

2019-20 Annual Environmental Watering Priorities for the South Australian River Murray Water Resource Plan Area

The information contained in this document is prepared for the purpose of complying with South Australia's obligations in respect to annual environmental watering priorities for the South Australian River Murray Water Resource Plan Area, in accordance with Chapter 8 of the Basin Plan (Environmental watering plan).

1. Summary

Annual environmental watering priorities have been prepared and are presented here for the surface waters of the South Australian River Murray Water Resource Plan (River Murray WRP) area¹.

The River Murray WRP area does not include the Coorong and Murray Mouth, which are part of the SA Murray Region WRP area, however in recognition of the intrinsic connection between the Coorong and the Lower Lakes, South Australia seeks to manage the site as a whole through the River Murray Long Term Watering Plan (DEWNR 2015)².

The annual environmental watering priorities for the River Murray WRP area include a range of actions proposed for three priority environmental assets: the SA River Murray Channel; SA River Murray floodplain; and the Coorong, Lower Lakes and Murray Mouth, as well as actions within these assets such as weir pool manipulations and wetland watering. The actions proposed relate to potential water resource availability scenarios provided by the Murray-Darling Basin Authority (MDBA).

These priorities have been developed in accordance with the principles and method described in Chapter 8 Part 6 of the Basin Plan and will be incorporated into the *2019-20 Annual Environmental Watering Plan for the South Australian River Murray* (in preparation).

2. Introduction

The preparation of annual environmental watering priorities (the priorities) for the surface water in the South Australian River Murray Water Resource Plan area occurs annually in accordance with the Basin Plan, Chapter 8, Division 4. Chapter 8 - Environmental Watering Plan requires Basin States to identify the priorities for surface water in each water resource plan area for the upcoming water

¹ This is defined as the River Murray prescribed watercourse and includes the surface water in the River Murray and floodplain from the South Australian border to and including Lake Alexandrina and Lake Albert. Portions of the Angas, Bremer and Finnis Rivers and Currency Creek that enter Lake Alexandrina are also included.

² The Coorong is considered by the Basin Plan to be part of the SA Murray Region WRP area, however it is addressed in the priorities for the SA River Murray WRP Area (i.e. this document) as the ecological outcomes of in the Coorong are primarily driven by surface water inputs from the River Murray. This is consistent with the approach taken in the LTWP. 2019-20 Annual Environmental Watering Priorities for the South Australian River Murray Water Resource Plan Area

accounting period. In accordance with the Basin Plan, this document identifies watering priorities for the priority environmental assets (PEAs) and priority ecosystem functions (PEFs) of the water resource plan area, and identifies the assumptions upon which the priorities are based. This includes the expected holdings and quantities of held and planned environmental water.

Possible cooperative arrangements between environmental water holders and managers of environmental assets have been identified including coordinated delivery of environmental water between connected water resources (upstream and downstream). Priorities for the water accounting period have been prepared for submission to the Murray-Darling Basin Authority (MDBA) by 31 May 2019 before the commencement of the water accounting period.

The River Murray WRP has been submitted for assessment, and once accredited will require the annual environmental watering priorities to consider the register of held environmental water (to be established for this purpose), and the rules relating to planned environmental water. This document reflects the intention of these requirements. The priorities have been prepared having regard to the Basin Wide Environmental Watering Strategy (MDBA 2014), and are consistent with the Long-Term Watering Plan for the River Murray WRP area³ (DEWNR, 2015).

3. Identification of priorities

The Long-Term Watering Plan for the River Murray WRP area (LTWP) identifies the PEAs and PEFs, as well as the ecological objectives, targets and environmental water requirements (EWRs) for each. It also demonstrates alignment between these and the expected environmental outcomes of the Basin Wide Environmental Watering Strategy (BWEWS) (Murray-Darling Basin Authority, 2014).

As in previous years, a scenario-based approach was used to develop proposed priority watering actions for 2019-20. Proposed priority watering actions for 2019-20 have been identified for four of the six water resource availability scenarios provided by the MDBA in February 2019. The MDBA annual operating probabilities (AOP) provided included: 100% (worst case), 95% (very dry), 90% (dry), 75% (moderate), 50% (near average), and 25% (wet) (Figure 1). These percentages refer to the likelihood of exceeding different water resource availability based on the analysis of historical inflows, current storage volumes, and operational considerations for the upcoming year. A volume of held environmental water (HEW) potentially available for delivery to South Australia in 2019-20 under each of the resource availability scenarios was assumed for planning purposes (refer 'Assumptions').

The resource availability scenarios and assumed Held Environmental Water (HEW) availability was used to develop environmental watering proposals for each site/asset. The preparation of the

³ The Coorong is considered by the Basin Plan to be part of the SA Murray Region WRP area, however it is addressed in the priorities for the SA River Murray WRP Area (i.e. this document) as the ecological outcomes of in the Coorong are primarily driven by surface water inputs from the River Murray. This is consistent with the approach taken for the LTWP.

proposed priorities for the South Australian River Murray has involved detailed planning and consultation. The priorities have been developed with input from water and land managers, river operators, scientists, community, and indigenous groups.

Annual Priorities

Priority watering actions have been identified for the three PEAs defined in the South Australian River Murray LTWP. In addition, priority actions have been identified for a range of infrastructure operations (i.e. Chowilla, weir pool manipulation and wetland management) that significantly contribute to outcomes within the Priority Environmental Assets. A detailed summary of the watering actions proposed under each resource availability scenario is provided in Appendix 1.

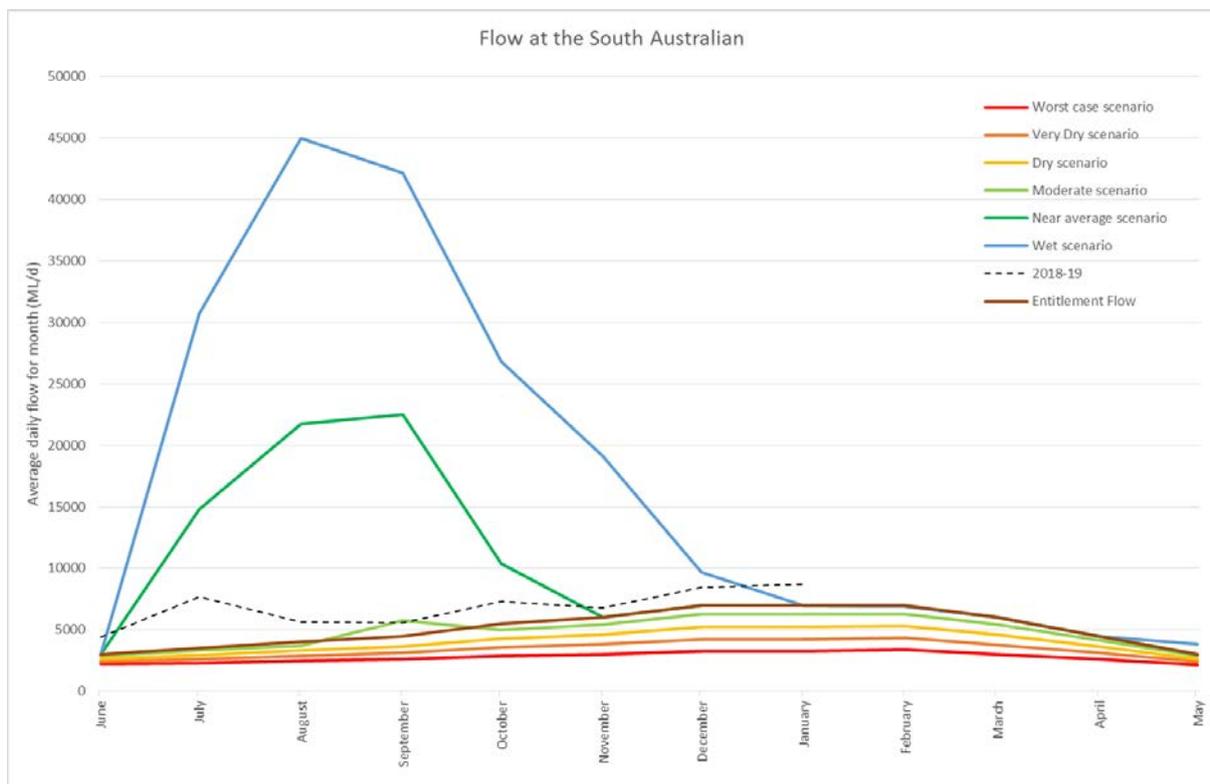


Figure 1. Annual operating probabilities provided by MDBA in February 2019 for the purpose of informing environmental water planning for 2019-20

Enhanced water delivery in spring and early summer is a priority for assets under all scenarios. This is consistent with the modelled natural hydrology for the lower Murray. Sustained lower level delivery throughout the remainder of the year is also a priority for maintaining flows through the barrages into the Coorong and through the Murray Mouth. In the dry to moderate scenarios, the focus is on managing for in channel, low floodplain and localised Coorong outcomes. In the wetter scenarios, it is proposed to enhance and prolong flows to support in-channel functions related to flow hydraulics,

and to maintain the condition of areas of the floodplain and wetlands that have not been inundated since the high flows of 2016. This will also provide higher barrage flows throughout spring and into early summer to support outcomes in the CLLMM. All of the proposed actions are scalable and will be managed to further enhance the benefits of water delivered for system-scale floodplain, channel and CLLMM outcomes.

A range of wetland watering actions are also proposed including drying and refilling a number of managed pool-connected wetlands and pumping priority temporary sites. Wetland watering actions will be undertaken by DEW staff and in conjunction with several non-government organisations (NGOs) including Nature Foundation of South Australia (NFSA), Renmark Irrigation Trust (RIT), Ngarrindjeri Regional Authority (NRA), Accolade Wines (Banrock Station), and Australian Landscape Trust (ALT).

Assumptions

Held Environmental Water Availability

The work required to inform the development of the priorities was undertaken between February and April 2019. For the purposes of planning and prioritisation, an estimate of potential held environmental water (HEW) availability under each resource scenario was made based on environmental water delivery in recent years and advice from water holders (Table 1).

Due to the ongoing very dry conditions, there was some delay in gaining an understanding of potential environmental water availability in 2019-20. For example, South Australian projections of opening water allocations are provided in mid-April. There are also relatively large volumes of HEW carry-over available in 2019-20 as a result of delivery constraints in 2018-19. These carry-over volumes have been factored into the estimates provided in Table 1.

Table 1. Estimate of held environmental water available under each resource availability scenario

Scenario	Estimate of HEW available (GL)
Dry (90%)	1200 GL
Moderate (75%)	1400 GL
Near Average (50%)	1700 GL
Wet (25%)	2200GL

HEW is available from the following sources – the Commonwealth Environmental Water Holder (CEWH), MDBA -The Living Murray (TLM), the Victorian Environmental Water Holder (VEWH), the South Australian Minister for Environment and Water and non-government organisations. For each water holder, information relating to volumes of registered entitlements and Long-Term Average Annual Yield (LTAAY) is presented below.

Commonwealth Environmental Water

Total Commonwealth environmental water holdings within the Southern Connected Basin are approximately 2,028 GL (at 28 February 2019), with varying levels of security and a LTAAAY of 1,474 GL⁴.

Of this volume, approximately 161 GL of registered entitlement (145 GL LTAAAY) is held in South Australia and forms part of South Australia's entitlement flow. Most of this holding is Class 3 and the availability of this water in 2019-20 will be in line with the River Murray Allocation Framework (SAMDB NRMB 2019). This water is considered HEW under the River Murray WRP and will be recorded on the Register of Held Environmental Water, as required under the Basin Plan, once the River Murray WRP is accredited.

Approximately 530 GL of carry-over from 2019-20 will be available in 2019-20.

The Living Murray Environmental Water

TLM holdings are approximately 480 GL Long-Term Cap Equivalent (LTCE). The Minister for Environment and Water holds 45 GL of TLM water in South Australia which is part of South Australia's Entitlement Flow (Class 3). The availability of this water in 2019-20 will be in line with the River Murray Allocation Framework (SAMDB NRMB 2019). This water is considered HEW under the River Murray WRP and any trades will be recorded on the Register of Held Environmental Water, as required under the Basin Plan, once the River Murray WRP is accredited.

It is anticipated that approximately 87 GL of River Murray Increased Flows (RMIF) from the Snowy Agreement will be carried over in the River Murray into 2019-20. A further 277 GL exists within the Snowy Storages however this water cannot be called on for use in the River Murray until these storages reach the trigger level. It could be several years until the Snowy Storages recover to the level where this can occur.

Victorian Environmental Water Holder

The Victorian Environmental Water Holder (VEWH) manages environmental water holdings in the Murray, Goulburn and Campaspe rivers. Under some circumstances, the VEWH may trade HEW to South Australia, generally as a result of return flows from upstream environmental watering actions. This water is protected within the River Murray and delivered through to the end of system. This water is considered HEW under the River Murray WRP and any trades will be recorded on the Register of Held Environmental Water, as required under the Basin Plan, once the River Murray WRP is accredited.

⁴ <http://www.environment.gov.au/water/cewo/about/water-holdings> viewed 15 May 2019
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South Australian Minister for Environment and Water

In addition to TLM holdings, the South Australian Minister for Environment and Water holds approximately 45.2 GL of water access entitlements in South Australia that are committed to environmental purposes and form part of South Australia's Entitlement Flow.

Of this total volume, 37.6 GL is within the Wetlands Consumptive Pool (Class 9) described in the Water Allocation Plan for the River Murray Prescribed Watercourse (WAP) (SAMDB NRMB, 2019). This water is held on licence for managed pool-connected wetlands within the River Murray WRP area and is sourced from the Dilution and Loss component of South Australia's Entitlement. This volume does not affect water available for consumptive use. Approximately 1 GL is committed to the management of Tolderol Wetland for environmental outcomes.

Approximately 6.5 GL has been committed for environmental use through the *Implementation Plan for Augmentation of the Adelaide Desalination Plant* and the location of its use is flexible (within the South Australian portion of the Murray-Darling Basin). This water is Class 3 and as such availability in 2019-20 will be in line with the River Murray Allocation Framework (SAMDB NRMB 2019).

Small volumes are held by the South Australian Minister for Environment and Water on interstate licences (less than 2 GL in total) and are general security water.

Decisions on the use of environmental water held by the South Australian Minister for Environment and Water are made within DEW consistent with approved policies and procedures and in line with the annual priorities. This water is considered HEW under the draft River Murray WRP and any trades will be recorded on the Register of Held Environmental Water, as required under the Basin Plan, once the WRP becomes accredited.

Non-Government Organisations

Nature Foundation South Australia (NFSA) holds 0.074 GL of Class 3 Water Access Entitlement on licence. The Murray-Darling Association (MDA) holds 0.018 GL of Class 3 Water Access Entitlement. For 2019-20, Accolade Wines holds 1.38 GL of Wetlands Consumptive Pool water (Class 9) for the management of the pool-connected areas of Banrock Station Wetland Complex.

This water is considered HEW under the draft River Murray WRP and any trades will be recorded on the Register of Held Environmental Water, as required under the Basin Plan, once the WRP becomes accredited.

Expected Holdings of HEW for 2019-20

The expected holdings of HEW for 2019-20 are incorporated into the Annual Operating Probabilities (AOP) provided by the MDBA in February 2019 (see Figure 1).

Planned Environmental Water Availability

Planned Environmental Water (PEW) is defined under the River Murray WRP (awaiting accreditation) as any water that is committed or preserved for achieving environmental purposes or outcomes and that cannot be used for any other purpose unless required in emergency (in accordance with section 6 of the Water Act). PEW is also identified through the 2019 River Murray WAP. The categories of water listed below are all defined as PEW in the SA River Murray WRP.

Dilution and Loss

Dilution and Loss Entitlement (696 GL) is defined under clause 88(b) of the Murray-Darling Basin Agreement and this entitlement is defined as PEW in the SA River Murray WRP once it is accredited.

The 2002 River Murray WAP established a maximum of 200 GL for wetland management purposes which equates to the evaporative losses of pool connected wetlands. This water is accounted from the Dilution and Loss Entitlement in the 2019 River Murray WAP (SAMDB NRMB 2019) and as such, is not included in the consumptive pool.

Unallocated wetlands water is the evaporative losses of unmanaged pool connected wetlands (200 GL) minus the entitlements in the Wetland Consumptive Pool (38.95 GL) and the volume in the Environmental Consumptive Pool (7.2 GL).

Approximately 46 GL of the Class 9 water is held on licences and is HEW (see above). The remaining 154 GL is considered to be planned environmental water (PEW) and is protected from consumptive use through the River Murray WAP and the River Murray WRP once it is accredited.

Unallocated entitlement

The unallocated portion of annual South Australian Entitlement minus any volume deferred, minus any volume made available for class 9 water access entitlements is considered PEW under the River Murray WRP, once accredited.

Unregulated flows

The River Murray WAP 2019, preserves above entitlement flows for the purposes of achieving environmental outcomes under Principle 6, unless required for emergencies⁵. This is reflected in the River Murray WRP, which is awaiting accreditation.

Unregulated flows generally occur in response to high rainfall events upstream from South Australia. The MDBA Southern Connected Basin Environmental Water Committee (SCBEWC) has delegated authority from the Basin Officials Committee (BOC) to authorise use of River Murray Unregulated Flow (RMUF) for environmental purposes in the River Murray.

Under the different scenarios presented in Figure 1, unregulated flow provides an increase in volume of water above South Australia's Entitlement Flow. Unregulated flows are critical for the health of South Australia's environmental assets.

⁵ consistent with Part 1 Section 6 of the Water Act 2012 on planned environmental water
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Additional Dilution Flows and Lindsay River Allowance

Other water received by South Australia also contributes to environmental outcomes in the River Murray including Additional Dilution Flow and the Lindsay River Allowance.

Eastern Mount Lofty Ranges Inflows

Flows received into Lake Alexandrina from the Eastern Mount Lofty Ranges (EMLR) tributaries (including Currency Creek, Tookayerta Creek and the Finniss, Angas and Bremer rivers), cannot be used for consumptive purposes under the Water Allocation Plan for the EMLR, and are considered PEW once they are within the River Murray WRP area. Inflows to the site from the EMLR tributaries average 78 GL per year and are less than 2 percent of the flows from the River Murray (average 5,685 GL per year) (Alcorn 2010).

Expected Quantities of PEW for 2019-20

The expected quantities of PEW for 2019-20 are incorporated into the Annual Operating Probabilities (AOP) provided by the MDBA in February 2019 (see Figure 1).

4. Co-operative Watering Arrangements

Between Water Resource Planning Areas

Water holders and managers of environmental water have worked together for several years to plan and coordinate annual multi-site environmental watering trials (Trials). The Trials aim to maximise the use of environmental water and return flows at multiple sites as water moves through the Southern Connected Basin. In 2013, the Basin Officials Committee (BOC) agreed on long-term objective of the Trials to work towards incorporating environmental delivery into normal River Murray operations. This is occurring by identifying and analysing issues and making changes to operational practices.

The Trials have tested a range of actions including new accounting methods, addition of environmental water to unregulated flow, use of loss factors and coordination of environmental releases with natural flow peaks. Each Trial built on lessons learned from the previous year and enhances understanding of the key elements for successful outcomes. A review of the Trials has been undertaken and a report documenting the outcomes is in preparation for incorporation into the existing framework for managing whole of Basin river flows.

The SCBEWC and Water Liaison Working Group (WLWG) contribute to the development of the multi-site events each year. Real-time Operational Advisory Groups hold regular teleconferences to ensure coordination and communication during events and rapid response to any issues that may arise. Membership of these groups includes holders of HEW and managers of PEW, managers of environmental assets and River operators. South Australia has representatives on these cross-jurisdictional committees and is participating in the planning for large scale environmental watering events for 2019-20.

In addition, a cross-jurisdictional River Murray channel watering event is being planned to maximise all channel flows for the benefit of the main River channel biota, habitat and functions. This event will enhance spring flow delivery to SA by coordinating upstream environmental water releases.

Within the River Murray Water Resource Planning area

Existing mechanisms to assist with coordinating environmental watering within the WRP area are described in Section 4.2.1 of the LTWP (DEWNR, 2015).

For 2019-20, DEW has developed a multi-site plan for the coordinated delivery of environmental water within the WRP area. The South Australian multi-site watering plan seeks to align site-specific watering actions that have been identified in this document, maximise the effectiveness of environmental water delivery and enhance ecological outcomes throughout the system. This multi-site approach is supported by South Australian policy which prevents return flows from environmental watering actions, such as the operation and testing of the Chowilla regulator and weir raisings, from being re-allocated for consumptive use, ensuring this water will flow down the river and be delivered to the CLLMM for ecological benefit.

The SA multi-site watering action has been provided to the MDBA, water holders and relevant environmental managers via SCBEWC.

References

Department of Environment, Water and Natural Resources (DEWNR) 2015, *South Australian River Murray Region Long-Term Environmental Watering Plan*, Government of South Australia, Adelaide

Department of the Environment and Energy (2019), *Environmental water holdings*, viewed on 15 April 2019, Commonwealth Environmental Water Office, <www.environment.gov.au/water/cewo/portfolio-mgt/holdings-catchment>.

Murray–Darling Basin Authority (MDBA) 2014, *Basin-Wide Environmental Watering Strategy*, Commonwealth of Australia, Canberra

O'Connor, J., Steggles, T., Higham, J., & Rumbelow, A. (2015). *Ecological objectives, targets, and environmental water requirements for the Coorong, Lower Lakes and Murray Mouth*. Adelaide: Department of Environment Water and Natural Resources.

South Australian Murray–Darling Basin Natural Resources Management Board (SAMDB NRMB) 2019, *The Water Allocation Plan for the River Murray Prescribed Watercourse*, Government of South Australia, Adelaide

Appendix 1. Summary of environmental watering priorities proposed for 2019-20

Dry (90% AOP) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	Spring inundation of fringing Lower Lakes wetlands (~0.8 m AHD) and enhanced barrage releases	4 months – Sept - Dec	<ul style="list-style-type: none"> ○ Objectives ○ Lower Lakes fringing & submerged vegetation ○ Upstream migration of YOY congolli and common galaxias ○ Localised estuary for estuarine fish, macroinvertebrates, waterbirds ○ Maintain lake levels ~0.8 m AHD October to December ○ Provide for southern bell frog & small bodied threatened fish recruitment 	457
	Continuous barrage releases for fish passage	8 months – Jan – Jun and Jul-Aug	<ul style="list-style-type: none"> ○ Provide continuous fishway/barrage releases & localised estuarine conditions ○ Downstream movement and recruitment of congolli and common galaxids ○ Upstream lamprey migration and recruitment ○ Provide continuous connectivity between river & estuary ○ Maintain lake levels >0.5m AHD all year 	322
Channel and Floodplain	Spring pulse $\geq 10,000$ ML/day with minimum 60-day duration commencing after mid-October and incorporating a short (minimum 20-days) peak $\geq 15,000$ ML/day	Minimum 60 days – mid-October to mid-December	<ul style="list-style-type: none"> ○ Water level variability in the upper weir pool resulting in: <ul style="list-style-type: none"> ○ Altered light environment for biofilms; contribute to a median biofilm composition that is not dominated by filamentous algae ○ Recruitment of emergent aquatic vegetation species ○ Increase potential for lateral recharge to generate near-bank freshwater lenses ○ Some expansion of habitats available to invertebrate species associated with littoral plants ○ Short-term (20-day) improvement in velocity, resulting in: <ul style="list-style-type: none"> ○ Abundant moderate-fast (0.18–0.25 m s⁻¹) habitat (although fast (>0.25 m s⁻¹) habitat remains scarce) ○ Mean velocity in all reaches >0.2 m/s ○ Support propagule entrainment and transport 	419
Weirpool	No weir pool manipulations proposed	N/A	N/A	N/A
Chowilla	Pump to up to 8 priority wetlands	Sept-Nov	<ul style="list-style-type: none"> ○ Fringing vegetation – support seedlings ○ Reduce soil salinity and improved soil moisture at sites ○ Support the maintenance of long lived vegetation: black box, River red gums, lignum and River cooba. ○ Provide refuge habitats for a range of biota including waterbirds. ○ Providing breeding opportunities for frogs including Southern bell frogs (nationally threatened). 	8

Site	Action	Details	Objectives	Vol GL
	Pulse flows through Chowilla anabranch via Pipeclay & Slaney Creek weirs	20 weeks – Oct - Feb	<ul style="list-style-type: none"> ○ Fast flowing habitat for large bodied fish ○ Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds) ○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates. 	N/A
Pike	Pulse flows through Tanyaca via Margaret Dowling and Deep Creek inlets	12 weeks Dec-Feb	<ul style="list-style-type: none"> ○ Fast flowing habitat for medium and large bodied fish - generate mean channel velocity in the range of 0.2-0.5mS⁻¹ ○ Mobilise carbon and nutrients to support aquatic food ○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates. 	N/A
	Temporary in-channel rise up to maximum 15.0 mAHD (0.45 m) at Pike Environmental Regulator and up to maximum 15.41 mAHD (0.66 m) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlets.	6 weeks Jan-Feb	<ul style="list-style-type: none"> ○ Instate variability in hydraulic conditions (depth, velocity, turbulence) ○ Reduced salinity of near-bank groundwater ○ Reduced soil salinity and improved soil moisture availability in inundated and adjacent zones ○ Improve biofilm quality ○ Improved vegetation growth in riparian zone ○ Support ongoing growth of seedlings and saplings of river red gum, black box and cooba that have established in response to flooding and environmental watering recent years 	1 GL ⁶
Wetlands	Delivery of water via pumping and gravity at up to 22 priority wetland sites located along the River Murray from the border to the Lower Lakes.	Sept-Feb (pumped wetlands) Jul-Jun (gravity fed wetlands)	<ul style="list-style-type: none"> ○ Support known populations of Murray hardyheads (nationally threatened), including providing conditions for breeding opportunities. ○ Support the maintenance of long lived vegetation: black box, River red gums, lignum and River cooba. ○ Provide refuge habitats for waterbirds. ○ Providing breeding opportunities for Southern bell frogs (nationally threatened). ○ Regent parrot (nationally threatened) populations supported. 	8
	Operate infrastructure to implement a range of hydrological phases (including drying, refilling, pool level and flow through) at 38 the pool connected wetlands.	Jul-Jun	<ul style="list-style-type: none"> ○ Consolidate wetland bed soils during dry phases and improve water turbidity during wet phases ○ Create or improve freshwater lens and reduce risks of salinisation ○ Encourage growth of riparian, littoral, groundcover and aquatic vegetation ○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Ensure fringing long lived vegetation is maintained 	37.5
	Additional delivery of water to temporary wetlands sites by Non-Government Organisations including NRA, RIT, ALT, Accolade and NFSA	Jul-Jun	<ul style="list-style-type: none"> ○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Support the maintenance of vegetation including long lived vegetation: black box, River red gums, lignum and River cooba. ○ Population of Regent parrot (nationally threatened) supported at Banrock 	Approx 10-15

⁶ Volume based on inflows of 50 ML/day

Moderate (75% AOP) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	Spring inundation of fringing Lower Lakes wetlands (~0.8 m AHD) and enhanced barrage releases	4 months – Sept - Dec	<ul style="list-style-type: none"> ○ Lower Lakes fringing & submerged vegetation ○ Upstream migration of YOY congolli and common galaxias ○ Localised estuary for estuarine fish, macroinvertebrates, waterbirds ○ Maintain lake levels ~0.8 m AHD October to December ○ Provide for southern bell frog & small bodied threatened fish recruitment 	432
	Continuous barrage releases for fish passage	8 months – Jan - June & Jul-Aug	<ul style="list-style-type: none"> ○ Provide continuous fishway/barrage releases & localised estuarine conditions ○ Downstream movement and recruitment of congolli and common galaxids ○ Upstream lamprey migration and recruitment ○ Provide continuous connectivity between river & estuary ○ Maintain lake levels >0.5m AHD all year 	320
Channel and Floodplain	Spring pulse $\geq 10,000$ ML/day with minimum 60-day duration commencing after mid-October and incorporating a short (minimum 20-days) peak $\geq 15,000$ ML/day	Minimum 60 days – mid-October to mid-December	<ul style="list-style-type: none"> ○ Water level variability in the upper weir pool resulting in: <ul style="list-style-type: none"> ○ Altered light environment for biofilms; contribute to a median biofilm composition that is not dominated by filamentous algae ○ Recruitment of emergent aquatic vegetation species ○ Increase potential for lateral recharge to generate near-bank freshwater lenses ○ Some expansion of habitats available to invertebrate species associated with littoral plants ○ Short-term (20-day) improvement in velocity, resulting in: <ul style="list-style-type: none"> ○ Abundant moderate-fast (0.18–0.25 m s⁻¹) habitat (although fast (>0.25 m s⁻¹) habitat remains scarce) ○ Mean velocity in all reaches >0.2 m/s ○ Support propagule entrainment and transport 	419
Weir Pool Manipulation	Raise Weir Pool 6 up to +42cm above normal pool level (NPL) Raise Weir Pool 5 up to +50cm above NPL Raise Weir Pool 2 up to +52cm above NPL	Approx. 115 days total duration (incl. filling and drawdown phase) with minimum 75 days at maximum raised level – Aug - Nov	<ul style="list-style-type: none"> ○ Water level variability upstream of the weirs, generating: <ul style="list-style-type: none"> ○ Growth and expansion of littoral vegetation including Juncus, Cyperus gymnocaulos, Schoenoplectus validus ○ Understorey plant community sustained and productive ○ Create diverse and productive biofilm and macroinvertebrate communities ○ Provide breeding habitat for small fish (in littoral vegetation) and reed-dependent waterbirds ○ Groundwater exchange with river and relieve soil salinity stress in littoral zone ○ Contribute water to in-channel flows during drawdown in late spring to assist in delivering water to the CLLMM and maintaining Lock 1 flow target when climate conditions tend to become hotter and drier 	23.3 (includes return flows of 18.6)

Site	Action	Details	Objectives	Vol GL
Chowilla	Pump to up to 8 priority wetlands	Sept-Nov	<ul style="list-style-type: none"> ○ Fringing vegetation – support seedlings ○ Reduce soil salinity and improved soil moisture at sites ○ Support the maintenance of long lived vegetation: black box, River red gums, lignum and River cooba. ○ Provide refuge habitats for a range of biota including waterbirds. ○ Providing breeding opportunities for frogs including Southern bell frogs (nationally threatened). 	8
	Pulse flows through Chowilla anabranch via Pipeclay & Slaney Creek weirs in conjunction with raising weir pool 6.	20 weeks – Oct - Feb	<ul style="list-style-type: none"> ○ Fast flowing habitat for large bodied fish ○ Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds) ○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates. 	N/A
Pike	Pulse flows through Tanyaca via Margaret Dowling and Deep Creek inlets	12 weeks Dec-Feb	<ul style="list-style-type: none"> ○ Fast flowing habitat for medium and large bodied fish - generate mean channel velocity in the range of 0.2-0.5mS⁻¹ ○ Mobilise carbon and nutrients to support aquatic food ○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates. 	N/A
	Temporary in-channel rise up to maximum 15.0 mAHD (0.45 m) at Pike Environmental Regulator and up to maximum 15.41 mAHD (0.66 m) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlets.	6 weeks Jan-Feb	<ul style="list-style-type: none"> ○ Instate variability in hydraulic conditions (depth, velocity, turbulence) ○ Reduced salinity of near-bank groundwater ○ Reduced soil salinity and improved soil moisture availability in inundated and adjacent zones ○ Improve biofilm quality ○ Improved vegetation growth in riparian zone ○ Calibration of surface water model 	1 GL ⁷
Wetlands	Delivery of water via pumping and gravity at up to 22 priority wetland sites located along the River Murray from the border to the Lower Lakes.	Sept-Feb (pumped wetlands) Jul-Jun (gravity fed wetlands)	<ul style="list-style-type: none"> ○ Support known populations of Murray hardyheads (nationally threatened), including providing conditions for breeding opportunities. ○ Support the maintenance of long lived vegetation: black box, River red gums, lignum and River cooba. ○ Provide refuge habitats for waterbirds. ○ Providing breeding opportunities for Southern bell frogs (nationally threatened). ○ Regent parrot (nationally threatened) populations supported. 	8
	Operate infrastructure to implement a range of hydrological phases (including drying, refilling, pool level and flow	Jul-Jun	<ul style="list-style-type: none"> ○ Consolidate wetland bed soils during dry phases and improve water turbidity during wet phases ○ Create or improve freshwater lens and reduce risks of salinisation ○ Encourage growth of riparian, littoral, groundcover and aquatic vegetation 	37.5

⁷ Volume based on inflows of 50 ML/day

Site	Action	Details	Objectives	Vol GL
	through) at 38 the pool connected wetlands.		<ul style="list-style-type: none"> ○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Ensure fringing long lived vegetation is maintained 	
	Additional delivery of water to temporary wetlands sites by Non-Government Organisations including NRA, RIT, ALT, Accolade and NFSA	Jul-Jun	<ul style="list-style-type: none"> ○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Support the maintenance of vegetation including long lived vegetation: black box, River red gums, lignum and River cooba. ○ Regent parrot (nationally threatened) populations supported 	Approx 10-15

Near Average (50% AOP) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	Extend unregulated flows through spring and into early summer for Coorong North Lagoon outcomes	4 months - Oct – Jan (extension of unregulated flows)	<ul style="list-style-type: none"> ○ Estuarine conditions throughout North Lagoon ○ Lower Lakes levels raised >0.8 m AHD in spring ○ Provide for fish migration and connectivity ○ Upstream migration of YOY congolli and common galaxias ○ Improve North Lagoon habitat for benthic macroinvertebrates, migratory birds and adult estuarine fish ○ Spawning and recruitment of black bream and greenback flounder ○ Feeding habitat for migratory waders 	514
	Continuous barrage releases for fish passage	5 months - Feb - Jun	<ul style="list-style-type: none"> ○ Provide continuous fishway/barrage releases & localised estuarine conditions ○ Downstream movement and recruitment of congolli and common galaxids ○ Upstream lamprey migration and recruitment ○ Provide continuous connectivity between river & estuary ○ Maintain lake levels >0.5m AHD all year 	301
Channel and Floodplain	Target EWR-IC3 (Median discharge QSA 20,000 ML/day)	90-days - Sep to Nov	<ul style="list-style-type: none"> ○ Abundant fast flowing habitat (>0.25 m/s) available ○ Improved soil water availability and reduced soil salinity ○ Growth of emergent aquatic plants in temporary wetlands inundated by elevated flows ○ Improved river red gum population demographics in inundated areas and areas adjacent due to lateral recharge of groundwater ○ Support spawning and recruitment of golden perch and silver perch by creating conditions conducive to reproductive activity when temperature thresholds (20 degrees) are exceeded ○ Improved survival of Murray cod and catfish larvae 	490
Weir Pool Manipulation	Raise weir pool 3 by up to 30 cm if QSA ≥ 20,000 ML/d for duration of Weir Pool Manipulation (WPM) hydrograph	75 days - July - Oct	<ul style="list-style-type: none"> ○ Flush salt from Lake Bonney ○ Littoral zone carbon cycling and soil condition improvements ○ maintain riparian vegetation condition ○ Improve biofilm quality 	29.1 GL (includes return flows - 26.8)

	Lower weir pool 3 to -10 cm below Normal Pool Level (NPL) if QSA \geq 20,000 ML/d for duration of Weir Pool Manipulation (WPM) hydrograph	25 Days - Oct	<ul style="list-style-type: none"> ○ Sediment exposure will enable soil oxidation and nutrient cycling processes to occur improving soil chemical and physical condition ○ Littoral zone carbon cycling and soil condition 	5.5 GL (refill vol)
	Raise Weir Pool 6 up to +59cm above NPL Raise Weir Pool 5 up to +50cm above NPL Raise Weir Pool 2 up to +75cm above NPL	Approx. 105 days (incl. filling and drawdown phase) – Jul - Oct	<ul style="list-style-type: none"> ○ Wetland inundation, connectivity and production ○ Health, growth and reproduction of floodplain vegetation ○ Access for aquatic fauna to floodplain and wetland habitats, particularly during key breeding and foraging periods ○ Transfer of particulate organic matter from the floodplain to the river channel 	23.6 (includes return flows of 20.7)
Chowilla	Pump to up to 8 priority wetlands	Sept-Nov	<ul style="list-style-type: none"> ○ Fringing vegetation – support seedlings ○ Reduce soil salinity and improved soil moisture at sites ○ Support the maintenance of long lived vegetation: black box, River red gums, lignum and River cooba. ○ Provide refuge habitats for a range of biota including waterbirds. ○ Providing breeding opportunities for frogs including Southern bell frogs (nationally threatened). 	8
	Pulse flows through Chowilla anabranch via Pipeclay & Slaney Creek weirs in conjunction with raising weir pool 6.	20 weeks – Oct - Feb	<ul style="list-style-type: none"> ○ Fast flowing habitat for large bodied fish ○ Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds) ○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates. 	N/A
Pike	Pulse flows through Tanyaca via Margaret Dowling and Deep Creek inlets	12 weeks Dec-Feb	<ul style="list-style-type: none"> ○ Fast flowing habitat for medium and large bodied fish - generate mean channel velocity in the range of 0.2-0.5mS⁻¹ ○ Mobilise carbon and nutrients to support aquatic food ○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates 	N/A
	Temporary in-channel rise up to maximum 15.0 mAHD (0.45 m) at Pike Environmental Regulator and up to maximum 15.41 mAHD (0.66 m) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlets.	6 weeks Jan-Feb	<ul style="list-style-type: none"> ○ Instate variability in hydraulic conditions (depth, velocity, turbulence) ○ Reduced salinity of near-bank groundwater ○ Reduced soil salinity and improved soil moisture availability in inundated and adjacent zones ○ Improve biofilm quality ○ Improved vegetation growth in riparian zone ○ Support ongoing growth of seedlings and saplings of river red gum, black box and cooba 	1 GL ⁸

⁸ Volume based on inflows of 50 ML/day

Wetlands	Delivery of water via pumping and gravity at up to 18 priority wetland sites located along the River Murray from the border to the Lower Lakes.	Sept-Feb (pumped wetlands) Nov-Jun (gravity fed wetlands)	<ul style="list-style-type: none"> ○ Support known populations of Murray hardyheads (nationally threatened), including providing conditions for breeding opportunities. ○ Support the maintenance of long lived vegetation: black box, River red gums, lignum and River cooba. ○ Provide habitats and food resources for waterbirds. ○ Providing breeding opportunities for Southern bell frogs (nationally threatened). ○ Regent parrot (nationally threatened) populations supported. 	6
	Operate infrastructure to implement a range of hydrological phases (including drying, refilling, pool level and flow through) at 38 the pool connected wetlands.	Nov-Jun	<ul style="list-style-type: none"> ○ Consolidate wetland bed soils during dry phases and improve water turbidity during wet phases ○ Create or improve freshwater lens and reduce risks of salinisation ○ Encourage growth of riparian, littoral, groundcover and aquatic vegetation ○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Ensure fringing long lived vegetation is maintained 	Up to 37.5
	Additional delivery of water to temporary wetlands sites by Non-Government Organisations including NRA, RIT, ALT, Accolade and NFSA	Jul-Jun	<ul style="list-style-type: none"> ○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Support the maintenance of vegetation including long lived vegetation: black box, River red gums, lignum and River cooba. ○ Population of Regent parrot (nationally threatened) supported (Banrock) 	Approx 10-15

Wet (25% AOP) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	Extend unregulated flows through spring and into early summer for Coorong North & South Lagoon outcomes	4 months - Oct-Jan	<ul style="list-style-type: none"> ○ <i>Ruppia tuberosa</i> germination and recruitment ○ Salinity benefits to North and South Lagoons ○ Estuarine fish utilise both north and south lagoons for growth and recruitment ○ Adequate food availability in north and south lagoons for all guilds of waterbirds ○ Open Murray Mouth & salt/nutrient export ○ Abundance and extent of macroinvertebrates increases 	701
	Continuous barrage releases for fish passage	5 months - Feb-Jun	<ul style="list-style-type: none"> ○ Provide continuous fishway/barrage releases & localised estuarine conditions ○ Downstream movement and recruitment of congolli and common galaxids ○ Upstream lamprey migration and recruitment ○ Provide continuous connectivity between river & estuary ○ Maintain lake levels >0.5m AHD all year 	210
Channel and Floodplain	Target EWR-FP1 described in the SA River Murray LTWP (Median discharge OSA 50,000 ML/d)	30 days - Sep	<p>All SA River Murray Channel targets are relevant and in addition:</p> <ul style="list-style-type: none"> ○ Inundation of the SA River Murray Floodplain PEA commences ○ Large Murray cod recruitment event 	165

	Target EWR-IC7 described in the SA River Murray LTWP (Median discharge QSA 40,000 ML/day)	90 days - Sep-Nov	<ul style="list-style-type: none"> ○ Support large-scale breeding by eight riparian frog species ○ Inundation of the entire SA River Murray Channel priority environmental asset (PEA) ○ Heterotrophic productivity becomes dominant ○ Significant areas of temporary wetland connected to the River ○ Growth, condition and recruitment of native vegetation from emergent, amphibious and flood-dependent functional groups is supported across the entire elevation gradient of the SA River Murray Channel PEA 	311
Weir Pool Manipulation	Raise weir pool 3 by up to 30 cm and lower to -10 cm below Normal Pool Level (NPL) if QSA ≥ 20,000 ML/d for duration of Weir Pool Manipulation (WPM) hydrograph	75 days - July - Oct	<ul style="list-style-type: none"> ○ Flush salt from Lake Bonney ○ Improve soil condition to maintain riparian vegetation condition ○ Improve biofilm quality 	WPR 26.3 GL (includes return flows of 22.1)
	Lower weir pool 3 to -10 cm below Normal Pool Level (NPL) if QSA ≥ 20,000 ML/d for duration of Weir Pool Manipulation (WPM) hydrograph	25 Days - Oct	<ul style="list-style-type: none"> ○ Flush salt from Lake Bonney ○ Littoral zone carbon cycling and soil condition improvements ○ maintain riparian vegetation condition ○ Improve biofilm quality 	WPL 3.92 GL (refill volume)
	Raise Weir Pool 5 up to +50cm above NPL Raise Weir Pool 2 up to +75cm above NPL	Approx. 135 days (incl. filling and drawdown phase) - Jul – Nov	<ul style="list-style-type: none"> ○ See objectives under Near Average scenario, noting there will be an increased area of influence due to higher flows under a Wet scenario 	21.8 (includes return flows of 17.6)
Chowilla	Operate Chowilla regulator to generate a max- floodplain inundation. (<i>Chowilla regulator – 19.85m AHD; L6 – 19.85m AHD</i>)	157 days – July-Dec	<ul style="list-style-type: none"> ○ Potentially test regulator and ancillary structures to higher operating levels ○ Improve soil moisture availability to within ranges conducive to active tree growth to reduce potential for loss of tree condition, and support progressive improvement of long-lived vegetation ○ Generate an increase in the proportion of trees for which condition scores are above the Ecological Target – specifically targeting re-watering mid-level elevation Black Box to consolidate benefits from 2016 managed inundation and unregulated flow event ○ Instate connectivity to mid-elevation floodplain and all key wetlands ○ Contribute to ensuring the long-term sustainability of floodplain tree community by support ongoing growth of seedlings and saplings of River Red Gum, Black Box and Cooba ○ Improve condition of Lignum in inundated areas ○ Provide breeding habitat for waterbirds, amphibians and invertebrates. ○ Create conditions conducive to germination and growth of flood dependent and flood responsive vegetation ○ Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds) 	110.8 (includes return flows of 61.8)

			<ul style="list-style-type: none"> o Improve condition of floodplain habitat for dependent species including reptiles, woodland birds and mammals 	
Pike	Pulse flows through Tanyaca via Margaret Dowling and Deep Creek inlets	12 weeks Dec-Feb	<ul style="list-style-type: none"> o Fast flowing habitat for medium and large bodied fish - generate mean channel velocity in the range of 0.2-0.5mS⁻¹ o Mobilise carbon and nutrients to support aquatic food o Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates. 	N/A
	Temporary in-channel rise up to maximum 15.0 mAHD (0.45 m) at Pike Environmental Regulator and up to maximum 15.41 mAHD (0.66 m) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlets.	6 weeks Jan-Feb	<ul style="list-style-type: none"> o Instate variability in hydraulic conditions (depth, velocity, turbulence) o Reduced salinity of near-bank groundwater due to lateral infiltration of low salinity surface water o Reduced soil salinity and improved soil moisture availability in inundated and adjacent zones o Improve biofilm quality o Improved vegetation growth in riparian zone o Support ongoing growth of seedlings and saplings of river red gum, black box and cooba 	1 GL ⁹
Wetlands	Delivery of water via pumping and gravity at up to 5 priority wetland sites located along the River Murray from the border to the Lower Lakes.	Sept-Feb (pumped wetlands) Feb-Jun (gravity fed wetlands)	<ul style="list-style-type: none"> o Support the maintenance of long lived vegetation: black box, River red gums, lignum and River cooba. o Provide habitats and food resources for waterbirds. o Providing breeding opportunities for Southern bell frogs (nationally threatened). o Regent parrot (nationally threatened) populations supported. 	2
	Operate infrastructure to implement a range of hydrological phases (including drying, refilling, pool level and flow through) at 38 the pool connected wetlands.	Jan-Jun	<ul style="list-style-type: none"> o Consolidate wetland bed soils during dry phases and improve water turbidity during wet phases o Create or improve freshwater lens and reduce risks of salinisation o Encourage growth of riparian, littoral, groundcover and aquatic vegetation o Provide habitat for fish, turtles, frogs and water dependent birds o Ensure fringing long lived vegetation is maintained 	Up to 37.5
	Additional delivery of water to temporary wetlands sites by Non-Government Organisations including NRA, RIT, ALT, Accolade and NFSA	Jul-Jun	<ul style="list-style-type: none"> o Provide habitat for fish, turtles, frogs and water dependent birds o Support the maintenance of vegetation including long lived vegetation: black box, River red gums, lignum and River cooba. o Regent parrot (nationally threatened) populations supported 	Approx 10-15

⁹ Volume based on inflows of 50 ML/day

