of the floodplain is likely for 2017–18. If required, it is anticipated that demands in Gunbower Forest will be met primarily by other water holders in 2017–18.	Moderate – following proposed drying for Gunbower Forest in 2017–18 (unless a natural event occurs to allow 'piggybacking' of environmental water).	Low		
		Moderate											
		~8,000 ha via Koondrook-Perricoota Forest infrastructure.		Koondrook-Perricoota	Koondrook-Perricoota		Moderate Site requires further water to consolidate benefits from natural inundation in 2016–17.		Commonwealth environmental water unlikely to be used in this area unless third party impacts are resolved. If watering proceeds it is anticipated that demands in Koondrook-Perricoota Forest will be met in partnership with other water holders.	Moderate	Moderate		
		High											
		Infrastructure delivery to Gunbower and Koondrook-Perricoota Forests targeting river red gum forest equivalent to around 27-35,000 ML/day @ Torrumbarry Weir.	Up to 4,000 ha via Gunbower Forest infrastructure.	1 in 3-4 years (3 years).	Gunbower	Gunbower – ~3,000 ha inundated		Low	Maintain	As per small Gunbower option above.	Moderate – following proposed drying for Gunbower Forest in 2017–18 (unless a natural event occurs to allow 'piggybacking' of environmental water).	Low	
			Moderate										
		Up to 16,000 ha via Koondrook-Perricoota Forest infrastructure.		Koondrook-Perricoota	Koondrook-Perricoota		Moderate Site requires further water to consolidate benefits from natural iniundation in 2016–17.		As per small Koondrook-Perricoota option above.	Moderate	Moderate		
		High											
Mid Murray Off-Channel Wetlands and ephemeral creeks Hume to Euston <sup>4</sup>	Infrastructure delivery targeting <b>permanent</b> off-channel wetlands.	Annually				High Requirement for water to manage salinity to provide suitable habitat for threatened species, such as the Murray hardyhead.	Protect	Commonwealth environmental water may be provided, along with water supplied by other water holders.		High	High		
	Critical												
	Infrastructure delivery targeting <b>semi-Permanent</b> <sup>2</sup> off-channel wetlands.	3-7 in 10 years (5 years).				Moderate Requirement for water at some sites to support waterbirds and flora / fauna typical of a deepwater marsh, while other sites are ready for a drying phase.	Maintain			Low	Moderate		
	Moderate												
	Infrastructure delivery targeting <b>ephemeral</b> off-channel wetlands.	1 in 5 years.				Low Water delivered to most ephemeral Central Murray Wetlands in previous years and drawdown / drying phases are ensuing in some wetlands. Top up flows / partial fills may be provided, subject to water availability.	Maintain			Low	Moderate		
											Moderate		

Key - events in previous years

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

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

Key - potential watering in 2017-18

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

Key - urgency of environmental demands

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

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



**Table 3b:** Environmental demands, priority for watering in 2017–18 and outlook for coming years in the Mid Murray Region – **HIGH/VERY HIGH WATER RESOURCE AVAILABILITY (HIGH ALLOCATION, MODERATE/HIGH INFLOW) IN 2017–18**

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history (from all sources of water)			2017–18			Implications for future demands		
						Predominant urgency of environmental demand for water	Purpose under <u>high</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19
	Flow/volume	Required frequency (maximum dry interval)	2014–15 (mod)	2015–16 (drying)	2016–17 (dry)						Not met in 2018–19
River Murray from Hume Dam to Euston and Barmah-Millewa Forest <sup>1</sup>	2,000-4,000 ML/day @ Yarrawonga Weir throughout year for fish habitat and water quality in main river channel and Barmah-Millewa creeks.	Continuous requirement.				Moderate	Improve	High likelihood of being met via a combination of natural flows, consumptive deliveries and environmental water.	Moderate	Moderate	
										High	
	12,000 ML/day @ Yarrawonga Weir for at least 7 days and up to 70 days in winter/spring targeting in-channel outcomes and anabranches.	4 in 5 years (4 years).				Moderate	Improve	High likelihood of being met via a combination of natural flows, consumptive deliveries and environmental water. Even without overbank flows, some Commonwealth environmental water may be delivered to low-lying creeks and anabranches for drought refuge.	Moderate	Low	
										Moderate	
	16,000 ML/day @ Yarrawonga Weir for at least 7 days and up to 100-150 days in winter/spring targeting in-channel outcomes and giant rush wetlands.	1 in 2-3 years (5-6 years).				Moderate	Improve	High likelihood of being met via a combination of natural flows, consumptive deliveries and environmental water (Commonwealth environmental water deliveries limited to flow rates that manage third party impacts).	Low	Low	
										Moderate	
	25,000-35,000 ML/day @ Yarrawonga Weir (unregulated flow) for at least 7 days (river red gum forest) and followed by flows of 18,000 ML/day, or greater, for three to five months targeting Moira grassland.	2-3 in 5 years (6 years) for river red gums.  Annual (2 years) for Moira grass.				High Flows of sufficient magnitude and duration required to maintain the extent of Moira grass in both Barmah and Millewa forests.	Improve	Requires significant natural flow trigger, with Commonwealth environmental water contribution limited to recession component. Note operational challenges identified in Attachment B.	Moderate	Moderate	
										High	
Edward-Wakool River System <sup>5</sup>  (further detail on Edward-Wakool sites is provided at Attachment D)	Permanent waterways.	Annually.				Moderate	Improve	A high potential for environmental water to contribute to this action to continue system recovery and support native fish communities.	Moderate	Moderate	
										High	
	Ephemeral waterways and wetlands.	1 in 2 years (3 years) for aquatic vegetation and water quality.				Moderate	Improve	Likely to be watered in partnership with NSW OEH to contribute to improving riparian health and water quality.	Moderate	Moderate	
										Moderate	
	Forests.	2-3 in 5 years (6 years) for river red gums.				Moderate Werai Forest, which, unlike Barmah-Millewa or Koondrook-Perricoota forests, had not received environmental water or significant inundation until the 2016 flood.	Improve	More extensive watering could be considered in future years, subject to operational delivery infrastructure, third party impacts and return flows being addressed.	Moderate	Low	
										High	
Gunbower Creek <sup>2</sup>	Winter low flow and summer ramp down to support juvenile fish and maintain habitat connectivity during off-irrigation season: • Winter base flow (up to 400 ML/day @ Gunbower Weir for 90 days). Net use ~8,000 ML	Annually (1 year).		Magnitude reached but not for full duration.		High Base flow of sufficient magnitude and duration urgently required for maintaining Murray cod population.	Improve	A high potential to support native fish communities.	High	High	
										High	
	Spring pulse and stable summer flows for fish breeding: • Base-flow of up to 550 ML/day in spring • High flow up to 700 ML/day for 120 days in spring/summer. • Summer low flow up to 300 ML/day for 60 days in summer/autumn.	Fish spawning fresh 2 in 3 years.		Base flow met. Fresh magnitude reached but not for full duration.		Moderate Elevated flows within the creek are required in most years to support native fish spawning to maintain the diversity and condition of small and large-bodied native fish populations.	Improve	A high potential to support native fish communities.	Moderate	Moderate	
										High	

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history (from all sources of water)			2017–18			Implications for future demands					
	Flow/volume		Required frequency (maximum dry interval)	2014–15	2015–16	2016–17	Predominant urgency of environmental demand for water	Purpose under <u>high</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2018–19 if watering occurred as planned in 2017–18	2019–20 Range of likely demand	Met in 2018–19		
				(mod)	(drying)	(dry)						Not met in 2018–19		
Gunbower-Koondrook-Perricoota Forest <sup>3</sup>	Small-moderate action (25,000 ML/day @ Torrumbarry Weir for at least 20 days and up to 150 days in winter/spring) targeting permanent and semi-permanent wetlands.	~3,000 ha via Gunbower Forest infrastructure.	6-9 in 10 years (2 years).	Gunbower	Gunbower ~3,000 ha inundated	Gunbower	Low Significant watering action in 2014–15 and 2015–16 and natural flood event in 2016–17 inundated various wetlands in Gunbower Forest. A drying phase across the majority of the floodplain is planned for 2017–18, with the exception of high value, permanent wetlands.	Improve	A drying phase across the majority of the floodplain is likely for 2017–18. If required, it is anticipated that demands in Gunbower Forest will be met primarily by other water holders in 2017-18.	Moderate – following proposed drying for Gunbower Forest in 2017–18 (unless a natural event occurs to allow 'piggybacking' of environmental water).	Low			
		~8,000 ha via Koondrook-Perricoota Forest infrastructure.		Koondrook-Perricoota	Koondrook-Perricoota	Koondrook-Perricoota	Moderate Site requires further water to consolidate benefits from natural inundation in 2016–17.		Commonwealth environmental water unlikely to be used in this area unless third party impacts are resolved. If watering proceeds it is anticipated that demands in Koondrook-Perricoota Forest will be met in partnership with other water holders.	Moderate-High	Moderate	High		
	Infrastructure delivery to Gunbower and Koondrook-Perricoota Forests targeting river red gum forest equivalent to around 27-35,000 ML/day @ Torrumbarry.	Up to 4,000 ha via Gunbower Forest infrastructure.	1 in 3-4 years (3 years).	Gunbower	Gunbower ~3,000 ha inundated		Low	Improve	As per small Gunbower option above.	Moderate – following proposed drying for Gunbower Forest in 2017–18 (unless a natural event occurs to allow 'piggybacking' of environmental water).	Low			
		Up to 16,000 ha via Koondrook-Perricoota Forest infrastructure.		Koondrook-Perricoota	Koondrook-Perricoota		Moderate Site requires further water to consolidate benefits from natural inundation in 2016–17.		As per small Koondrook-Perricoota option above.	Moderate-High	Moderate	High		
	Mid Murray Off-Channel Wetlands and ephemeral creeks Hume to Euston <sup>4</sup>	Infrastructure delivery targeting <b>permanent</b> off-channel wetlands.	Annually.				High Requirement for water to manage salinity to provide suitable habitat for threatened species, such as the Murray hardyhead.	Improve	Commonwealth environmental water may be provided, along with water supplied by other water holders.	High	High	High	Critical	
		Infrastructure delivery targeting <b>semi-Permanent</b> <sup>2</sup> off-channel wetlands.	3-7 in 10 years (5 years).				Moderate Requirement for water at some sites to support waterbirds and flora / fauna typical of a deepwater marsh. Other sites are ready for a drying phase.	Improve		Low	Moderate	Moderate		
Infrastructure delivery targeting <b>ephemeral</b> off-channel wetlands.		1 in 5 years.				Low Water delivered to most ephemeral Central Murray Wetlands in previous years and drawdown / drying phases are ensuing in some wetlands. Top up flows / partial fills may be provided, subject to water availability.	Maintain	Low		Moderate	Moderate			
						Critical Habitat Flows	Where feasible and effective to do so, provide critical refuge for aquatic species such as large bodied native fish during hypoxic events.							
						Carryover potential	A carryover target of 300–10 GL for the Southern-connected Basin is being targeted to meet early season water requirements in 2018–19 (See Section 2.6)							
						Trade potential	Under high and very high water resource availability scenarios, there may be an opportunity to sell allocations (subject to an assessment that a reasonable level of supply or demand exists within the water market). The issue of whether to sell allocation will be considered once there is greater certainty regarding environmental water use during the winter-spring period, most likely from October 2017 onwards. (see section 2.5)							
						References	1. Murray and Barmah-Millewa Forest indicators adapted from Department of the Environment (2011a), MDBA (2012d) and DPI Fisheries 2016. 2. Sourced from North Central CMA (2013; 2014b; 2015b; 2016b; 2017). 3. Adapted from MDBA (2012c), MDBA 2012 (f), Department of the Environment (2011d). 4. Sourced from North Central CMA (2014a; 2015a; 2016a). 5. Compiled using multiple sources (Hale & SKM 2011; Watts et al 2013; Watts et al 2014; Watts et al 2015; Webster 2010). Previous watering actions and their outcomes have also been used for all indicators.							
<b>Key - events in previous years</b> <div><div></div> means demand was met by Commonwealth environmental water or any other source <div></div> means demand was partially met by Commonwealth environmental water or any other source (may be used to indicate infrastructure assisted delivery) <div></div> means water not provided (or not required) Note that not all demands require water every year; drying phases are important for floodplains and temporary wetlands or streams</div> <div><b>Key - potential watering in 2017-18</b> <div></div> means a high priority for Commonwealth environmental watering (full or partial contribution, and subject to seasonal and operational considerations) <div></div> means a secondary priority for Commonwealth environmental watering, likely to be met via other means (other water holders, or natural flows) <div></div> means a low priority for Commonwealth environmental watering</div> <div><b>Key - urgency of environmental demands</b> <div></div> means critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage <div></div> means high demand for water i.e. needed in that particular year <div></div> means moderate demand for water i.e. water needed that particular year and/or next <div></div> means low demand for water i.e. water generally not needed that particular year <div></div> means very low demand for water i.e. water generally not needed that particular year or the following year Note that demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime</div>														

Key - events in previous years

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

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

Key - potential watering in 2017-18

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

Key - urgency of environmental demands

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

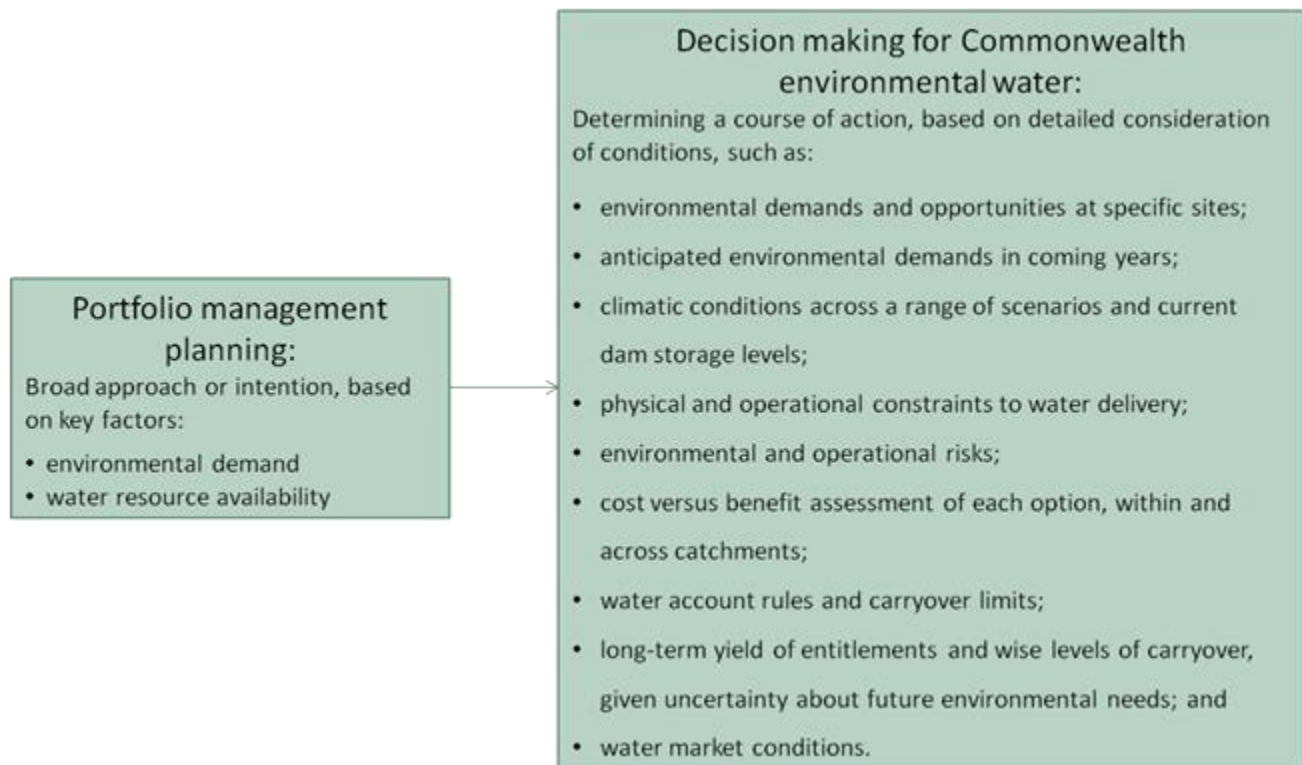
Note that demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime

## 3. Next steps

### 3.1. From planning to decision making

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

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



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

### 3.2. Further information

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

Or the sites below:

- Water use: [www.environment.gov.au/topics/water/commonwealth-environmental-water-office/assessment-framework](http://www.environment.gov.au/topics/water/commonwealth-environmental-water-office/assessment-framework)
- Carryover: <http://www.environment.gov.au/topics/water/commonwealth-environmental-water-office/portfolio-management/carryover>
- Trade: *Discussion Paper – Trade of Commonwealth Environmental Water and Commonwealth Environmental Water Trading Framework*: <http://www.environment.gov.au/water/cewo/trade/trading-framework>



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

Expected outcomes from the Basin-wide Environmental Watering Strategy (MDBA 2014) that are relevant to the Mid Murray Region are described below.

## RIVER FLOWS AND CONNECTIVITY

Base flows are at least 60 per cent of the natural level.

Contributing to a 30 per cent overall increase in flows in the River Murray.

A 30–60 per cent increase in the frequency of freshes, bankfull and lowland floodplain flows.

## VEGETATION

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

Improve condition of black box, river red gum and lignum shrublands.

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

Increased periods of growth for non-woody vegetation communities that closely fringe or occur within the river and creek channels, and those that form extensive stands within wetlands and low-lying floodplains including Moira grasslands in Barmah–Millewa Forest.

### Vegetation extent

Region	Area of river red gum (ha)	Area of black box (ha)	Area of coolibah (ha)	Shrublands	Non-woody water dependent vegetation
Murray (assessment is for entire Murray catchment)	90,600*	41,700*	-	Lignum along the River Murray from the junction with the Wakool River to downstream of Lock 3, including Chowilla and Hattah Lakes	Closely fringing or occurring within the Murray, Edward, Kiewa, Mitta Mitta, Niemur and Wakool rivers and Tuppall Creek; Moira grasslands in the Barmah–Millewa Forest

### Black box condition

Region	Vegetation condition score		Percent of vegetation assessed (within the managed floodplain)
	0 – 6	>6 – 10	
Murray (assessment is for entire Murray catchment)	33 per cent	65 per cent	28 per cent

### River red gum condition

Region	Vegetation condition score					Percent of vegetation assessed (within the managed floodplain)
	0 – 2	>2 – 4	>4 – 6	>6 – 8	>8 – 10	
Murray (assessment is for entire Murray catchment)	2 per cent	1 per cent	10 per cent	51 per cent	35 per cent	51 per cent

## 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 Mid Murray

Environmental asset	Total abundance and diversity	Drought refuge	Colonial waterbird breeding	Shorebird abundance	In scope for C'th watering
Gunbower–Koondrook–Perricoota			*		Yes
Kerang wetlands	*				Yes
Barmah–Millewa	*		*		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 1–2 years.
- Moderate to long-lived with a spread of age classes and annual recruitment in at least 80 per cent of years.

Increased movements of key species.

Expanded distribution of key species and populations.

### Key species for the Mid Murray

Species	Specific outcomes	In-scope for C'th water in the Mid Murray?
Flathead galaxias ( <i>Galaxias rostratus</i> )	Expand the core range in the wetlands of the River Murray.	Yes
Freshwater catfish ( <i>Tandanus tandanus</i> )	Expand the core range in Columbo-Billabong Creek and Wakool system	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 peelii</i> )	A 10–15 per cent increase of mature fish (of legal take size) in key populations	Yes
Murray hardyhead ( <i>Craterocephalus fluviatilis</i> )	Expand the range of at least two current populations. Establish 3–4 additional populations, with at least one in the Mid Murray conservation unit.	Yes
Olive perchlet ( <i>Ambassis agassizii</i> )	Olive perchlet are considered extinct in the southern Basin. Reintroduction using northern populations is the main option for recovery. Candidate sites may result from improved flow that reinstates suitable habitat in the River Murray.	Restoration of flow to River Murray could support the future reintroduction of the species.

Species	Specific outcomes	In-scope for C'th water in the Mid Murray?
River blackfish ( <i>Gadopsis marmoratus</i> )	Expand the range of current populations from the Mulwala canal	Yes
Silver perch ( <i>Bidyanus bidyanus</i> )	Expand the core range within the River Murray (Yarrawonga–Euston)	Yes
Southern purple-spotted gudgeon ( <i>Mogurnda adspersa</i> )	-	Yes
Southern pygmy perch ( <i>Nannoperca australis</i> )	Expand the range of current populations at Barmah-Millewa and other Mid Murray wetlands	Yes
Trout cod ( <i>Maccullochella macquariensis</i> )	Expand the range of trout cod up the Murray upstream of Lake Mulwala and into the Kiewa River. For the connected population of the Murrumbidgee–Murray–Edwards: continue downstream expansion.	Yes
Two-spined blackfish ( <i>Gadopsis bispinosus</i> )	Establish additional populations (no specific locations identified)	Yes

#### Important Basin environmental assets for native fish in the Mid Murray

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge	In-scope for C'th water
Koondrook–Perricoota	*	*	*	*	*		Yes
Gunbower	*	*	*	*	*		Yes
Barmah–Millewa	*	*	*	*	*	*	Yes
Edward–Wakool system	*		*	*		*	Yes
Weraï Forest			*	*			Yes
Billabong–Yanco–Columbo Creeks		*	*	*	*	*	Yes
Lake Mulwala	*		*	*	*	*	Yes

# Attachment B – Library of watering actions

## Operational considerations in the Mid Murray Region

The delivery of environmental water in the Mid Murray is currently constrained by the release capacities from storages, channel capacities and system constraints. Relevant constraints to be considered include:

- To avoid unseasonable inundation of Barmah-Millewa Forest during summer, delivery through the Barmah Choke is limited to approximately 10 300 ML/day downstream of Yarrawonga.
- The delivery of Commonwealth environmental water in the Mid Murray is affected by constraints in the tributaries of the Mid Murray, particularly the Goulburn River. Releases on major tributaries (to avoid unacceptable third party impacts) may limit the delivery of water to Mid Murray Region sites.
- Channel capacity may limit the delivery of Commonwealth environmental water in certain parts of the Mid Murray Region. On the River Murray main channel there are various flow constraints to avoid the inundation of property and privately owned infrastructure. At Deniliquin, flows in the Edward River above 17 100 ML/day result in minor flood events (MDBA 2013).

Further information about constraints in the Mid Murray Region can be found in the *Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2003* (NSW) (pt 10 cls 51) and *Constraints Management Strategy 2013 to 2024* (MDBA 2013).

## 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 Mid Murray Region and the levels of water resource availability that relate to these actions.

**Table 4:** Summary of potential watering actions for the Mid Murray Region

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
River Murray from Hume Dam to Euston	2,000-4,000 ML/day at Yarrawonga Weir throughout year for fish habitat and water quality in main river channel and Barmah-Millewa creeks.	1a. Mid River Murray Channel Flow: Contribute to low-level in-stream flows where required to provide fish habitat and water quality outcomes, and to re-connect river with low-lying wetlands and creeks, subject to appropriate trigger.				
	12,000 ML/day at Yarrawonga Weir for at least 7 days and up to 70 days in winter/spring targeting in-channel outcomes and anabranches.  16,000 ML/day at Yarrawonga Weir for at least 7 days to 100-150 days in winter/spring targeting in-channel outcomes and giant rush wetlands.		1b. Mid River Murray Channel Flow: Contribute to in-stream flows to promote fish movement, condition, spawning and recruitment of flow specialists and floodplain fish species and to re-connect river with low-lying wetlands and creeks, subject to appropriate trigger.			
Barmah-Millewa Forest	25,000-35,000 ML/day at Yarrawonga Weir (unregulated flow) for at least 7 days (river red gum forest) and followed by 15,000 ML/day flows for three to five months targeting Moira grassland.		2. Barmah-Millewa Forest Flow: Contribute to an overbank flow (15,000-18,000 ML/day following large unregulated peak) to inundate up to 35,000 ha of floodplain and river red gum; to promote fish movement, condition, spawning and recruitment of some fish species (flow and floodplain specialists); and to support completion of naturally triggered bird breeding events.			
Edward-Wakool River System	Permanent waterways.	3a. To maintain in-stream habitat, particularly aquatic vegetation and areas supporting the various life stages of native fish. Environmental water use is most likely to contribute to in-channel base flows and freshes. It may also be used to provide a more gradual recession to periods of high flow (e.g. rain rejection flows) and improve water quality.				
	Ephemeral waterways and wetlands.	3b. To maintain ephemeral in-stream and wetland habitat, particularly water quality, aquatic vegetation and areas supporting the various life stages of native fish, frogs, birds and aquatic invertebrates.				
	Forests.			3c. To maintain vegetation health and to contribute to hydrological connectivity and nutrient/carbon cycling processes.		



Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
<b>Gunbower Creek</b>	<p>Winter baseflows of up to 400 ML/day for 90 days and summer/autumn ramp down 300 ML/day for 60 days.</p> <p>Spring pulse and stable summer flows to support fish breeding:</p> <ul style="list-style-type: none"> <li>• Base flow of up to 550 ML/day in spring.</li> <li>• Single fresh up to 700 ML/day for 120 days in spring/summer.</li> </ul>	<p>4. Gunbower Creek Channel Flow: Contribute to in-stream flows to support the survival and condition of juvenile fish and stimulate lateral movement of large-bodied native fish, aquatic invertebrates and carbon between Gunbower Creek and Gunbower Forest.</p>				

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
Gunbower-Koondrook-Perricoota Forest	Small-moderate action (25,000 ML/day) at Torrumbarry Weir for at least 20 days and up to 150 days in winter/spring targeting permanent and semi-permanent wetlands or: <ul style="list-style-type: none"><li>~3,000 ha via Gunbower Forest infrastructure.</li><li>~8,000 ha via Koondrook-Perricoota Forest infrastructure.</li></ul>				5. Gunbower Forest Flow: Deliver water to inundate river red gum forest; support survival, condition and spawning of native fish (floodplain specialists) and/or supporting the completion of a bird breeding event.	
	Infrastructure delivery to Gunbower and Koondrook-Pericoota Forests targeting river red gum forest equivalent to around 27,000-35,000 ML/day at Torrumbarry Weir, or: <ul style="list-style-type: none"><li>4 000 ha via Gunbower Forest infrastructure.</li><li>Up to 16,000 ha via Koondrook-Perricoota Forest infrastructure.</li></ul>				6. Koondrook-Perricoota Forest Flow: Use infrastructure to provide flows to inundate river red gum forest; support bird breeding and/or support survival, condition and spawning of native fish (floodplain specialists).	
Mid Murray Off-Channel Wetlands Hume to Euston	Permanent Wetlands.	7. Water a range of annual, semi-annual, intermittent Mid Murray wetlands across all scenarios, subject to seasonal cues.				
	Semi-permanent Wetlands.					
	Ephemeral Wetlands.					

Note: Under certain resource availabilities, option 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.

## Potential watering actions – standard operating arrangements

Table 4 identifies the range of potential watering actions in the Mid Murray Region 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.

A note on approvals: watering actions in the Mid Murray would be implemented with local delivery partners who will play a key role in engaging with the local community and third parties and implement the event. As some actions may be constrained by other demands in the system, the Office will seek advice from river operators on the timing, magnitude and duration of the proposed event.

### **Watering Action 1a, 1b, 2, 5 and 6: Mid River Murray channel flow; Barmah-Millewa Forest flow; and Gunbower-Koondrook-Pericoota Forest high flow (within constraints).**

#### *Standard operational considerations:*

- In-stream environmental watering seeks to target improved seasonality of flows to promote spawning of flow specialist fish species and to re-connect river with low-lying wetlands. As such, an action will generally be in response to an appropriate flow triggers, such as rainfall events and flows upstream of Hume Dam and in tributaries (e.g. Ovens, Kiewa, Goulburn and Murrumbidgee rivers).
- Larger channel flows will naturally enter creeks and anabranches, low lying wetlands (e.g. Coppingers Lagoon, Duck Lagoon, Douglas Swamp, Boals-Deadwoods, St Helena Swamp, Black Swamp, Walthours Swamp, Moira Lake, Barmah Lake and Gulpa Creek Complex). In some cases infrastructure may be used to provide flow conditions for fish outcomes (e.g using Mary Ada regulator to provide flows for native fish in Toupna Creek).
- Barmah-Millewa Forest:
  - To create significant flows into Barmah-Millewa Forest, significant natural flows are required, with Commonwealth environmental water only provided to extend the duration of flows once the flow rate recedes to a level that does not create unacceptable third party impacts. Regulators may be opened or closed on either side to influence the extent and duration of flows into Barmah and Millewa forests.
  - The action would typically occur during winter or spring, consistent with natural seasonality. Unless otherwise agreed, Commonwealth environmental water will be delivered to target a maximum water level of 3.0 m at the Tocumwal Gauge (which corresponds to about 15,000 ML/day). From December to May, flows downstream of Yarrawonga Weir are managed below 10 300 ML/day to avoid unseasonal inundation of Barmah-Millewa Forest.
  - Higher flows that enter anabranches and creeks in Millewa Forest may connect with the Edward-Wakool system and provide further benefits.
  - With other factors influencing the extent of floodplain marsh species such as Moira grass, complementary natural resource management activities will be important if Commonwealth environmental water is to be provided to extend Barmah-Millewa Forest flows, such as managing the encroachment by river red gums and grazing by vertebrate pests.
- Gunbower-Koondrook Pericoota Forest:
  - Environmental water may be contributed to channel flows to connect the River Murray with Gunbower and Koondrook-Perricoota forests.
  - A suitable flow trigger is required for environmental water to piggy-back on and resource availability may often be a limiting factor. The action would likely occur as part of a multi-site connected flow action through the Mid Murray.

- The use of Commonwealth environmental water in Koondrook-Perricoota Forest will depend on necessary State approvals being in place and an assessment of risks including, but not limited to, water quality issues and potential third party impacts.
- Environmental water delivery may be constrained by other demands on the system, especially during irrigation season, and capacity to release and coordinate releases from multiple storages.

*Typical extent:*

- Flow rates will be dependent on flow conditions, target outcomes and the operational considerations described above. Releases from Hume Dam will have most impact (in terms of flow variability) on flows in the upper Mid-Murray channel (from Hume to the Barmah Choke). Significantly influencing flow variability in the River Murray downstream of the Barmah Choke requires coordination of water delivery from other tributaries (e.g. the Goulburn and Murrumbidgee rivers).
- In Barmah-Millewa Forest, the extent would generally be sufficient in terms of magnitude (initial unregulated trigger of at least 20 000–25 000 ML/day) and duration (at least three months) to water large areas of floodplain marsh including Moira grassland and allow the open wetland vegetation to complete its flowering. Less frequently, and following a larger unregulated trigger, flows may inundate broader areas of river red gum forest. This action may also contribute to outcomes in the Edward-Wakool system (Action 3).
- For Gunbower Forest, the extent will be determined by the watering scenario agreed to by the site manager and water holders.
- For Koondrook-Perricoota Forest the extent will be limited to low-lying anabranches and semi-permanent wetlands to avoid unacceptable third party impacts.

**Watering Action 3a, 3b and 3c: Edward-Wakool River system**

*Standard operational considerations:*

- WaterNSW is responsible for managing flows in the Edward-Wakool River system, which is highly regulated. Depending on the location and purpose of the action, water may also be sourced from either Murray Irrigation and/or private landholder irrigation infrastructure. Commonwealth environmental water may be delivered in combination with natural, consumptive or other held or planned environment water.
- Forest and ephemeral waterway actions will be timed for winter/spring and late autumn to minimise the risk of hypoxic blackwater impacts. Operational considerations for Werai Forest are being reviewed to improve the potential for watering to be undertaken in future years.
- Contingency flows may be made available, if required, to provide critical refuge habitat for aquatic species such as large bodied native fish during hypoxic events.
- Planning for actions will take into consideration the potential impacts of inundating areas that have acid sulphate soils and/or deep pools that may result in the movement of salt.
- During the irrigation off-season (winter) regulating/irrigation systems are usually shut down, thereby limiting the ability to provide environmental flows at that time. During winter 2017, following discussions with the community and relevant NSW agencies, a trial of winter watering into the Yallakool-Wakool and Colligen-Niemur systems is planned, targeting native fish and instream aquatic vegetation outcomes.

*Typical extent:* Flows will be delivered within constraints, unless otherwise agreed with potentially impacted landholders and state government agencies.

#### **Watering Action 4 and 5: Gunbower Creek channel flow and Gunbower Forest flow**

*Standard operational considerations:*

- Environmental water can be delivered to Gunbower Creek in combination with consumptive flows to the Torrumbarry Irrigation Area. Water levels in Gunbower Creek are largely driven by irrigation demand. Commonwealth environmental water will be used to account for the losses associated with the delivery of consumptive water en route through Gunbower Creek.
- High flows in Gunbower Creek can also be used to push water into Gunbower Forest using the Hipwell Road regulator. The native fish population in the highly regulated Creek can be enhanced by delivering targeted environmental flows to provide improved conditions for native fish year-round.
- When delivering water during the irrigation season, the environment shares the capacity of Gunbower Creek with irrigation flows. As such, there is potential for system capacity constraints to interrupt the supply of environmental water to Gunbower Forest.
- Unless otherwise agreed, Commonwealth environmental water will not be used to contribute to flow rates above 700 ML/day at Cohuna Weir to avoid unplanned inundation of private land.
- A number of planned infrastructure works are scheduled between 2017–18 to 2021–22 that will require Gunbower Creek water levels to be lowered. This has the potential to impact upon the deliverability of the full fish hydrograph and therefore presents a possible threat to the vulnerable native fish population in Gunbower Creek. Infrastructure maintenance works may be undertaken which may impact the ability to deliver the full fish hydrograph for Gunbower Creek in 2017–18.

*Typical extent:* In-channel flows through to inundation of up to 4 800 ha of river red gum forest.

#### **Watering Action 6: Koondrook-Perricoota Forest via infrastructure works**

*Standard operational considerations:*

- Commonwealth environmental water provided to Wakool River-Yallakool Creek (in the Edward–Wakool system) may assist with managing outflows from Koondrook-Perricoota Forest into the Wakool River.
- Water would be delivered to Koondrook–Perricoota Forest via the Torrumbarry Weir pool and inundation managed using a series of regulators. Outfalls to the Wakool River may need to be managed to prevent third party impacts and water quality issues.

*Typical extent:* To be determined by the watering scenario agreed to by the site manager and water holders.

*Approvals:* Commonwealth environmental water may be used in this area subject to potential third party impacts being resolved.

#### **Watering Action 7: Mid Murray off-channel wetlands – Hume to Euston**

*Standard operational considerations:*

- The Mid Murray wetlands are scattered along the River Murray on the New South Wales side, while almost wholly contained within the Torrumbarry Irrigation Region in Victoria. Many of the wetlands are now cut-off from natural inundation and are reliant on the managed delivery of environmental water. The delivery of environmental water to these wetlands is constrained by a number of factors such as restrictions to delivery outlets and channel capacity.
- Multiple wetlands having similar watering regimes and requiring water at the same time results in competition for resource availability, particularly in drier years. Prioritisation and ultimately trade-off decisions may be required during low resource availability periods.
- As most of the Mid Murray wetlands in Victoria are now managed to maintain permanent or semi-permanent saline water habitats, the decision to provide environmental water may not only relate to lake levels, but also active management of salinity concentrations conducive to salt-tolerant species.

*Typical extent:* Individual wetland sites in the Mid Murray region, from Hume Dam to Euston.

# Attachment C – Long-term water availability

## Commonwealth environmental water holdings

The Commonwealth holds the following entitlements in the Mid Murray Region:

- NSW Murray High Security
- NSW Murray General Security
- NSW Murray Conveyance
- NSW Murray Supplementary
- Victorian Murray High Reliability
- Victorian Murray Low Reliability

In addition, the Commonwealth holds entitlements in the Southern-connected Basin that can be used to deliver environmental water to the Mid Murray Region. 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](http://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 Mid Murray Region include:

- Environmental Entitlement: The Living Murray Program – Murray–Darling Basin Authority
- Environmental Entitlement: New South Wales – New South Wales Office of Environment and Heritage
- Bulk Entitlement – Victorian Environmental Water Holder
- River Murray Increased Flows entitlements: Jointly managed by New South Wales Office of Environment and Heritage and Victorian Environmental Water Holder

## Planned environmental water

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












- Barmah-Millewa Environmental Allowance:
  - Provides an annual allocation of up to 150 GL (100 GL high security and 50 GL low security allocation). This water can be used to deliver flows to meet ecological objectives in the Barmah-Millewa Forest in accordance with specific rules.
  - A maximum of 700 GL of water can be carried over from one water year to the next. Responsibility for the Barmah-Millewa Environmental Water Allowance is shared between NSW and Victoria. More information about this water allowance is available from the *Barmah-Millewa Forest Environmental Water Management Plan* (MDBA 2012e).
- New South Wales Murray Regulated River Water Source Additional Environmental Allowance:
  - the maximum volume held is calculated as 0.15 ML multiplied by the total number of regulated river (high security) unit shares
  - releases of water from the Murray Regulated River Water Source Additional Environmental Allowance can be made for the purpose of contributing to any of the objectives (a) to (i) outlined in the Water Sharing Plan (Section 2, Clause 10).

Attachment D - Environmental demands and priorities for watering in 2017–18 in the Edward-Wakool system

Environmental assets	Primary objective of flows	Indicative demand (for all sources of water in the system)	Required frequency (maximum dry interval)	Watering history (from all sources of water)							2017-18			
				2009-10 (drought)	2010-11 (very wet) (HBW)	2011-12 (wet) (HBW)	2012-13 (wet)	2013-14 (moderate)	2014-15 (drying)	2015-16 (dry) (BGA)	2016-17 (very wet) (HBW)	Predominant urgency of environmental demand for water	Purpose under low inflow scenario	Potential Commonwealth environmental water contribution?
Yallakool & Wakool (below the confluence with the Yallakool)	Maintenance of native fish habitat and instream aquatic vegetation Longitudinal connectivity Fish spawning and movement Nutrient cycling Water Quality	Base flows <sup>1</sup> of ~170ML/d for 300 days (~51 GL) from late winter till late Autumn <sup>1</sup>	1 in 1 (2 years)									High Critical minimum flows to avoid long term damage	Protect	Likely to be met by consumptive demands except in a very dry year & in such scenario CEW may be used to prevent system from being cut off
		Small events <sup>2</sup> of ~30-60 GL (~600ML/d) for 60-120 days in late winter to early summer <sup>1,2</sup>	2 in 3 (4 years)									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Protect	Priority for Commonwealth environmental water to continue ecosystem recovery
		Pulse/Fresh of (~600ML/d peak for 2 days) for 7 days in winter-spring or spring-summer with slow recession	As Required									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Protect	Commonwealth environmental water may be used if there are no multi-site/return flow watering actions or natural events.
Colligen/ Niemur	Maintenance of instream aquatic vegetation and native fish habitat Longitudinal connectivity Fish movement Nutrient cycling Water Quality	Base flows <sup>1</sup> of ~170ML/d for 300 days (~51 GL) from late winter till late Autumn <sup>1</sup>	1 in 1 (2 years)									High Critical minimum flows to avoid long term damage	Protect	Likely to be met by consumptive demands except in a very dry year & in such scenario CEW may be used to prevent system from being cut off
		Small events <sup>2</sup> of ~450ML/d for 60-120 days (~27-54 GL) in late winter to early summer <sup>1,2</sup>	2 in 3 (4 years)									Moderate To maintain recession flows on rain-rejection or natural events and see to extend inundation within constraints if possible	Protect	Commonwealth environmental water may be used to provide habitat flows such as those received in the Yallakool in previous years.
		Pulse/Fresh of (~450ML/d peak for 2 days) for 7 days in winter-spring with slow recession	As Required									Moderate To provide for a pulse to fill low commence to flow backwaters, flood runners and wetlands for nutrient cycling and later return to the system.	Protect	Commonwealth environmental water may be used if these are no multi-site or natural events.
Edward River	Flow variability Longitudinal connectivity Fish spawning and movement	Pulse/reverse pulse events aligned with River Operations, particularly Stevens Weir for outcomes D/S of the weir.	1 in 1 (2 years)									Moderate To provide improved flow variability at a time when a spawning response from native fish in the Edward River downstream of Stephens Weir may be achieved.	Protect	Commonwealth environmental water may be used if these are no multi-site, natural events or capacity to manipulate operation flows enroute to South Australia.
Ephemeral Streams (e.g. Tuppal, Merran & Little Merran Creeks)	Longitudinal connectivity Water Quality Maintenance of native animal habitat and instream aquatic vegetation	Small events <sup>1</sup> ~6 GL a year in stream Winter/Spring/ Autumn events	1 in 2 (2 years)									Moderate Some watering may be important to supplement flows to maintain water quality and ecosystem health.	Protect	Commonwealth environmental water may be used in these systems, depending on the individual need. Sites may be more likely to be water by NSW OEH.
Fringing Wetlands (e.g. Private wetlands on Colligen Creek)	As above	Small site specific actions <10 GL	Site specific									Site Specific	Protect	Commonwealth environmental water may be used in these systems, depending on the individual need. Sites may be more likely to be water by NSW OEH.
Weral Forest	Water Quality Maintenance riparian vegetation	Small events of ~5 GL to provide drought refuge.	2-3 in 5 years (6 years) for river red gums									Moderate	Protect	Commonwealth environmental water could be considered in future years, subject to stakeholder support, operational delivery infrastructure, third party impacts and return flows being addressed.
Koondrook- Perricoota Forest	Water Quality Maintenance riparian vegetation	Small event 30 GL over 60 days to inundate around 1500ha of forest, wetlands and creeks.	2-3 in 5 years (6 years) for river red gums									Moderate	Protect	As for Weral Forest above.
Edward Wakool System - Winter Flows	Reinstatement of natural hydrograph for winter period Longitudinal connectivity Fish recruitment Aquatic vegetation reestablishment	Edward River - Provide slightly higher base winter flow of ~ 300 ML/d added to base flow at Toonlook over mid May to July (~ 27 GL) if Stevens Weir is fully open.	1 in 2 (2 years)									Moderate To provide improved connectivity and aquatic habitat at a time when Edward River downstream of Stephens Weir is subject to annual low flows.	Protect	Commonwealth environmental water may be considered subject to stakeholder discussions and infrastructure maintenance requirements by WaterNSW.
		Yallakool Creek, Wakool River, Colligen Creek-Niemur River, Merran Creek	1 in 2 (2 years)									Moderate To provide improved connectivity and aquatic habitat at a time of year when these system have historically been shut down (no flow).	Protect	As for Edward River above.
Edward Wakool System – Recession Flows	Maintenance of instream aquatic vegetation and native fish habitat	~15GL within constraints to provide more natural recession flows off rain rejection and unregulated events in the system. <sup>2</sup>	As Required									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Protect	Commonwealth environmental water may be used to manage flow recessions associated with natural or rain-rejection events.
Edward Wakool System - Critical Habitat flows	Water quality Provision of refuges for native fish	~30 -120 GL a year to manage hypoxic black water events and other critical habitat needs. <sup>2</sup>	As Required									Critical Support of aquatic communities is critical during hypoxic events.	Avoid Damage	Highest priority for Commonwealth environmental water if triggers are met.
Key - events in previous years														
<div></div> means demand was met, by Commonwealth environmental water or any other source														
<div></div> means demand was partially met, by Commonwealth environmental water or any other source (may be used to indicate infrastructure assisted delivery)														
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Note that not all demands require water every year, drying phases are important for floodplains and temporary wetlands or streams														
Key - potential watering in 2017-18														
<div></div> means a high priority for Commonwealth environmental watering (full or partial contribution, and subject to seasonal and operational considerations)														
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Note that demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime														
The information in this table was compiled using a number of sources (below). Where no specific information was available and/or where constraints excluded the recommended actions, previous water actions and their outcomes were used as a basis for developing watering options.														
References: 1 Hale, J and SKM (2011), <i>Environmental Water Delivery: Edward-Wakool</i> . 2 Adapted from Watts et al (2013), <i>Monitoring the ecosystem responses to Commonwealth environmental water delivered to the Edward-Wakool river system, 2012-13</i> and Watts et al (2014), <i>Monitoring the ecosystem responses to Commonwealth environmental water delivered to the Edward-Wakool river system, 2013-14</i> and Watts et al (2015), <i>Commonwealth Environmental Water Office Long Term Intervention Monitoring Project: Edward-Wakool Selected Area Synthesis Report, 2014-15</i> . 3 Webster, R (2010), <i>Environmental Monitoring of Weral Forest Environmental Flow</i> .														



Environmental assets	Primary objective of flows	Indicative demand (for all sources of water in the system)	Required frequency (maximum dry interval)	Watering history (from all sources of water)								2017-18		
				2009-10 (drought)	2010-11 (very wet) (HBW)	2011-12 (wet) (HBW)	2012-13 (wet)	2013-14 (moderate)	2014-15 (drying)	2015-16 (dry) (BGA)	2016-17 (very wet) (HBW)	Predominant urgency of environmental demand for water	Purpose under moderate inflow scenario	Potential Commonwealth environmental water contribution?
Yallakool & Wakool (below the confluence with the Yallakool)	Maintenance of native fish habitat and instream aquatic vegetation Longitudinal connectivity Fish spawning and movement Nutrient cycling Water Quality	Base flows <sup>1</sup> of ~170ML/d for 300 days (~51 GL) from late winter till late Autumn <sup>1</sup>	1 in 1 (2 years)									High Critical minimum flows to avoid long term damage	Protect	Likely to be met by consumptive demands except in a <u>very dry year</u> & in such scenario CEW may be used to prevent system from being cut off
		Multiple or longer small events <sup>2</sup> of ~30-60 GL (~600ML/d) for 60-120 days in late winter to early summer <sup>1,2</sup>	2 in 3 (4 years)									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Maintain	Priority for Commonwealth environmental water to continue ecosystem recovery
		Multiple or longer pulses/freshes of (~600ML/d peak for 2 days) for 7 days in winter-spring or spring-summer with slow recession	As Required									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Maintain	Commonwealth environmental water may be used if there are no multi-site/return flow watering actions or natural events.
Colligen/ Niemur	Maintenance of instream aquatic vegetation and native fish habitat Longitudinal connectivity Fish movement Nutrient cycling Water Quality	Base flows <sup>1</sup> of ~170ML/d for 300 days (~51 GL) from late winter till late Autumn <sup>1</sup>	1 in 1 (2 years)									High Critical minimum flows to avoid long term damage	Protect	Likely to be met by consumptive demands except in a <u>very dry year</u> & in such scenario CEW may be used to prevent system from being cut off
		Small events <sup>2</sup> of ~450ML/d for 60-120 days (~27-54 GL) in late winter to early summer <sup>1,2</sup>	2 in 3 (4 years)									Moderate To maintain recession flows on rain-rejection or natural events and see to extend inundation within constraints if possible	Maintain	Commonwealth environmental water may be used to provide habitat flows such as those received in the Yallakool in previous years.
		Multiple or longer pulses/freshes of (~450ML/d peak for 2 days) for 7 days in winter-spring with slow recession	As Required									Moderate To provide for a pulse to fill low commence to flow backwaters, flood runners and wetlands for nutrient cycling and later return to the system.	Maintain	Commonwealth environmental water may be used if these are no multi-site or natural events.
Edward River	Flow variability Longitudinal connectivity Fish spawning and movement Nutrient cycling	Multiple pulses/reverse pulses aligned with River Operations, particularly Stevens Weir for outcomes D/S of the weir.	1 in 1 (2 years)									Moderate To provide improved flow variability at a time when a spawning response from native fish in the Edward River downstream of Stevens Weir may be achieved.	Maintain	Commonwealth environmental water may be used if these are no multi-site, natural events or capacity to manipulate operation flows enroute to South Australia.
Ephemeral Streams (e.g. Tuppal, Merran & Little Merran Creeks)	Longitudinal connectivity Water Quality Maintenance of native animal habitat and instream aquatic vegetation	Small events <sup>1</sup> ~6 GL a year in stream Winter/Spring/ Autumn events	1 in 2 (2 years)									Moderate Some watering may be important to supplement flows to maintain water quality and ecosystem health.	Maintain	Commonwealth environmental water may be used in these systems, depending on the individual need. Sites may be more likely to be water by NSW OEH.
Fringing Wetlands (e.g. Private wetlands on Colligen Creek)	As above	Small site specific actions <10 GL	Site specific									Site Specific	Maintain	Commonwealth environmental water may be used in these systems, depending on the individual need. Sites may be more likely to be water by NSW OEH.
Weral Forest	Water Quality Maintenance riparian vegetation	Moderate sized watering events to provide water larger area of forest and flush organic matter from late Autumn to early Spring <sup>3</sup>	2-3 in 5 years (6 years) for river red gums									Moderate Large areas of Weral Forest were innundated in 2016-17.	Maintain	Commonwealth environmental water could be considered in future years, subject to stakeholder support, operational delivery infrastructure, third party impacts and return flows being addressed.
Koondrook- Perricoota Forest	Water Quality Maintenance riparian vegetation	Moderate sized watering events to provide water larger area of forest and flush organic matter from late Autumn to early Spring <sup>4</sup>	2-3 in 5 years (6 years) for river red gums									Moderate Large areas of Koondrook-Pericoota Forest were innundated in 2016-17.	Maintain	As for Weral Forest above.
Edward Wakool System - Winter Flows	Reinstatement of natural hydrograph for winter period Longitudinal connectivity Fish recruitment Aquatic vegetation reestablishment	Edward River - Provide slightly higher base winter flow of ~ 300 ML/d added to base flow at Toonlook over mid May to July (~ 27 GL) if Stevens Weir is fully open.	1 in 2 (2 years)									Moderate To provide improved connectivity and aquatic habitat at a time when Edward River downstream of Stephens Weir is subject to annual low flows.	Maintain	Commonwealth environmental water may be considered subject to stakeholder discussions and infrastructure maintenance requirements by WaterNSW.
		Yallakool Creek, Wakool River, Colligen Creek-Niemur River, Merran Creek	1 in 2 (2 years)									Moderate To provide improved connectivity and aquatic habitat at a time of year when these system have historically been shut down (no flow).	Maintain	As for Edward River above.
Edward Wakool System - Recession Flows	Maintenance of instream aquatic vegetation and native fish habitat	~15GL within constraints to provide more natural recession flows off rain rejection and unregulated events in the system. <sup>2</sup>	As Required									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Maintain	Commonwealth environmental water may be used to manage flow recessions associated with natural or rain-rejection events.
Edward Wakool System - Critical Habitat flows	Water quality Provision of refuges for native fish	~30-120 GL a year to manage hypoxic black water events and other critical habitat needs. <sup>2</sup>	As Required									Critical Support of aquatic communities is critical during hypoxic events.	Protect	Highest priority for Commonwealth environmental water if triggers are met.

<b>Key - events in previous years</b>	
	means demand was met, by Commonwealth environmental water or any other source
	means demand was partially met, by Commonwealth environmental water or any other source (may be used to indicate infrastructure assisted delivery)
	means water not provided (or not required)
Note that not all demands require water every year, drying phases are important for floodplains and temporary wetlands or streams	
<b>Key - potential watering in 2017-18</b>	
	means a high priority for Commonwealth environmental watering (full or partial contribution, and subject to seasonal and operational considerations)
	means a secondary priority for Commonwealth environmental watering, likely to be met via other means (other water holders, or natural flows)
	means a low priority for Commonwealth environmental watering
<b>Key - urgency of environmental demands</b>	
	means critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage
	means high demand for water i.e. needed in that particular year
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	means low demand for water i.e. water generally not needed that particular year
	means very low demand for water i.e. water generally not needed that particular year or the following year
Note that demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime	
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References: 1 Hole, J and SKM (2011), <i>Environmental Water Delivery: Edward-Wakool</i> . 2 Adapted from Watts et al (2013), <i>Monitoring the ecosystem responses to Commonwealth environmental water delivered to the Edward-Wakool river system, 2012-13</i> and Watts et al (2014), <i>Monitoring the ecosystem responses to Commonwealth environmental water delivered to the Edward-Wakool river system, 2013-14</i> and Watts et al (2015), <i>Commonwealth Environmental Water Office Long Term Intervention Monitoring Project: Edward-Wakool Selected Area Synthesis Report, 2014-15</i> . 3 Webster, R (2010), <i>Environmental Monitoring of Werai Forest Environmental Flow</i> .	

Environmental assets	Primary objective of flows	Indicative demand (for all sources of water in the system)	Required frequency (maximum dry interval)	Watering history (from all sources of water)								2017-18		
				2009-10 (drought)	2010-11 (very wet) (HBW)	2011-12 (wet) (HBW)	2012-13 (wet)	2013-14 (moderate)	2014-15 (drying)	2015-16 (dry) (BGA)	2016-17 (very wet) (HBW)	Predominant urgency of environmental demand for water	Purpose under high inflow scenario	Potential Commonwealth environmental water contribution?
Yallakool & Wakool (below the confluence with the Yallakool)	Maintenance of native fish habitat and instream aquatic vegetation Longitudinal connectivity Fish spawning and movement Nutrient cycling Water Quality	Base flows <sup>1</sup> of ~170ML/d for 300 days (~51 GL) from late winter till late Autumn <sup>1</sup>	1 in 1 (2 years)									High Critical minimum flows to avoid long term damage	Improve	Likely to be met by consumptive demands except in a very dry year & in such scenario CEW may be used to prevent system from being cut off
		Multiple or longer small events <sup>2</sup> of ~30-60 GL (~600ML/d) for 60-120 days in late winter to early summer <sup>1,2</sup>	2 in 3 (4 years)									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Improve	Likely to be met by wetter catchment conditions and/or higher operational flows through the system
		Multiple or longer pulses/freshes of (~600ML/d peak for 2 days) for 7 days in winter-spring or spring-summer with slow recession	As Required									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Improve	Commonwealth environmental water may be used to extend the recession of periods of high flows events (both natural and operational).
Colligen Creek & Niemur River	Maintenance of instream aquatic vegetation and native fish habitat Longitudinal connectivity Fish movement Nutrient cycling Water Quality	Base flows <sup>1</sup> of ~170ML/d for 300 days (~51 GL) from late winter till late Autumn <sup>1</sup>	1 in 1 (2 years)									High Critical minimum flows to avoid long term damage	Improve	Likely to be met by consumptive demands except in a very dry year & in such scenario CEW may be used to prevent system from being cut off
		Multiple or longer small events <sup>2</sup> of ~450ML/d for 60-120 days (~27-54 GL) in late winter to early summer <sup>1,2</sup>	2 in 3 (4 years)									Moderate To maintain recession flows on rain-rejection or natural events and see to extend inundation within constraints if possible	Improve	Likely to be met by wetter catchment conditions and/or higher operational flows through the system
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Edward River	Flow variability Longitudinal connectivity Fish spawning and movement Nutrient cycling	Multiple pulses/reverse pulses aligned with River Operations, particularly Stevens Weir for outcomes D/S of the weir.	1 in 1 (2 years)									Moderate To provide improved flow variability at a time when a spawning response from native fish in the Edward River downstream of Stephens Weir may be achieved.	Improve	Commonwealth environmental water may be used depending on catchment conditions and if these is capacity to manipulate operation flows enroute to South Australia.
Ephemeral Streams (e.g. Tuppai, Merran & Little Merran Creeks)	Longitudinal connectivity Water Quality Maintenance of native animal habitat and instream aquatic vegetation	Small events <sup>1</sup> ~6 GL a year in stream Winter/Spring/ Autumn events	1 in 2 (2 years)									Moderate Some watering may be important to supplement flows to maintain water quality and ecosystem health.	Improve	Likely to be met by wetter catchment conditions and/or higher operational flows through the system
Fringing Wetlands (e.g. Private wetlands on Colligen Creek)	As above	Small site specific actions <10 GL	Site specific									Site Specific	Improve	Likely to be met by wetter catchment conditions and/or higher operational flows through the system
Weral Forest	Water Quality Maintenance riparian vegetation	Longer moderate sized watering events to provide water larger area of forest and flush organic matter from late Autumn to early Spring <sup>3</sup>	2-3 in 5 years (6 years) for river red gums									Moderate Large areas of Weral Forest were innundated in 2016-17.	Improve	Commonwealth environmental water could be considered in future years, subject to stakeholder support, operational delivery infrastructure, third party impacts and return flows being addressed.
Koondrook- Perricoota Forest	Water Quality Maintenance riparian vegetation	Longer moderate sized watering events to provide water larger area of forest and flush organic matter from late Autumn to early Spring <sup>4</sup>	2-3 in 5 years (6 years) for river red gums									Moderate Large areas of Koondrook-Pericoota Forest were innundated in 2016-17.	Improve	As for Weral Forest above.
Edward Wakool System - Winter Flows	Reinstatement of natural hydrograph for winter period Longitudinal connectivity Fish recruitment	Edward River - Provide slightly higher base winter flow of ~ 300 ML/d added to base flow at Toonalook over mid May to July (~ 27 GL) if Stevens Weir is fully open.	1 in 2 (2 years)									Moderate To provide improved connectivity and aquatic habitat at a time when Edward River downstream of Stephens Weir is subject to annual low flows.	Improve	Commonwealth environmental water may be considered subject to stakeholder discussions and infrastructure maintenance requirements by WaterNSW.
		Yallakool Creek, Wakool River, Colligen Creek-Niemur River, Merran Creek	1 in 2 (2 years)									Moderate To provide improved connectivity and aquatic habitat at a time of year when these system have historically been shut down (no flow).	Improve	As for Edward River above.
Edward Wakool System – Recession Flows	Maintenance of instream aquatic vegetation and native fish habitat	~15GL within constraints to provide more natural recession flows off rain rejection and unregulated events in the system. <sup>2</sup>	As Required									Moderate Depending on the scale and timing of the event, less likely under a low resource availability scenario.	Improve	Commonwealth environmental water may be used to manage flow recessions associated with natural or rain-rejection events.
Edward Wakool System - Critical Habitat flows	Water quality Provision of refuges for native fish	~30 GL a year to manage hypoxic black water events and other critical habitat needs. <sup>2</sup>	As Required									Critical Support of aquatic communities is critical during hypoxic events.	Protect	Highest priority for Commonwealth environmental water if triggers are met.

Key - events in previous years

	means demand was met, by Commonwealth environmental water or any other source
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	means water not provided (or not required)

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

Key - potential watering in 2017-18

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

Key - urgency of environmental demands

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

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

The information in this table was compiled using a number of sources (below). Where no specific information was available and/or where constraints excluded the recommended actions, previous water actions and their outcomes were used as a basis for developing watering options.

References: 1 Hale, J and SKM (2011), *Environmental Water Delivery: Edward-Wakool*. 2 Adapted from Watts et.al (2013), *Monitoring the ecosystem responses to Commonwealth environmental water delivered to the Edward-Wakool river system, 2012-13* and Watts et.al (2014), *Monitoring the ecosystem responses to Commonwealth environmental water delivered to the Edward-Wakool river system, 2013-14* and Watts et al (2015), *Commonwealth Environmental Water Office Long Term Intervention Monitoring Project: Edward-Wakool Selected Area Synthesis Report, 2014-15*. 3 Webster, R (2010), *Environmental Monitoring of Weral Forest Environmental Flow*.



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