2019-20 Annual Water for the Environment Plan

For the South Australian River Murray

Government of South Australia

Department for Environment and Water

Foreword

The *2019-20 Annual Water for the Environment Plan for the South Australian River Murray* (the Annual Plan) is a key element in South Australia's river management framework. It builds upon actions delivered in previous annual plans and is guided by the ecological objectives and targets in the *Long Term Environmental Watering Plan for the South Australian River Murray (2015)*.

The Annual Plan is prepared as part of Basin Plan prioritisation and planning processes, which determine how available environmental water will be used in the Murray-Darling Basin. A wide range of stakeholders have been engaged in its development, supporting a transparent process to determine environmental watering priorities.

Each year the water resource outlook is different, volumes of available environmental water change and environmental watering priorities vary. This presents a challenge to water holders and managers to maximise outcomes from the available resources. The current outlook for 2019-20 is for dry conditions in the Murray-Darling Basin, which would see not only low natural flows but also a limited availability of water for the environment. Despite this, it is well understood that conditions can change rapidly; therefore the plan presents the priority needs of environmental water delivery under a wide range of conditions.

I would like to thank all those who have been involved in the planning, management and delivery of water for the environment and look forward to another successful watering year in 2019-20.

Ben Bruce, Executive Director, Water and River Murray
Department for Environment and Water
November 2019

Royal Spoonbill in breeding condition. Photo: Adrienne Rumbelow, DEW

Acknowledgements

The Department for Environment and Water (DEW) acknowledges and pays respect to the Traditional Owners and their Nations, of the Murray-Darling Basin, who have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters.

In addition to DEW staff, input from representatives and employees of the following organisations has been gratefully received:

- Banrock Station, Accolade Wines
- Chowilla Community Reference Committee
- Commonwealth Environmental Water Office (CEWO)
- Coorong, Lower Lakes and Murray Mouth Community Advisory Panel
- First Peoples of the River Murray and Mallee Region
- Local Action Planning groups and Landcare groups
- Murray-Darling Basin Authority (MDBA)
- Nature Foundation SA
- Ngarrindjeri Aboriginal Corporation (NAC), including the Mannum Aboriginal Community Association Incorporated
- Renmark Irrigation Trust (RIT)
- River Murray Advisory Committee (RMAC)
- Scientific Advisory Group for the Lower Lakes, Coorong and Murray Mouth
- South Australian Murray-Darling Basin Natural Resources Management (SAMDB NRM) Board
- South Australian Research and Development Institute (SARDI)
- University of Adelaide
- Flinders University
- Other South Australian government departments through interagency reference groups

DEW

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The Annual Plan presents South Australia's preferences for environmental water delivery along the South Australian River Murray for the 2019-20 water year. It describes water delivery requirements to best achieve a range of environmental outcomes along the South Australian stretch of the river, its floodplains and wetlands, through to the Murray Mouth and Coorong, consistent with requirements under the Murray-Darling Basin Plan. In doing so, it identifies opportunities to maximise outcomes from watering in South Australia by using return flows from upstream watering actions. It also promotes delivery of water for the environment to the Coorong, Lower Lakes and Murray Mouth (CLLMM) while providing benefits to upstream environmental assets and functions en route.

The Annual Plan is presented as follows:

- Section 1: provides background information relevant to environmental watering including recent hydrological conditions in the region.
- Section 2: summarises how environmental managers engaged with external stakeholders and Indigenous groups to develop their environmental watering proposals and assess any potential risks and the process to develop the Annual Plan.
- Section 3: highlights the linkages between the objectives for environmental watering in South Australia and the overall environmental objectives for water-dependent ecosystems identified in the Basin Plan, as well as the management objectives of the major environmental water holders.
- Section 4: presents the annual environmental watering priorities for the South Australian River Murray Water Resource Plan (WRP) area, which were submitted to the MDBA in accordance with Basin Plan requirements. It also describes a multi-site watering action for the use of environmental water within the South Australian River Murray region. This South Australian multi-site watering demonstrates how the effectiveness of environmental water delivery can be maximised through aligning the timing, magnitude and duration of watering actions at multiple locations along the South Australian River Murray.
- Section 5: provides practical information for implementing environmental watering actions, including an overview of licensing, trade, accounting and reporting mechanisms.

1 Introduction

1.1 Purpose of this Plan

The Annual Plan guides water delivery for the environment in the South Australian River Murray for the 2019-20 water year and has been developed in consultation with key stakeholders. The Annual Plan presents the priorities for environmental watering for a range of water availability scenarios, which are required to be submitted to the MDBA annually under the Basin Plan (DEW 2019a).

The purpose of this document is to:

- document South Australia's priority environmental water needs and inform water holders of the preferred patterns of delivery for 2019-20
- guide the delivery of environmental water to South Australia to maximise the potential outcomes throughout the South Australian lower Murray system
- identify opportunities, where appropriate, to enhance environmental outcomes through the operation of infrastructure
- make information on priority environmental watering activities available to stakeholders.

The Annual Plan is a part of South Australia's contribution to the Basin-wide environmental water management framework (see Appendix A) and integrates all of the proposed watering activities for the water year ahead in the River Murray in South Australia. It has been developed based on the best available data and science; however, water availability and delivery is subject to change depending on actual river and climatic conditions, which will inform real-time and adaptive water use.

This is the fifth annual plan to be developed since the publication of the *Long Term Environmental Watering Plan for the South Australian River Murray Water Resource Plan Area* (Department of Environment Water and Natural Resources, 2015). The long-term watering plan (LTWP) is a requirement under the Basin Plan for each WRP area and must identify priority environmental assets, priority ecosystem functions, as well as ecological objectives, targets and environmental watering requirements (EWRs). The South Australian River Murray LTWP identifies three priority environmental assets: the CLLMM, the River Murray Channel and the River Murray Floodplain.

The priorities for watering in 2019-20 identified in this Annual Plan are consistent with the assets and EWRs described in the South Australian River Murray LTWP, as well as being consistent with the Basin-Wide Environmental Watering Strategy (Murray-Darling Basin Authority, 2014a).

1.2 What is Environmental Watering?

Environmental watering is the delivery or use of water to achieve environmental outcomes – that is, ecological benefits that contribute to a healthy, working river. Environmental watering ensures that important values of the South Australian River Murray, its wetlands and floodplains and the CLLMM are maintained and that environmental objectives are achieved.

Environmental water management along the River Murray in South Australia is coordinated by the Department for Environment and Water (DEW), with significant input from other government agencies, non-government organisations, scientific bodies and community stakeholders.

The South Australian environmental water planning and management framework includes the development of the Annual Environmental Watering Priorities, the Annual Plan, the Annual Report, the SA River Murray LTWP, the state's environmental watering policy and procedures and management of the South Australian environmental water and water received by South Australia from the Commonwealth Environmental Water Holder (CEWH), The Living Murray Program (TLM) and other environmental water holders.

1.2.1 On-ground Management

DEW coordinates environmental water delivery in partnership with SA Water, environmental water holders, the community and other Basin governments.

DEW has responsibility for the management of a range of floodplain and wetland sites in the South Australian Murray-Darling Basin. These include TLM icon sites including the Chowilla Floodplain, the River Murray Channel and the CLLMM, along with a range of wetland and floodplain sites. DEW also coordinates and oversees the management of infrastructure for environmental outcomes (e.g. raising weir pools and operating flow control structures and regulators on wetlands).

A number of non-government organisations are involved in on-ground management of water for the environment and associated monitoring, including Australian Landscape Trust (ALT), Banrock Station-Accolade Wines, Local Action Planning and Landcare groups, Nature Foundation SA, Ngarrindjeri Aboriginal Corporation (NAC) and Renmark Irrigation Trust (RIT). These organisations facilitate grass roots environmental activities with local landholders and other community groups.

1.2.2 Environmental Water Categories

Environmental water is generally described as 'held' or 'planned' environmental water, where:

- **Held environmental water** is water held on the licence of a water holder who determines that this water will be used for environmental watering activities. Held environmental water may be either a purchased allocation or an allocation granted under the water holder's entitlements. This can be flexibly managed and released according to demands/agreed actions.
- **Planned environmental water** is water that is not held on a water licence, but is committed or preserved for environmental purposes or environmental outcomes and cannot be used for any other purpose unless required for emergency purposes.

Potential sources and volumes of held and planned environmental water for 2019-20 are described in this document and in the South Australian River Murray WRP (DEW 2019b).

River red gums on Chowilla Creek at sunset. Photo: Jan Whittle, DEW

1.3 The 2018-19 Water Year in Review

A brief summary of the 2018-19 water year is outlined below to provide some context to the conditions leading up to the 2019-20 water year. More information from earlier years can be found on the DEW website at: http://www.environment.sa.gov.au/managing-natural-resources/river-murray/restoring-river-health/environmental-water.

South Australia received entitlement flow throughout 2018-19 and there was only a very brief unregulated flow event in December 2018. Flows to South Australia peaked at 12,000 megalitres per day (ML/day) in January 2019 (Figure 1).

In total, approximately 850 gigalitres (GL) of held environmental water was delivered to South Australia. The CEWH provided approximately 562 GL (including approximately 155 GL held on licences in South Australia) and TLM provided approximately 96 GL (including 45 GL held on licences in South Australia) of environmental water to South Australia in 2018-19. South Australia also received approximately 35 GL of environmental water in the form of return flows from upstream watering actions undertaken by the Victorian Environmental Water Holder (VEWH). An additional 111 GL of River Murray Increased Flow was also delivered. Approximately 45 GL of environmental water held by the then South Australian Minister for Water and the River Murray was delivered to pool-connected wetlands, temporary wetlands and the CLLMM. The monthly delivery profile is presented in Figure 2.

Environmental water delivered to South Australia was used to support numerous watering actions throughout the year, including:

- raising Weir 2 by 50 centimetres (cm) and Weir 5 by 45 cm in Spring
- operating Chowilla Regulator to raise anabranch water levels within-channel by 2.1 m, including raising Weir 6 by 22 cm
- inundating over 40 temporary wetland and floodplain areas (including wetlands on Chowilla Floodplain and sites managed by DEW, Australian Landscape Trust, Banrock Station and Nature Foundation SA) via pumping or irrigation
- wetting and drying of pool-connected wetlands
- managing the CLLMM throughout the year, including manipulating water levels in the Lower Lakes and maintaining barrage and fishway releases.

Monitoring data has not yet been fully analysed but preliminary results indicate that some of the key ecological outcomes from these environmental watering actions were:

- improved in-stream productivity
- improved condition of riparian and wetland vegetation communities
- enhanced survival of seedlings and saplings of native floodplain tree species that germinated during previous high flow and managed inundation events
- frog breeding, including successful metamorphosis of southern bell frogs
- fishway and barrage outflows throughout the year providing continuous connectivity between the river and its estuary and significant salt export from the Murray-Darling Basin
- significant diadromous fish migration, including upstream migration of young-of-year congolli and common galaxias in Spring and Summer
- large numbers of colonial waterbirds nesting in the Lower Lakes
- high abundances and extended distribution of smallmouth hardyhead in the Coorong, a key prey species for piscivorous waterbirds and large-bodied fish.

More information on the outcomes of the environmental watering actions in 2018-19 will be presented in the annual environmental watering report that is produced in late 2019.

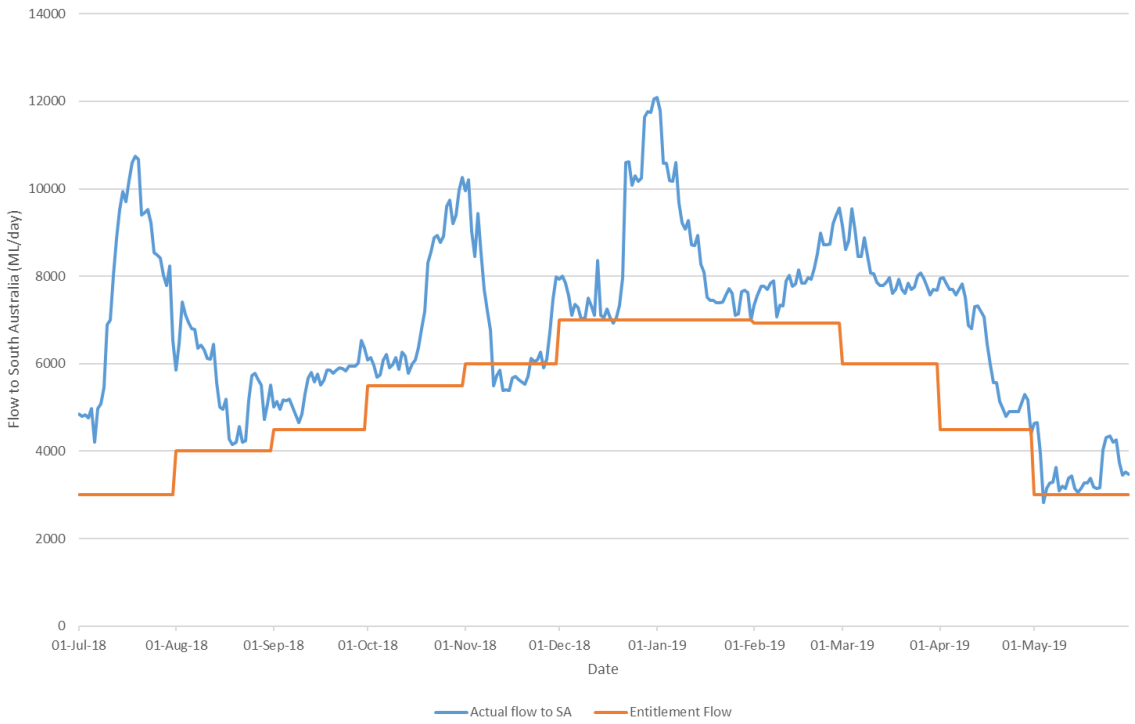

Figure 1. River Murray flows at the South Australian border throughout 2018-19

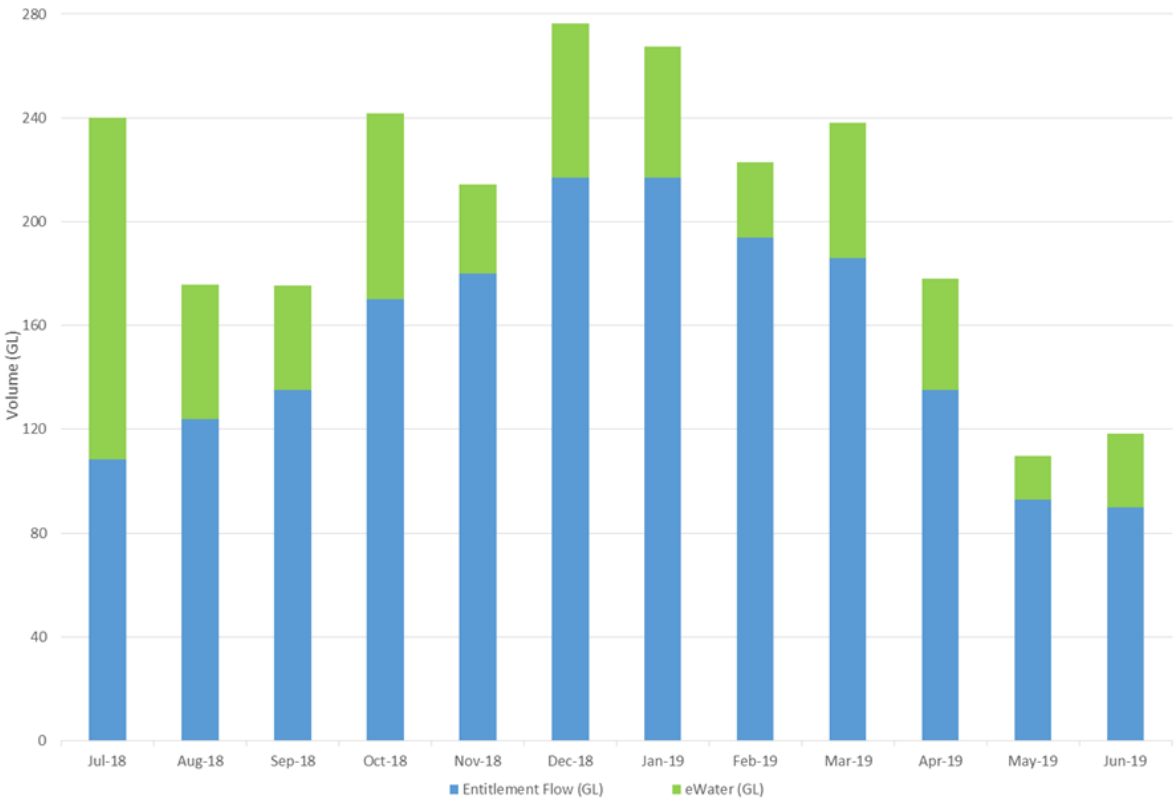

Figure 2. Monthly volumes of water delivered to South Australia in 2018-19

2 Annual Planning Process

2.1 Approach

The Basin Plan requires Basin governments to identify their annual environmental watering priorities for the upcoming water year and submit them to the MDBA by 31 May. South Australia commences annual planning each February, which includes the development of site based annual environmental watering proposals. Site-based proposals are prepared by the site managers and then consolidated into an overarching priorities document. Watering proposals developed for sites in the South Australian River Murray region in 2019-20 and their proponents are listed in Table 1. DEW leads the annual planning and prioritisation process with input from site and water managers, Traditional Owners and stakeholder groups.

Preparation of the priorities provides an opportunity to consolidate the suite of watering actions proposed for the South Australian River Murray for the upcoming water year. This work is useful for coordinating watering along the River Murray, informing decisions relating to water delivery and evaluating environmental outcomes.

In addition to the large scale actions identified in the annual priorities, managed wetting and drying of pool-connected wetlands and pumping to temporary wetlands will be undertaken by DEW, Nature Foundation SA, Renmark Irrigation Trust, Banrock Station and the Australian Landscape Trust.

As part of the annual planning process, environmental watering proposals are provided to the southern-connected Basin Environmental Watering Committee (SCBEWC). SCBEWC is coordinated by the MDBA and brings together agencies from the Commonwealth, New South Wales, Victorian and South Australian governments to coordinate and manage environmental water across the southern-connected Basin within the Murray-Darling Basin. SCBEWC ensures environmental water management is consistent with the Environmental Watering Plan (Chapter 8 of the Basin Plan), including the *Basin-wide Environmental Watering Strategy* and facilitates collective environmental water planning for the major water holders. This approach supports effective coordination while allowing different environmental water holders to make independent decisions on watering actions.

Table 1. Environmental watering proposals submitted to the MDBA and/or CEWO for 2019-20

Watering Proposal	Proponent
Lower Lakes, Coorong and Murray Mouth	DEW
SA River Murray Channel	DEW
Chowilla Floodplain	DEW
Weir Manipulation – raising and lowering	DEW
Valley Wetlands, Gorge wetlands, Lower Lakes fringing wetlands, Disher Creek and Berri Disposal Basins	DEW
Wetlands in the Renmark area	Renmark Irrigation Trust
Various wetlands	Nature Foundation SA
SA multi-site proposal	DEW

2.2 Community Engagement

A wide range of stakeholders and community groups were consulted regarding the environmental watering actions proposed for 2019-20. This consultation is undertaken by the respective site managers through long-standing and ongoing arrangements. The stakeholders consulted during development of the proposals included the CLLMM Community Advisory Panel, CLLMM Scientific Advisory Group, Chowilla Community Reference Committee, Local Action Planning associations, Landcare organisations, local government, private landholders, industry groups and the general public. Consultation occurred via meetings at which annual priorities were presented and discussed, and on site tours. Some groups also had the opportunity to provide comment on written watering proposals.

Engagement between DEW and non-government organisations that deliver environmental water to wetlands also occurs to coordinate wetland management activities across the region.

Coorong, Lower Lakes and Murray Mouth Community Advisory Panel at Salt Creek. Photo: Stephen Madigan, DEW

Community tour at Chowilla with the Berri Agricultural Bureau members. Photo: Alison Stokes, DEW

2.3 Indigenous Engagement

During development of the 2019-20 Annual Plan, Indigenous engagement was undertaken by the environmental water managers when developing their watering proposals. This included engagement with the NAC on watering objectives and

actions proposed for the CLLMM and the River Murray Channel and Floodplain and with the First Peoples of the River Murray and Mallee Region (FPRMM) on the actions proposed for the Chowilla Floodplain, the River Murray Channel and Floodplain, wetland pumping and weir manipulation watering actions.

A specific workshop was held with South Australian representatives of the Murray Lower Darling Rivers Indigenous Nations, which complemented presentations provided at meetings throughout the year to discuss planning and delivery of water for the environment.

Site tours were conducted with the FPRMM on the Chowilla floodplain and at a range of wetland sites to gain input into planning and to review sites where previous delivery of water for the environment had occurred. Presentations are also provided to the FPRMM Working Group and at NAC Water Statement of Commitment meetings throughout the year regarding water for the environment planning and delivery across the region.

Chowilla Floodplain tour with the First People of the River Murray and Mallee. Photo: Alison Stokes, DEW

2.4 Risk Assessment

Risks related to the planned environmental watering actions for 2019-20 have been identified and assessed and are addressed within specific site watering plans, event plans and within the SCBEWC watering proposals. Risk management is undertaken in accordance with Basin Plan requirements and includes consideration of flow management targets for a number of key water quality factors (including dissolved oxygen, cyanobacteria or bio-volume and salinity). In particular, site and water managers consider potential water quality impacts during annual and real-time planning (including potential cumulative impacts from multi-site actions), manage any risks that may emerge once water is being delivered in real time, and report annually on how they have had regard for flow management targets as part of their obligations under the Basin Plan.

3 Environmental Watering Objectives

The high-level objectives of environmental watering in South Australia for 2019-20 are to:

- coordinate delivering water for the environment to South Australia to maximise the potential outcomes for floodplains, wetlands, the channel and the CLLMM
- maintain and/or improve bird, vegetation and fish communities subject to the prevailing conditions
- maximise outcomes from watering in South Australia by using return flows where possible
- deliver environmental water to the CLLMM while providing benefits to upstream environmental assets and functions en route
- maximise environmental outcomes through the operation of infrastructure where appropriate
- deliver environmental water consistent with the EWRs of the priority environmental assets and priority ecosystem functions described in the South Australian River Murray LTWP.

The ecological objectives for specific watering activities are summarised in Section 4 and detailed in Appendix B. The high-level and specific ecological objectives are consistent with the objectives of the Basin Plan (Table 2) and TLM and CEWH ecological watering and management objectives (Table 3).

Fish monitoring within Lock 6 Wetland, Chowilla Floodplain. Photo: Sam Hardy, DEW

Table 2. Basin Plan overall environmental objectives (Chapter 8, Part 2)

Overall Environmental Objectives	
8.04 (a)	to protect and restore water-dependent ecosystems of the Murray-Darling Basin
8.04 (b)	to protect and restore the ecosystem functions of water-dependent ecosystems
8.04 (c)	to ensure that water-dependent ecosystems are resilient to climate change and other risks and threats
Protection and Restoration of Water-Dependent Ecosystems Objectives	
8.05 (2)	to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that: (a) declared Ramsar wetlands that depend on Basin water resources maintain their ecological character; and (b) water-dependent ecosystems that depend on Basin water resources and support the life cycles of species listed under the Bonn Convention, CAMBA, JAMBA or ROKAMBA continue to support those species; and (c) water-dependent ecosystems are able to support episodically high ecological productivity and its ecological dispersal.
8.05 (3)	to protect and restore biodiversity that is dependent on Basin water resources by ensuring that: (a) water-dependent ecosystems that support the life cycles of a listed threatened species or listed threatened ecological community, or species treated as threatened or endangered (however described) in state law, are protected and, if necessary, restored so that they continue to support those life cycles; and (b) representative populations and communities of native biota are protected and, if necessary, restored.
Protection and Restoration of Ecosystem Functions of Water-Dependent Ecosystems Objectives	
8.06 (2)	that the water quality of Basin water resources does not adversely affect water-dependent ecosystems and is consistent with the water quality and salinity management plan.
8.06 (3)	to protect and restore connectivity within and between water-dependent ecosystems, including by ensuring that: (a) the diversity and dynamics of geomorphic structures, habitats, species and genes are protected and restored; and (b) ecological processes dependent on hydrologic connectivity… (i) longitudinally along watercourses; and (ii) laterally between watercourses and their floodplains (and associated wetlands); and (iii)vertically between the surface and subsurface; are protected and restored; and (c) the Murray Mouth remains open at frequencies, for durations, and with passing flows, sufficient to enable the conveyance of salt, nutrients and sediment from the Murray-Darling Basin to the ocean; and (d) the Murray Mouth remains open at frequencies, and for durations, sufficient to ensure that the tidal exchanges maintain the Coorong's water quality (in particular salinity levels) within the tolerance of the Coorong ecosystem's resilience; and (e) the levels of the Lower Lakes are managed to ensure sufficient discharge to the Coorong and Murray Mouth and help prevent river bank collapse and acidification of wetlands below Lock 1, and to avoid acidification and allow connection between Lakes Alexandrina and Albert, by: (i) maintaining levels above 0.4 metres Australian Height Datum for 95% of the time, as far as practicable; and (ii) maintaining levels above 0.0 metres Australian Height Datum all of the time; and (f) barriers to the passage of biological resources (including biota, carbon and nutrients) through the Murray-Darling Basin are overcome or mitigated.
8.06 (5)	that natural in-stream and floodplain processes that shape landforms (e.g. the formation and maintenance of soils) are protected and restored.
8.06 (6)	to support habitat diversity for biota at a range of scales (e.g. the Murray-Darling Basin, riverine landscape, river reach and asset class).
8.06 (6)	to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (e.g. recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that: (a) flow sequences, and inundation and recession events, meet ecological requirements (e.g. cues for migration, germination and breeding); and (b) habitat diversity, extent, condition and connectivity that supports the life cycles of biota of water-dependent ecosystems (e.g. habitats that protect juveniles from predation) is maintained.
8.06 (7)	to protect and restore ecological community structure, species interactions and food webs that sustain water-dependent ecosystems, including by protecting and restoring energy, carbon and nutrient dynamics, primary production and respiration.
Ensuring Water-Dependent Ecosystems are Resilient to Climate Change and Other Risks and Threats	
8.07 (2)	that water-dependent ecosystems are resilient to climate change, climate variability and disturbances (e.g. drought and fire).
8.07 (3)	to protect refugia in order to support the long-term survival and resilience of water-dependent populations of native flora and fauna, including during drought to allow for subsequent re-colonisation beyond the refugia.
8.07 (4)	to provide wetting and drying cycles and inundation intervals that do not exceed the tolerance of ecosystem resilience or the threshold of irreversible change.
8.07 (5)	to mitigate human-induced threats (e.g. the impact of alien species, water management activities and degraded water quality).
8.07 (6)	to minimise habitat fragmentation.

Table 3. TLM and CEWO ecological watering objectives under each water resource availability scenario

	Extreme Dry	Dry	Median	Wet
Objective	*Avoid catastrophic/ irretrievable loss and maintain capacity for recovery*	*Improve capacity for recovery*	*Protect ecological health*	*Improve health and resilience*
Ecological Watering Objectives	Avoid irreversible loss of key environmental assets	Ensure priority river reaches and wetlands have maintained their basic functions	Ecological health of priority river reaches and wetlands have been protected and improved	Improve the health and resilience of aquatic ecosystems
Management Objectives	**TLM/CEWO** Avoid critical loss of species, communities and ecosystems Maintain key refuges Avoid irretrievable damage or catastrophic events	**TLM** Maintain river functioning with reduced reproductive capacity Maintain key functions of high priority wetlands Manage with dry-spell tolerances Support connectivity between sites **CEWO** Support the survival and growth of threatened species and communities including limited small-scale recruitment Maintain diverse habitats Maintain low flow river and floodplain functional processes in sites and reaches of priority assets	**TLM/CEWO** Enable growth, reproduction and small-scale recruitment for a diverse range of flora and fauna Promote low-lying floodplain-river connectivity Support medium flow river and floodplain functional processes	**TLM/CEWO** Enable growth, reproduction and large-scale recruitment for a diverse range of flora and fauna Promote higher floodplain-river connectivity Support high flow river and floodplain functional processes

4 Annual Priorities

4.1 Priority Identification Process

A scenario-based approach was used to develop proposed watering actions for 2019-20. Six resource availability scenarios were identified. These scenarios are based on the MDBA annual operating probabilities (AOP) provided in February 2019: 100 per cent (worst case), 95 per cent (very dry), 90 per cent (dry), 75 per cent (moderate), 50 per cent (near average) and 25 per cent (wet) (Figure 3). 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 (Table 4). For each scenario and each site/asset, objectives are defined and optimal water delivery determined (i.e. added to hydrographs) to achieve those objectives, taking into account estimated environmental water availability.

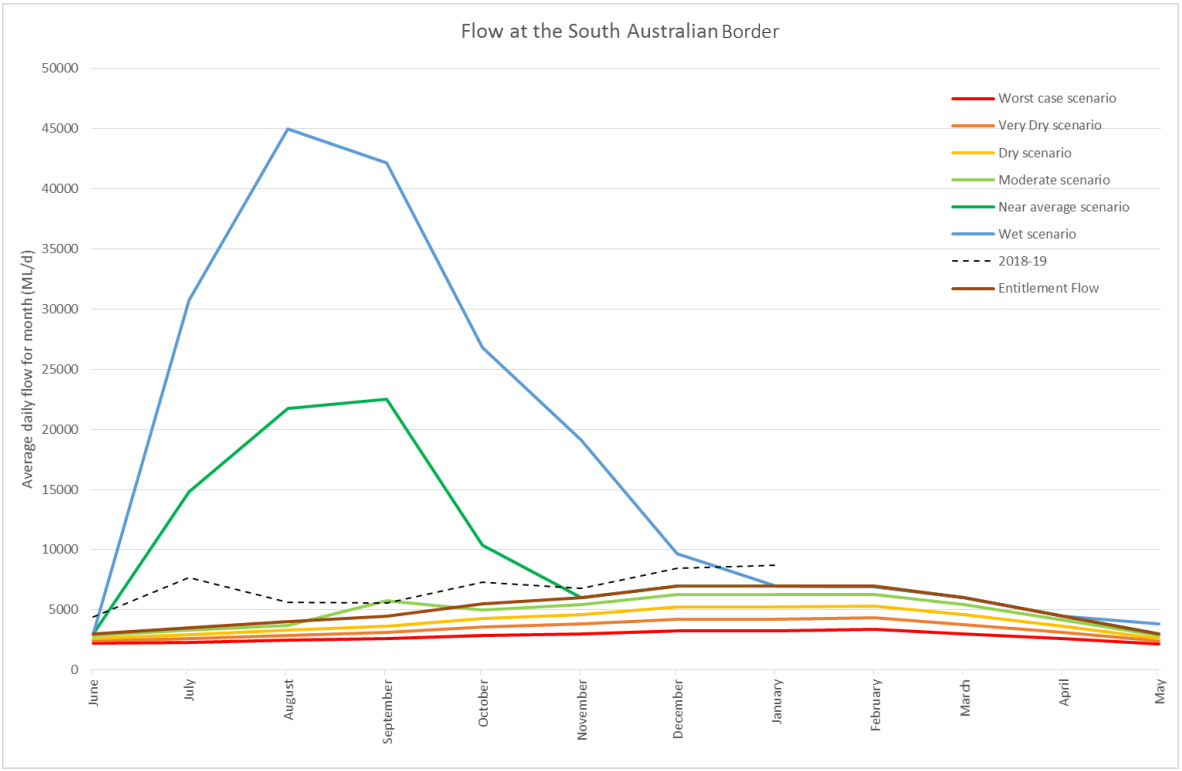

Figure 3. Annual operating probabilities provided by the MDBA in February 2019 for the purpose of informing environmental water planning for 2019-20

4.2 Priority actions for 2019-20

South Australia has developed discrete site-specific watering proposals for a number of locations throughout the South Australian River Murray system in 2019-20 as summarised in Table 1.

A summary of site-based actions are presented below and Appendix B provides detailed information for each scenario. Detailed descriptions of these actions and associated environmental objectives are also provided within the *2019-20 Annual Environmental Watering Priorities for the South Australian River Murray Water Resource Plan Area* (DEW, 2019).

Boggy Flat. Photo by Riverine Recovery Program, DEW

4.2.1 SA River Murray Channel and Floodplain

The proposed environmental watering actions for the main river channel and floodplain in South Australia seek to secure environmental water delivered to the South Australian border and along the entire length of the system in South Australia to subsequently arrive in the CLLMM. The proposed environmental water delivery pattern is aimed at enhancing flow conditions to meet the environmental water requirements identified in the SA River Murray LTWP (Department of Environment, Water and Natural Resources, 2015). Environmental water is generally sought in Spring/Summer, with the magnitude and duration of the action depending on climate conditions or scenarios.

In 2019-20, the focus is on working with upstream states, the MDBA and the CEWH on a coordinated River Murray watering action that targets outcomes throughout the system. The aim is to coordinate releases from Hume Dam and the Goulburn River, providing outcomes in both these upstream areas and arriving at the South Australian border at the optimal time and magnitude to provide outcomes in the lower Murray.

Under dry to near-average scenarios, this will generate a spring fresh (Figure 4) in the lower Murray which will support a range of outcomes in the main channel and near-bank areas. These outcomes include improved hydraulic conditions, increased food resources and habitat availability for native fish populations and native vegetation growth and survival through improved soil water availability and groundwater freshening.

In the wet and very wet scenarios, overbank flows (Figure 4) and broad-scale floodplain inundation will occur. In addition to the outcomes in the drier scenarios, in wet conditions watering actions will be focussed on inundation of temporary wetlands for frog and bird breeding, recruitment of large-bodied native fish such as Murray cod and widespread improvement in the condition of long-lived vegetation such as lignum, river red gum and black box.

Some areas of the channel and floodplain will also benefit from weir pool manipulations, which are proposed at a range of sites subject to the prevailing conditions. The change in water level will depend on the weir pool and flow conditions. No weir manipulations are proposed under the driest scenario. In a moderate scenario, it is proposed that weir pool 2 may be increased by 0.52 metres (m), weir pool 5 by 0.50 m and weir pool 6 by 0.42 m above normal pool level. If wetter conditions

occur then the height of the weir pool raisings at Weir 2 will increase to 0.75 m above normal pool level (NPL) and 0.59 m above NPL at Weir 6, while proposed Weir 5 raising remains +0.50 m above NPL. In near average and wet scenarios, raising of Weir 3 to 0.30 m above NPL followed by a 0.10 m lowering is also proposed.

The durations of these raising actions range from 105-135 days (including the filling and drawdown phase) depending on the scenario and will take place between July and November 2019. Weir raisings are undertaken to support the growth and expansion of littoral vegetation, create diverse and productive biofilm and macroinvertebrate communities, promote groundwater exchange with the river and relieve soil salinity stress in littoral zone (Lloyd *et al*, 2010).

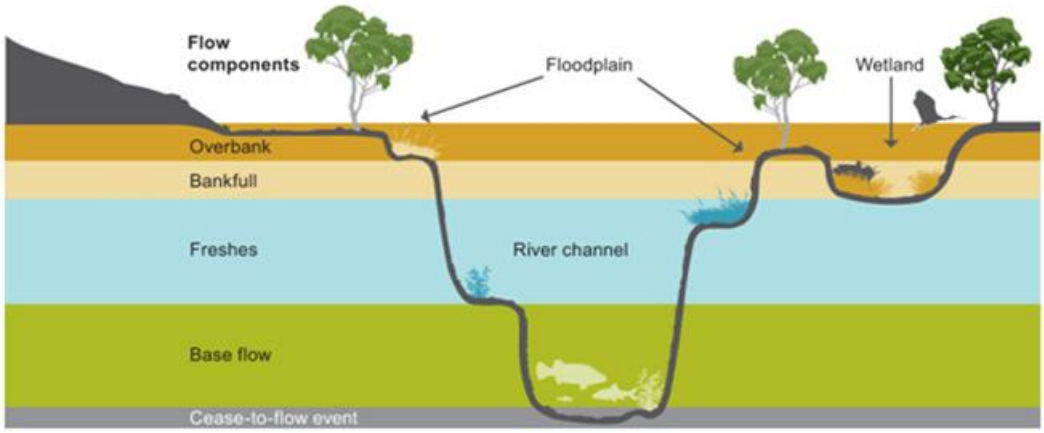

Figure 4. Conceptual illustration of flow components and their influence on different parts of the river channel and its floodplain (MDBA 2011)

4.2.2 Chowilla Floodplain

The proposed Chowilla Floodplain environmental watering actions only include the operation of the Chowilla Creek regulator if a wet water resource availability scenario eventuates. Under dry, moderate or near average water availability scenarios, operation of the environmental regulator is deemed not to be required. Under these conditions, the pumped delivery of water to a small number of priority wetlands and floodplain areas is planned.

If water availability improves to the wet scenarios, operating the regulator at maximum extent and the associated raising of Weir 6 could be undertaken to enable broad-scale inundation across approximately 7000 to 8000 hectares of floodplain and wetlands. Such an operation would provide benefits for trees and understorey vegetation and create breeding and feeding resources for a range of wildlife. This inundation would extend into areas of black box trees in the mid-elevation areas of the floodplain to consolidate the tree health benefits from watering and natural flooding in 2016.

Brandy Bottle Waterhole, Chowilla Floodplain. Photo: Alison Stokes, DEW

4.2.3 Wetlands

Seventeen wetland sites have been identified as priorities for receiving water for the environment in 2019-20 as part of the Natural Resources SAMDB watering program (Appendix C). Sites are primarily located in the Riverland region of the River Murray in South Australia, but also include wetlands fringing the Lower Lakes. Under dry to near average water resource scenarios, approximately 8 GL in total may be delivered to the priority sites.

Overland Corner December 2018, spoonbill and ibis using the wetland. Photo: NR SAMDB

Water delivery will occur primarily via pumping, with the exception of Bookmark Creek and Berri Evaporation Basin, which are gravity fed. In the event that unregulated flows greater than 40,000 ML/day occur in South Australia, the majority of the wetlands will be inundated and will not require pumping.

The ecological objectives at many of the wetlands include supporting black box, river red gum and lignum floodplain communities. Watering at a number of wetlands will also provide habitats for waterbirds, support the nationally threatened regent parrot and provide breeding opportunities for six frog species, including the nationally threatened southern bell frog.

Water proposed for Disher Creek and Berri Evaporation Basin is critical for supporting populations of the nationally threatened small-bodied fish, Murray hardyhead.

4.2.4 Lower Lakes, Coorong and Murray Mouth Icon Site

Lakes Alexandrina and Albert

Water for the environment will be used to help seasonally alter water levels in the weir pool below Lock 1 within the range 0.45-0.80 m Australian Height Datum (AHD) during 2019-20. Maximum levels (approximately 0.80 m AHD) will be prioritised between October and December 2019 to promote small-bodied fish, frog and invertebrate breeding in fringing wetlands of the Lower Lakes. Target species include the southern bell frog, Murray hardyhead and Yarra pygmy perch, all listed under the *Environment Protection and Biodiversity Conservation Act, 1999 (Commonwealth)*. Minimum levels (0.45-0.60 m AHD) will be prioritised in March and April 2020 to encourage aquatic plant germination and to maintain barrage releases to the Coorong estuary. Environmental water delivery and barrage operations will aim to maintain lake levels above the Basin Plan target of 0.4 m AHD.

David Wilson retrieving a fyke net in Lake Alexandrina. Photo: Scott Wedderburn, University of Adelaide

Barrage Operations

Environmental water is required to maintain continuous flow at all 11 fishways on the lower Murray barrages, providing year-round connectivity between the Lower Lakes and the Coorong estuary. When conditions allow, additional barrage flows will be prioritised adjacent to fishways, to facilitate migration for native fish.

During winter (July-August 2019) barrage flows prioritised from Goolwa, Mundoo and Tauwitchere barrages will facilitate upstream migration of pouched and short headed lamprey and downstream migration of adult congolli and common galaxias (diadromous fish). During Spring and early Summer (October-December 2019), barrage flows prioritised from Tauwitchere and Goolwa barrages will facilitate upstream migration of young-of-year congolli and common galaxias and the delivery of freshwater to the Coorong for salinity outcomes and the provision of freshwater-derived zooplankton and phytoplankton, which are important components of the estuarine food-chain.

Goolwa Barrage. Photo: Adrienne Rumbelow, DEW

Coorong and Murray Mouth Estuary

A range of outcomes can be achieved in the Coorong and Murray Mouth Estuary depending on the magnitude of flow. In extreme-dry conditions, a minimum of fishways-only flow can be maintained for the entire year, providing healthy mudflats

directly downstream of fishways, which provide feeding habitat for waterbirds and adult estuarine fish. Relatively small barrage flows in spring and early summer in addition to fishways-only flows, typical in a dry scenario, can provide suitable conditions for spawning and recruitment for estuarine fish such as black bream and greenback flounder. The area of influence is the zone directly downstream of the barrages and the northern region of the Coorong North Lagoon. Careful management of barrage releases is needed to create suitable salinity stratification within the water column for estuarine fish recruitment.

Moderate barrage flows can provide a greater area of influence and extend this spawning and recruitment zone for estuarine fish into the majority of the Coorong North Lagoon. Flows of this magnitude can also create suitable habitat throughout the entire North Lagoon to support adult estuarine fish, as well as suitable feeding habitat for waterbirds, particularly migratory waders.

High flow years can provide an even greater area of influence, extending to the Coorong South Lagoon. If high barrage flows occur between October and January, water levels in the Coorong South Lagoon may be maintained for long enough for the aquatic macrophyte *Ruppia tuberosa* to flower and set seed. High flows are also correlated to positive recruitment events for small-mouth hardyhead, an important food source in the Coorong for large-bodied fish and waterbirds.

Shorebirds foraging in exposed mudflats in the Coorong. Photo: Sabine Dittmann, Flinders University

4.2.5 2019-20 South Australian River Murray Multi-Site Watering Proposal

As described above, South Australia has developed discrete watering proposals for a number of locations throughout the South Australian River Murray system. The site-based watering proposals identify the volumes of environmental water required to undertake actions to meet the site-based outcomes.

In addition, a multi-site watering proposal has been developed which describes a coordinated environmental water delivery pattern for the South Australian River Murray. This multi-site proposal demonstrates opportunities to align the timing of watering actions at multiple locations and re-use water as it moves through the South Australian River Murray system. The multi-site proposal is based on the site-specific watering proposals developed within South Australia and will meet watering objectives at these sites, while also providing additional landscape-scale outcomes such as improved connectivity and enhanced dispersal of resources, propagules and water-dependent biota.

The multi-site proposal is underpinned by the objectives, targets and EWRs in the SA River Murray LTWP and the expected outcomes in the *Basin-wide Environmental Watering Strategy* (MDBA 2014).

The South Australian River Murray multi-site watering action has the following aims:

- coordinate the delivery of environmental water to South Australia to maximise the potential outcomes throughout the South Australian River Murray system
- provide pathways for the dispersal, migration and movement of native water-dependent biota[1]

[1] Modified from Basin Plan Schedule 9 - Criteria for identifying an ecosystem function

- provide pathways for the dispersal and movement of organic and inorganic sediment to maximise the delivery of resources to downstream reaches and to the ocean
- deliver environmental water to the CLLMM, while providing benefits to upstream environmental assets en route
- maximise environmental outcomes through the operation of infrastructure where appropriate
- increase the effectiveness of environmental watering and the extent of benefits by aligning the timing, magnitude and duration of discrete actions
- deliver water for the environment consistent with the EWRs of the SA River Murray LTWP and contribute to the ecological objectives for priority environmental assets and priority ecosystem functions described in the LTWP.

The estimated volume of water for the environment required to deliver the 2019-20 multi-site proposal ranges from approximately 919 GL in the moderate scenario to 1458 GL in the wet scenario. The multi-site volume represents the net volume of environmental water required to be delivered to the South Australian border to support all proposed watering actions in the South Australian River Murray for that scenario. It is additional to water for the environment held on South Australian licences, which is delivered as part of South Australia's entitlement and therefore, included in the base flow represented in the AOPs. It factors in return flows from site-based watering actions (e.g. channel pulses or Chowilla regulator operation) and their contribution to meeting other downstream demands. More environmental water is required under the dry scenario (963.4 GL) than the moderate scenario (919 GL) due to less 'base flows' being provided under the AOP (see Figures 5 and 6). Under the moderate scenario, the increase in water delivery in spring (base flows) is used for raising weir pools, which subsequently return water to the river later in the year when the weirs are returned to normal operating level. This water then contributes to the CLLMM watering action, resulting in less additional held environmental water needing to be called under the moderate scenario.

Information on the combination of actions under each scenario are shown in Table 4. The preferred monthly delivery pattern for the multi-site proposal is indicated in Figures 5-8 and has been designed to ensure that the required delivery patterns for site-based actions and outcomes are also met.

This multi-site proposal will continue to be used and revised during real-time management planning and was provided to environmental water holders via SCBEWC to support delivery planning for the 2019-20 water year.

Ground cuckoo-shrike. Photo: Helga Kieskamp

Table 4. Combination of South Australian actions per Annual Operating Probabilities (AOP) scenario

AOP Scenario	Watering actions	Volume (GL)
Dry - 90%	Meet CLLMM water for the environment demands (see Section 4.2.5 for detail) Meet Chowilla water for the environment demands for pumping (see Section 4.2.2 for detail) Meet water for the environment demands for pumping to wetlands outside of Chowilla (see Section 4.2.3 for detail) Deliver a 10,000 ML/day channel pulse in spring with a short (approximately 20 days) 15,000 ML/day peak	963.4 GL
Moderate - 75%	Meet CLLMM water for the environment demands (see Section 4.2.5 for detail) Meet Chowilla water for the environment demands for pumping (see Section 4.2.2 for detail) Meet water for the environment demands for South Australian weir pool manipulations (see Section 4.2.1 for detail) Meet water for the environment demands for pumping to wetlands outside of Chowilla (see Section 4.2.3 for detail) Deliver a 10,000 ML/day channel pulse in spring with a short (approximately 20 days) 15,000 ML/day peak	919.0 GL
Near average - 50%	Meet CLLMM water for the environment demands (see Section 4.2.5 for detail) Meet Chowilla water for the environment demands for pumping (see Section 4.2.2 for detail) Meet water for the environment demands for South Australian weir pool manipulations (see Section 4.2.1 for detail) Meet water for the environment demands for pumping to wetlands outside of Chowilla (see Section 4.2.3 for detail) Deliver South Australian River Murray channel flows with a median discharge at the South Australian border (QSA) of 20,000 ML/day (minimum discharge 15,000 ML/day) for 90 days in spring	1044.4 GL
Wet - 25%	Meet CLLMM water for the environment demands (see Section 4.2.5 for detail) Meet Chowilla water for the environment demands for Chowilla Regulator operation (see Section 4.2.2 for detail) Meet water for the environment demands for South Australian weir pool manipulations (see Section 4.2.1 for detail) Meet water for the environment demands for pumping to wetlands outside of Chowilla (see Section 4.2.3 for detail) Deliver South Australian River Murray channel and floodplain demands: • median QSA 40,000 ML/day (minimum discharge 35,000 ML/day) for 90 days in August-October • Median QSA 50,000 ML/day (minimum discharge 45,000 ML/day) for 30 days in September	1,458.3 GL

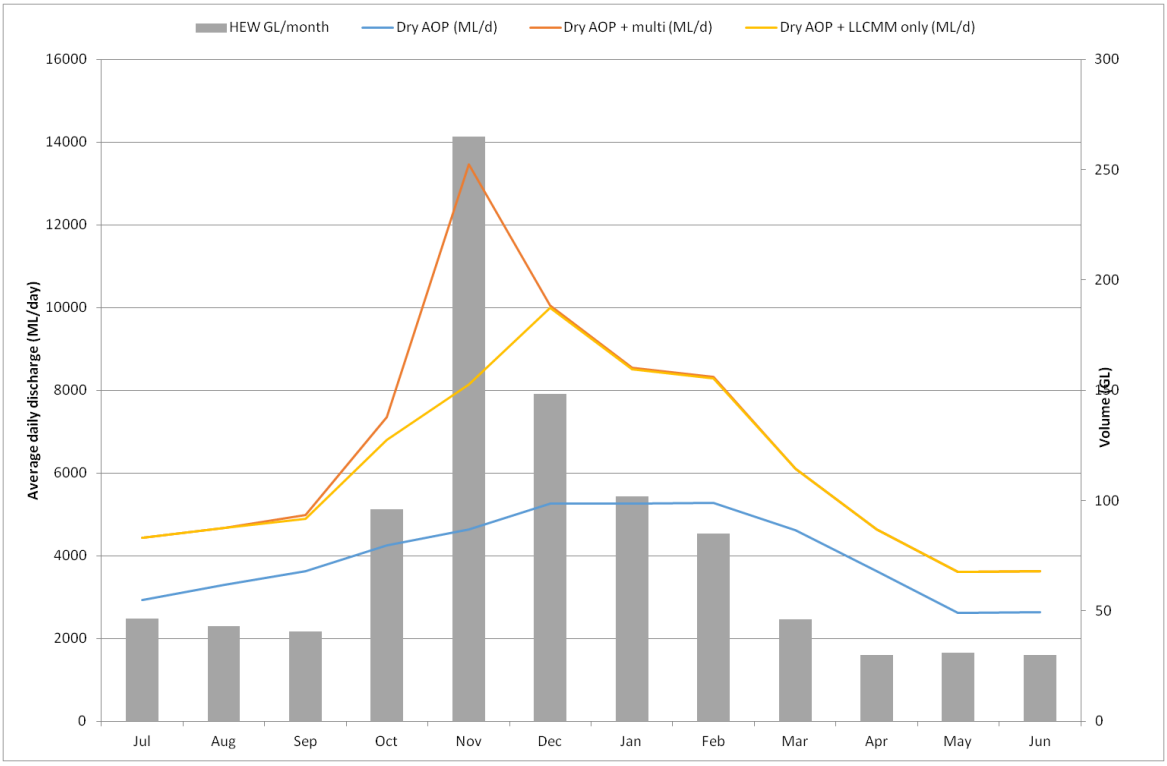

Figure 5. Preferred delivery pattern of South Australian multi-site environmental water under a dry (90%) AOP scenario. AOP + CLLMM demand is presented as a reference point only and is incorporated into the 'All South Australian demands'.

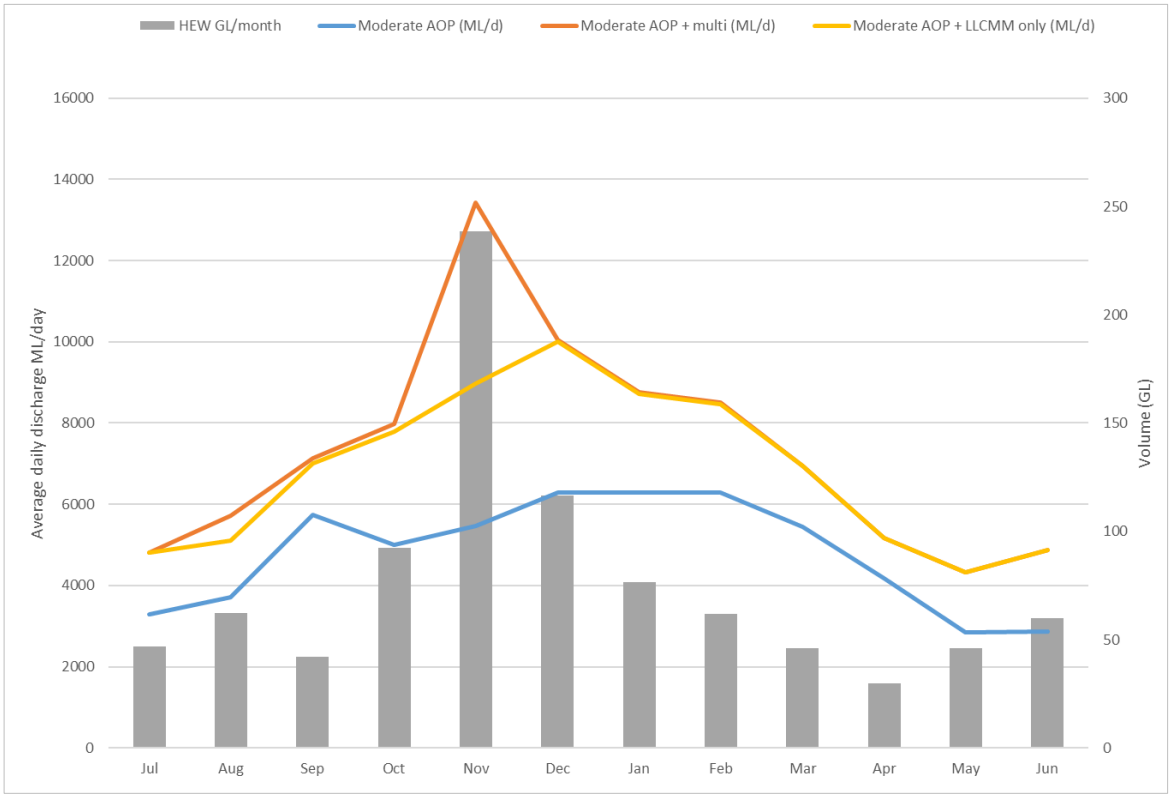

Figure 6. Preferred delivery pattern of South Australian multi-site environmental water under a moderate (75%) AOP scenario. AOP + CLLMM demand is presented as a reference point only and is incorporated into the 'All South Australian demands'

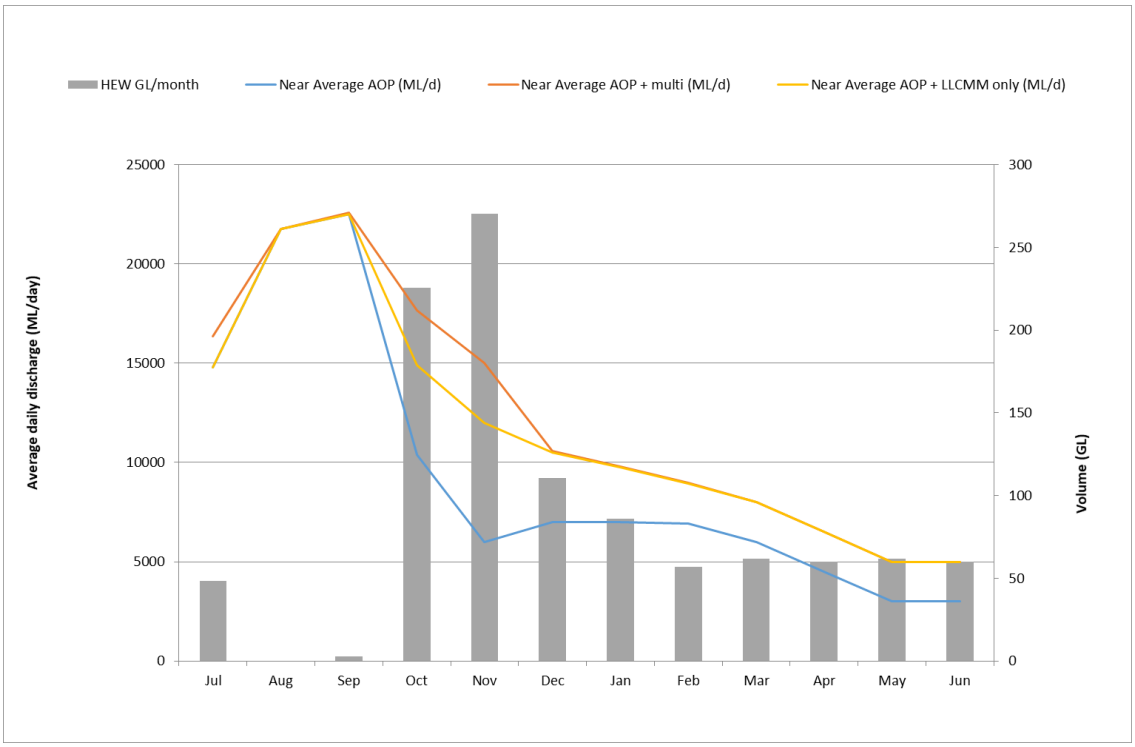

Figure 7. Preferred delivery pattern of South Australian multi-site environmental water under a near average (50%) AOP scenario. AOP + CLLMM demand is presented as a reference point only and is incorporated into the 'All South Australian demands'

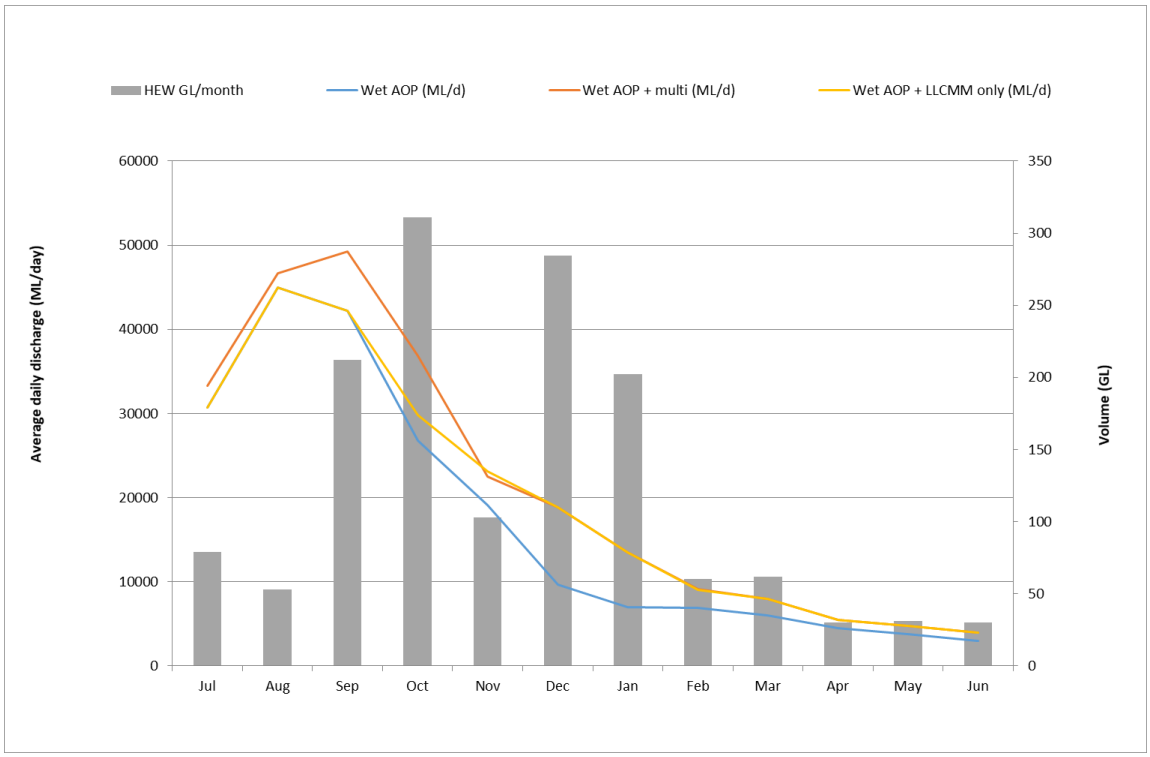

Figure 8. Preferred delivery pattern of South Australian multi-site environmental water under a wet (25%) AOP scenario. AOP + CLLMM demand is presented as a reference point only and is incorporated into the 'All South Australian demands'

4.3 Environmental Water Availability

4.3.1 Held Environmental Water

The priorities were developed between February and April 2019, which is prior to water allocation announcements being made. For the purposes of planning and prioritisation, potential held environmental water (HEW) availability was estimated under each resource availability scenario, based on environmental water delivery in recent years and advice from water holders (Table 4). Approximately 600 GL of carryover from 2018-19 will be available in 2019-20. This is from both the CEWO and TLM holdings across the southern-connected Basin. These carryover volumes have been factored into the estimates provided in Table 5.

Potential HEW availability is taken into account during planning so that the proposed actions and associated outcomes consider the feasibility of delivery.

Table 5. Estimate of held environmental water available in the southern-connected Basin in 2019-20 under each resource availability scenario (August 2019)

Scenario	Estimate of HEW available
Dry (90%)	**1300 GL**
Moderate (75%)	**1500 GL**
Near average (50%)	**2000 GL**
Wet (25%)	**2500 GL**

HEW is available from the following sources: the CEWH, TLM, VEWH, 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 is presented below. Water that is HEW under the South Australian River Murray WRP will be recorded on the Register of Held Environmental Water, as required under the Basin Plan.

Commonwealth Environmental Water

Total Commonwealth holdings of water for the environment within the southern-connected Basin are approximately 2108 GL (at 8 August 2019), with varying levels of security and a long-term average annual yield of 1544 GL[2].

Of this volume, approximately 161 GL of registered entitlement (145 GL long-term average annual yield) 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 NRM Board 2019).

The Living Murray Environmental Water

TLM holdings are approximately 480 GL long-term cap equivalent. 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 NRM Board 2019).

It is anticipated that approximately 108 GL of River Murray Increased Flows 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.

[2] http://www.environment.gov.au/water/cewo/about/water-holdings viewed 15 May 2019

Victorian Environmental Water Holder

The VEWH manages environmental water holdings in the Murray, Goulburn and Campaspe rivers. Under some circumstances, they 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 the system.

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, 38.95 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 6.5 GL has been committed for environmental use through the *Implementation Plan for Augmentation of the Adelaide Desalinisation Plant* and the location of its use is flexible (within the South Australian portion of the Murray-Darling Basin). In addition to this, approximately 1 GL is committed to the management of Tolderol Wetland for environmental outcomes. Both of these are Class 3 water and as such, availability in 2019-20 will be in-line with the River Murray water allocation framework detailed in the water allocation plan (SAMDB NRM Board 2019).

Non-Government Organisations

Nature Foundation SA 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. Class 3 water will be available in line with the *River Murray Allocation Framework* (SAMDB NRM Board 2019).

Salt Creek, Chowilla creek system. Photo: Alison Stokes, DEW

4.3.2 Planned Environmental Water Availability

Planned environmental water (PEW) is defined under the South Australian River Murray WRP 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 in the 2019 River Murray WAP

and includes the unallocated portion of annual South Australian entitlement flow, unregulated flows to South Australia, and the dilution and loss component of South Australia's entitlement flow.

4.4 Co-operative Watering Arrangements

4.4.1 Between Water Resource Planning Areas

Water holders and managers of water for the environment have worked together for several years to trial, plan and coordinate annual multi-site environmental watering events. The planning aims to maximise the use of water for the environment and return flows at multiple sites as water moves through the southern-connected Basin. The planning builds on several years of trials leading to incorporating environmental delivery into normal River Murray operations. Current water planning and delivery practices have benefited from several years of analysing issues and making changes to operational practices.

The SCBEWC and Water Liaison Working Group 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 and coordination of large scale environmental watering events for 2019-20.

4.4.2 Within the River Murray Water Resource Planning Area

Existing mechanisms to assist with coordinating environmental watering within the WRP area are described in Section 5.6.2 of the South Australian River Murray WRP (DEW 2019).

For 2019-20, DEW has developed a multi-site proposal for the coordinated delivery of water for the environment within the WRP area. The South Australian multi-site watering proposal 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 that 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.

5 Implementation of the Annual Plan

5.1. Overview

Implementation of the Annual Plan involves many steps and is undertaken throughout the year at a local, state and basin level, as illustrated in Figure 9 below. A range of policies and procedures supporting delivery of water for the environment in South Australia have been recently developed or modified to ensure consistency with Basin Plan requirements. These, along with existing policies and processes currently in place to guide environmental water management along the River Murray in South Australia, are described in *Prerequisite Policy Measures Implementation in South Australia. Overview of arrangements and mechanisms used to implement Prerequisite Policy Measures* (DEW, 2019).

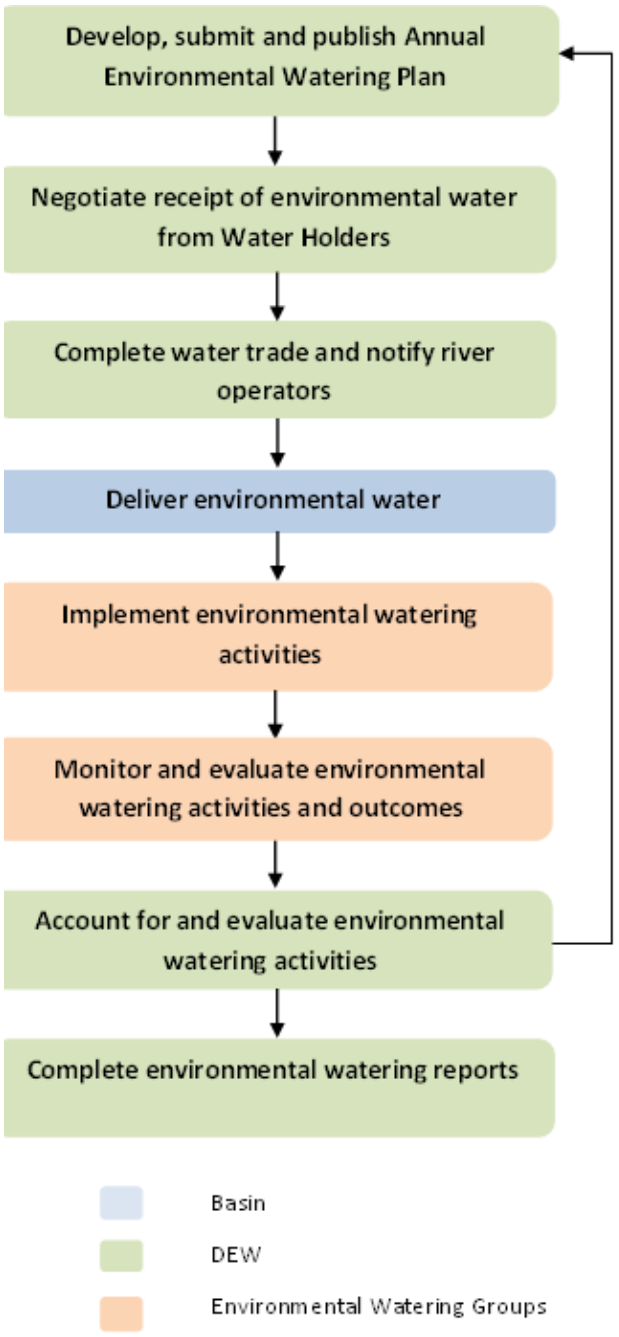

Figure 9. Implementation process for the Annual Environmental Watering Plan

5.2 Securing Water for the Environment

5.2.1 Coordinating Receipt of Environmental Water

Three sites within South Australia are eligible to access water from the TLM portfolio. These TLM icon sites are Chowilla Floodplain, the River Murray Channel and the CLLMM. Icon site managers provide watering proposals that form part of the State's annual environmental watering priorities and these are also submitted to SCBEWC to inform the use of the TLM portfolio. Decisions on the use of the TLM portfolio are made jointly by the partner governments. SCBEWC seeks to coordinate the delivery of TLM water with other environmental water holders where possible.

Each year, the CEWO undertakes portfolio management planning for Commonwealth owned environmental water, which includes multi-year planning for water delivery, trade and carryover. The South Australian River Murray region is included in the *River Murray Valley – Commonwealth Environmental Water Delivery Plan 2019-20*, which is available on the CEWH website. Watering schedules are developed that give effect to this portfolio management plan and outline the intended use of Commonwealth environmental water. These watering schedules are agreed by the CEWH and DEW.

The CEWH may also establish Partnership Agreements with non-government organisations for the delivery of Commonwealth environmental water along the River Murray in South Australia. Copies of these partnership agreements are available on the CEWH website. Decisions on the use of Commonwealth environmental water are made by the CEWH throughout the year based on seasonal, operational and management considerations (Commonwealth Environmental Water Office, 2013).

5.2.2 Completing Water Trades

Once an environmental water holder has committed water to an environmental watering action, then the water allocation may be traded onto a water account in South Australia. An alternative mechanism to facilitate delivery may be used such as Bulk Environmental Delivery facilitated by the MDBA in consultation with water holders and river operators.

5.3 Delivering Water for the Environment

DEW, SA Water and the MDBA work co-operatively to manage arrangements for delivering water to South Australia for all purposes, including water for the environment. The annual environmental watering priorities and watering actions are incorporated into *South Australia's River Murray Annual Operating Plan 2019-20* (DEW, in prep). Therefore, the water delivery required to support these priorities and actions is integrated with broader river operations planning.

The implementation of environmental watering actions is coordinated by water managers in consultation with other interested parties. There are several methods available for implementing environmental watering actions, including:

- adding environmental water upstream of the South Australian border for delivery to the River Murray Channel and CLLMM assets and potentially to the floodplain if flows are sufficiently high
- operating the barrages to influence water levels in the Lower Lakes and water movement into the Coorong and out to sea through the Murray Mouth
- operating the Chowilla Regulator and raising the main channel weirs to increase the extent of inundation
- operating anabranch inlet regulators to manage in-channel flow and water level
- pumping to discrete temporary wetland basins, which generally involves the installation of temporary embankments to retain water
- applying water to floodplain vegetation through drip irrigation or sprinklers
- operating flow control structures to implement wetting and drying regimes at pool-connected wetlands.

Proposed actions, delivery mechanism and cost are described by managers in their watering proposals. Real-time environmental management groups operate to adapt watering actions in response to changing conditions and provide advice on the preferred pattern of delivery for environmental outcomes. These groups include the Barrage Operations Advisory Group, Chowilla Operations Group and the Environmental Flows Reference Group.

5.4 Monitoring and Evaluation

Operational and ecological monitoring undertaken in association with environmental watering actions is outlined in the watering proposals developed by the environmental managers.

The TLM Program funds long-running condition and annual intervention monitoring at the Chowilla and CLLMM icon sites, with results used to inform water planning and delivery and environmental infrastructure operation. This monitoring is coordinated by the icon site managers in DEW and will continue in 2019-20.

The CEWO identifies any specific monitoring and reporting requirements in their watering schedules for the use of Commonwealth environmental water. In addition, the CEWO Long Term Intervention Monitoring Project (established in 2014 and ending June 2019) collects data in the River Murray Channel asset and has been designed to evaluate outcomes at the Basin-scale. It also demonstrates environmental outcomes from the delivery of Commonwealth environmental water at a regional level. SARDI have led the project in the lower Murray River. The current CEWO Monitoring, Evaluation and Research Project aims to extend to June 2022 the Long Term Intervention Monitoring, as well as selected activities that form part of the Murray-Darling Basin Environmental Water Knowledge and Research Project.

Other key monitoring programs associated with managing water for the environment along the River Murray in South Australia are:

- ongoing monitoring of selected South Australian River Murray wetlands and floodplain areas, undertaken by the Natural Resources SAMDB Floodplain and Wetlands team (DEW) in partnership with wetland community groups
- monitoring the ecological response from weir pool manipulation, which is coordinated by DEW and funded by the Commonwealth Government
- monitoring associated with the South Australian Riverland Floodplains Integrated Infrastructure Program on the Katarapko and Pike floodplains and in association with the Weir Pool Manipulation program.

DEW utilises information gathered through a range of monitoring programs, as described above. These programs have been established with specific purposes that generally relate to site-specific management plans and enable adaptive management of these sites. Information on the type of information gathered through each of these programs can be found in site-specific management and monitoring plans such as DEWNR (2017) and MDBA (2012).

Nature Foundation SA undertake operational monitoring (volumes, delivery dates, inundation extent and photo points) at all their watering sites. Ecological monitoring includes vegetation response of target species at all sites, as well as bird and frog observations at selected sites.

Eastern long-neck turtle. Photo: Nathan Creeper

5.5 Accounting and reporting

In 2019-20, DEW is responsible for managing and maintaining records for all actions managed by DEW including allocations, trades, water availability and water delivery. This data is used to report to water holders, reconcile the Minister's licences and water accounts, meet state obligations to report annually against Matter 9 of the Basin Plan (the identification of environmental water and the monitoring of its use) and report on environmental water management to stakeholders and other interested parties.

Non-government organisations generally operate through their own water licences and accounts and have their own record keeping and water accounting arrangements in place to ensure that water use remains within availability and to fulfil reporting requirements. Operational and ecological reporting requirements will be agreed between the delivery partners and the water holder.

DEW currently provides monthly reports and three-monthly forward plans to the CEWO on CLLMM environmental water delivery and annual reports on water delivery in the South Australian River Murray Channel and weir pools.

Reporting on the benefits and ecological outcomes of environmental watering events occurs through individual site reports. Key ecological outcomes are consolidated into the Annual Environmental Watering Report which is published on the DEW website each year.

Hunter's Creek. Photo: Kirsty Wedge, DEW

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Glossary: Selected Terms and Acronyms

Units of measurement commonly used (SI and non-SI Australian legal)

Name of unit	Symbol
day	d
gigalitre	GL
hectare	ha
megalitre	ML
metre	m
second	s

AHD – Australian Height Datum

AOP – Annual Operating Probabilities

Barrage — specifically any of the five low weirs at the mouth of the River Murray constructed to exclude seawater from the Lower Lakes

Basin — the area drained by a major river and its tributaries

CEWH – Commonwealth Environmental Water Holder; the person charged with responsibility for the Commonwealth Government's water that is held for environmental purposes

CEWO – Commonwealth Environmental Water Office; the office that supports the CEWH

CLLMM – Coorong, Lower Lakes and Murray Mouth. One of three priority environmental assets identified in the *Long Term Environmental Watering Plan for the SA River Murray Water Resource Plan Area*, and equivalent to the Lower Lakes, Coorong and Murray Mouth TLM Icon site. The names 'Coorong, Lower Lakes and Murray Mouth' and 'Lower Lakes, Coorong and Murray Mouth' are used interchangeably.

DEW — Department for Environment and Water (Government of South Australia)

Diadromous – fish that spend part of their lifecycle in both seawater and freshwater

Diversity — the distribution and abundance of different plant and animal species and communities within a specified area

Ecosystem — any system in which there is an interdependence and interaction between living organisms and their immediate physical, chemical and biological environment

Endangered species — any species in danger of extinction throughout all or a significant portion of its range

Entitlement flow — minimum monthly River Murray flow to South Australia agreed in the Murray-Darling Basin Agreement, 1992

Environmental water requirements — the water regimes needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk

Fishway — a generic term describing all mechanisms that allow the passage of fish along a waterway. Specific structures include fish ladders (gentle sloping channels with baffles that reduce the velocity of water and provide resting places for fish as they 'climb' over a weir) and fish lifts (chambers, rather like lift-wells, that are flooded and emptied to enable fish to move across a barrier)

Floodplain — defined in the *Natural Resources Management Act 2004* as 'any area of land adjacent to a watercourse, lake or estuary that is periodically inundated with water and includes any other area designated as a floodplain: (a) by an NRM plan; or, (b) by a Development Plan under the Development Act 1993

Flow regime — the character of the timing and amount of flow in a stream

Habitat — the natural place or type of site in which an animal or plant, or communities of animals and plants, live

Infrastructure — artificial lakes; dams or reservoirs; embankments, walls, channels or other works; buildings or structures; or pipes, machinery or other equipment

MDBA — Murray-Darling Basin Authority

Model — a conceptual or mathematical means of understanding elements of the real world that allows for predictions of outcomes given certain conditions. Examples include estimating storm run-off, assessing the impacts of dams or predicting ecological response to environmental change

Monitoring — (1) The repeated measurement of parameters to assess the current status and changes over time of the parameters measured (2) Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals and other living things

QSA – River flow to South Australia, as measured at the State border

Ramsar wetland —a wetland recognised under the international treaty on wetlands titled The Convention on Wetlands of International Importance Especially as Waterfowl Habitat

Return flow – environmental water used upstream for an event returns to the river and can be used for another event downstream

SAMDB NRM Board – South Australian Murray-Darling Basin Natural Resources Management Board

Threatened species — any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range

TLM – The Living Murray (MDBA program)

Water allocation — (1) In respect of a water licence means the quantity of water that the licensee is entitled to take and use pursuant to the licence. (2) In respect of water taken pursuant to an authorisation under Section 11 means the maximum quantity of water that can be taken and used pursuant to the authorisation

WAP — Water Allocation Plan; a legal document that sets out the rules for managing the take and use of water resources that have been identified as significant, or 'prescribed', under the *Natural Resources Management Act 2004*.

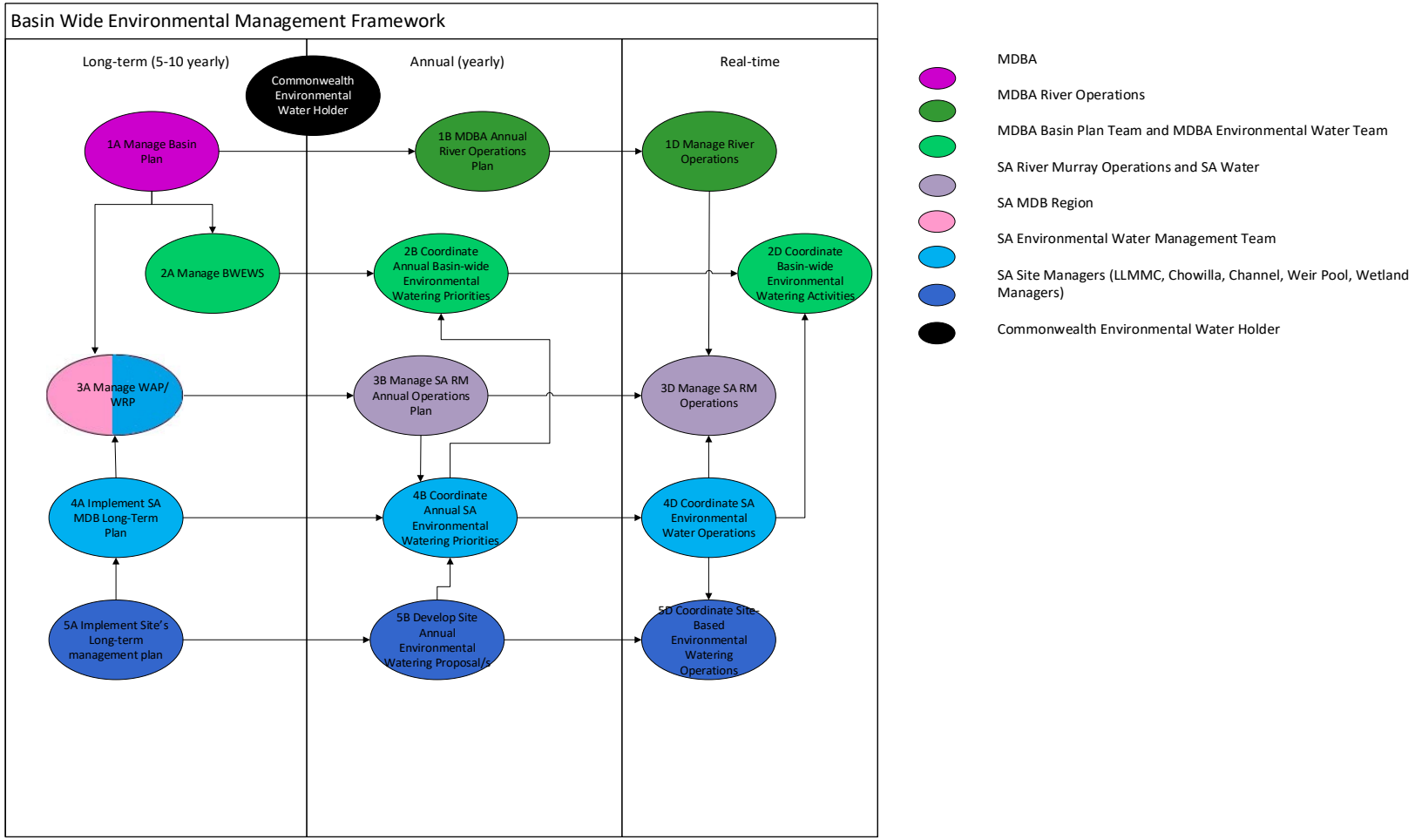
Water-dependent ecosystems — those parts of the environment, the species composition and natural ecological processes that are determined by the permanent or temporary presence of flowing or standing water, above or below ground. The in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, estuaries and lakes are all water-dependent ecosystems

Water licence — a licence granted under state legislation entitling the holder to take water from a prescribed watercourse, lake or well or to take surface water from a surface water prescribed area. This grants the licensee a right to take an allocation of water specified on the licence, which may also include conditions on the taking and use of that water. A water licence confers a property right on the holder of the licence and this right is separate from land title

Water year - The period between 1 July in any given calendar year and 30 June the following calendar year; also called a licensing year or a water-use year

Appendices

Appendix A. Basin-Wide Environmental Management Framework



Appendix B: Summary of environmental watering actions proposed for 2019-20 by environmental asset/site managers under five scenarios

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	○ Lower Lakes fringing and submerged vegetation ○ Upstream migration of young-of-year 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 and small bodied threatened fish recruitment	457
	Continuous barrage releases for fish passage	8 months: Jan-Jun and Jul-Aug	○ Provide continuous fishway/barrage releases and localised estuarine conditions ○ Downstream movement and recruitment of congolli and common galaxids ○ Upstream lamprey migration and recruitment ○ Provide continuous connectivity between river and estuary ○ Maintain lake levels >0.5 m AHD all year	322

Channel and Floodplain	Spring pulse ≥10,000 ML/day with minimum 60-day duration commencing after mid-October and incorporating a short (minimum 20 days) peak ≥15,000 ML/day	Minimum 60 days: mid-October to mid-December	○ Water level variability in the upper weir pool resulting in:
			  ○ 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:
			  ○ abundant moderate-fast (0.18–0.25 m/s) habitat (although fast (>0.25 m/s) habitat remains scarce)
			  ○ mean velocity in all reaches >0.2 m/s
			  ○ support propagule entrainment and transport
				419

Weir pool manipulation	No weir pool manipulations proposed	N/A	N/A	N/A

Site	Action	Details	Objectives	Vol GL
Chowilla	Pump to up to 8 priority wetlands	Sept-Nov	○ 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 and Slaney Creek weirs	20 weeks: Oct-Feb	○ 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 and waterbirds) ○ 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	○ Fast flowing habitat for medium and large bodied fish - generate mean channel velocity in the range of 0.2-0.5 m/s ○ 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 m AHD (0.45 m) at Pike Environmental Regulator and up to maximum 15.41 m AHD (0.66 m) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlets	6 weeks: Jan-Feb	○ 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[3]
Wetlands	Delivery of water via pumping and gravity at up to 17 priority wetland sites located along the River Murray from the border to the Lower Lakes	Sept-Feb (pumped wetlands) Jul-Jun (gravity-fed wetlands)	○ 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

[3] Volume based on inflows of 50 ML/day

Site	Action	Details	Objectives	Vol GL
	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	○ 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 NAC, RIT, ALT, Accolade Wines and Nature Foundation SA	Jul-Jun	○ 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

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	○ Lower Lakes fringing and submerged vegetation ○ Upstream migration of young-of-year 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 and small bodied threatened fish recruitment	432
	Continuous barrage releases for fish passage	8 months: Jan-June and Jul-Aug	○ Provide continuous fishway/barrage releases and localised estuarine conditions ○ Downstream movement and recruitment of congolli and common galaxids ○ Upstream lamprey migration and recruitment ○ Provide continuous connectivity between river and estuary ○ Maintain lake levels >0.5 m AHD all year	320

Channel and Floodplain	Spring pulse ≥10,000 ML/day with minimum 60-day duration commencing after mid-October and incorporating a short (minimum 20 days) peak ≥15,000 ML/day	Minimum 60 days – mid-October to mid-December	○ Water level variability in the upper weir pool resulting in:
			  ○ altered light environment for biofilms; contribute to a median biofilm composition that is not dominated by filamentous algae
			  ○ recruitment of emergent aquatic vegetation species
				419

Site	Action	Details	Objectives	Vol GL
			○ 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: ○ abundant moderate-fast (0.18–0.25 m/s) habitat (although fast (>0.25 m/s) habitat remains scarce) ○ mean velocity in all reaches >0.2 m/s ○ Support propagule entrainment and transport	
Weir Pool Manipulation	Raise Weir Pool 6 up to +42 cm above normal pool level Raise Weir Pool 5 up to +50 cm above normal pool level Raise Weir Pool 2 up to +52 cm above normal pool level	Approx. 115 days total duration (incl. filling and drawdown phase) with minimum 75 days at maximum raised level: Aug-Nov	○ Water level variability upstream of the weirs, generating: ○ 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)
Chowilla	Pump to up to 8 priority wetlands	Sept-Nov	○ 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 and Slaney Creek weirs in conjunction with raising weir pool 6	20 weeks: Oct-Feb	○ 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 and water birds) ○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates	N/A

Site	Action	Details	Objectives	Vol GL
Pike	Pulse flows through Tanyaca via Margaret Dowling and Deep Creek inlets	12 weeks: Dec-Feb	○ Fast flowing habitat for medium and large bodied fish - generate mean channel velocity in the range of 0.2-0.5 m/s ○ 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 m AHD (0.45 m) at Pike Environmental Regulator and up to maximum 15.41 m AHD (0.66 m) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlets	6 weeks: Jan-Feb	○ 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[4]
Wetlands	Delivery of water via pumping and gravity at up to 17 priority wetland sites located along the River Murray from the border to the Lower Lakes	Sept-Feb (pumped wetlands) Jul-Jun (gravity fed wetlands)	○ 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	○ 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 Wines and Nature Foundation SA	Jul-Jun	○ 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

[4] Volume based on inflows of 50 ML/day

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)	○ Estuarine conditions throughout North Lagoon ○ Lower Lakes levels raised >0.8 m AHD in spring ○ Provide for fish migration and connectivity ○ Upstream migration of young-of-year 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	○ Provide continuous fishway/barrage releases and localised estuarine conditions ○ Downstream movement and recruitment of congolli and common galaxids ○ Upstream lamprey migration and recruitment ○ Provide continuous connectivity between river and estuary ○ Maintain lake levels >0.5 m AHD all year	301
Channel and Floodplain	Target EWR-IC3 (Median discharge QSA 20,000 ML/day)	90 days: Sep-Nov	○ 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 hydrograph	75 days: July-Oct	○ Flush salt from Lake Bonney ○ Littoral zone carbon cycling and soil condition improvements ○ maintain riparian vegetation condition ○ Improve biofilm quality	29.1 (includes return flows of 26.8)
	Lower weir pool 3 to -10 cm below normal pool level if QSA ≥ 20,000 ML/d	25 days: Oct	○ 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 (refill volume)

Site	Action	Details	Objectives	Vol GL
	for duration of Weir Pool Manipulation hydrograph			
	Raise Weir Pool 6 up to +59 cm above normal pool level Raise Weir Pool 5 up to +50 cm above normal pool level Raise Weir Pool 2 up to +75 cm above normal pool level	Approx. 105 days (incl. filling and drawdown phase): Jul-Oct	○ 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	○ 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 and Slaney Creek weirs in conjunction with raising weir pool 6	20 weeks: Oct-Feb	○ 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 and 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	○ Fast flowing habitat for medium and large bodied fish - generate mean channel velocity in the range of 0.2-0.5 m/s ○ 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 m AHD (0.45 m) at Pike Environmental Regulator and up to maximum 15.41 m AHD (0.66 m) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlets	6 weeks: Jan-Feb	○ 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[5]

[5] Volume based on inflows of 50 ML/day

Site	Action	Details	Objectives	Vol GL
Wetlands	Delivery of water via pumping and gravity at up to 15 priority wetland sites located along the River Murray from the border to the Lower Lakes	Sept-Feb (pumped wetlands) Nov-Jun (gravity fed wetlands)	○ 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	○ 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 Wines and Nature Foundation SA	Jul-Jun	○ 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 Lagoon and Coorong South Lagoon outcomes	4 months: Oct-Jan	○ *Ruppia tuberosa* 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 and salt/nutrient export Abundance and extent of macroinvertebrates increases	701
	Continuous barrage releases for fish passage	5 months: Feb-Jun	○ Provide continuous fishway/barrage releases and localised estuarine conditions ○ Downstream movement and recruitment of congolli and common galaxids	210

Site	Action	Details	Objectives	Vol GL
			○ Upstream lamprey migration and recruitment ○ Provide continuous connectivity between river and estuary ○ Maintain lake levels >0.5 m AHD all year	
Channel and Floodplain	Target EWR-FP1 described in the SA River Murray LTWP (median discharge QSA 50,000 ML/d)	30 days: Sep	All SA River Murray Channel targets are relevant and in addition: ○ Inundation of the SA River Murray Floodplain priority environmental asset commences ○ Large Murray cod recruitment event ○ Support large-scale breeding by eight riparian frog species	165
	Target EWR-IC7 described in the SA River Murray LTWP (median discharge QSA 40,000 ML/day	90 days: Sep-Nov	○ Inundation of the entire SA River Murray Channel priority environmental asset ○ 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 priority environmental asset	311
Weir Pool Manipulation	Raise weir pool 3 by up to 30 cm and lower to -10 cm below normal pool level if QSA ≥ 20,000 ML/d for duration of Weir Pool Manipulation hydrograph	75 days: July-Oct	○ Flush salt from Lake Bonney ○ Improve soil condition to maintain riparian vegetation condition ○ Improve biofilm quality	WPR 26.3 (includes return flows of 22.1)
	Lower Weir Pool 3 to -10 cm below normal pool level if QSA ≥ 20,000 ML/d for duration of Weir Pool Manipulation hydrograph	25 days: Oct	○ Flush salt from Lake Bonney ○ Littoral zone carbon cycling and soil condition improvements ○ maintain riparian vegetation condition ○ Improve biofilm quality	WPL 3.92 (refill volume)
	Raise Weir Pool 5 up to +50 cm above normal pool level Raise Weir Pool 2 up to +75 cm above normal pool level	Approx. 135 days (incl. filling and drawdown phase): Jul-Nov	○ 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. (*Chowilla regulator – 19.85 m AHD; Weir 6 – 19.85 m AHD)*	157 days: July-Dec	○ 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	110.8 (includes return flows of 61.8)

Site	Action	Details	Objectives	Vol GL
			benefits from 2016 managed inundation and unregulated flow event o Instate connectivity to mid-elevation floodplain and all key wetlands o 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 o Improve condition of lignum in inundated areas o Provide breeding habitat for waterbirds, amphibians and invertebrates o Create conditions conducive to germination and growth of flood-dependent and flood-responsive vegetation o Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish and water birds) 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	o Fast flowing habitat for medium and large bodied fish - generate mean channel velocity in the range of 0.2-0.5 m/s 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 m AHD (0.45 m) at Pike Environmental Regulator and up to maximum 15.41 m AHD (0.66 m) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlets	6 weeks: Jan-Feb	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[6]

[6] Volume based on inflows of 50 ML/day

Site	Action	Details	Objectives	Vol GL
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)	○ 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	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	○ 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 Wines and Nature Foundation South Australia	Jul-Jun	○ 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

Appendix C: Priority Temporary Wetlands for Pumping in 2019-20 as part of the Natural Resources SAMDB Watering Program

Wetlands	Timing of watering
Morgan East	spring/summer
Molo Flat	spring/summer
Morgan Conservation Park south	spring/summer
Morgan Conservation Park north	spring/summer
Berri Evaporation Basin	spring and for remainder of year
Disher Creek	spring/summer
Wiela	late spring/summer
Bookmark Creek	spring and for remainder of year
Gerard lignum basin	spring/summer
Murtho	spring/summer
Katarapko Creek	spring/summer
Martin Bend	spring/summer
Yabby Creek	spring/summer
Overland Corner	spring/summer
Tolderol	ongoing through year
Wigley Reach	spring/summer
Hogwash Bend	late spring/summer

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Head Office
Level 5
81-95 Waymouth St
ADELAIDE SA 5000

Telephone +61 (8) 8463 7623

ABN 36702093234

Report prepared by:
Department for Environment and Water
Water and River Murray Branch
Water Infrastructure and Operations Directorate

www.environment.sa.gov.au

Government of South Australia

Department for Environment and Water