South Australia's River Murray Annual Operating Plan

2019-20

Chowilla at sunset

Dredging keeping the Murray Mouth open

Government of South Australia

Department for Environment and Water

Foreword

At the start of the 2019-20 water year, water resource conditions across the Murray-Darling Basin were very dry. *South Australia's River Murray Annual Operating Plan 2019-20* (SA Operating Plan) is the key document that guides transparent and coordinated River Murray operational decisions in South Australia. It describes how the desired outcomes are proposed to be delivered during 2019-20. It identifies how the River Murray in South Australia may be operated under a number of potential water availability scenarios to optimise the benefits to all water users, including water for the environment.

The SA Operating Plan aims to achieve some of the specific objectives in the *Basin Plan* and objectives in the *2019-20 Annual Water for the Environment Plan for the South Australian River Murray,* while meeting requirements in the *Australian Drinking Water Guidelines 2011.*

The SA Operating Plan is consistent with the *River Murray System Annual Operating Outlook 2019-20* (MDBA Annual Operating Outlook) prepared by the Murray-Darling Basin Authority, with input from the Commonwealth, New South Wales, Victorian and South Australian Governments through the Water Liaison Working Group.

A wide range of stakeholders have been engaged in the development of the SA Operating Plan, including the Murray-Darling Basin Authority and the River Murray Operations Working Group, which is a cross-agency group consisting of representatives with an in interest in how the River Murray is managed and operated in South Australia.

I would like to thank all those who have been involved in the planning, management and operations of the River Murray in South Australia.

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

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.

The SA Operating Plan was coordinated by DEW with input from members of the River Murray Operations Working Group (RMOWG). The RMOWG is a cross government agency group with representatives from:

- Department for Environment and Water
- SA Water
- Primary Industries and Regions SA, including the South Australian Research and Development Institute
- Environment Protection Authority

Input was also gratefully received from the MDBA.

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Introduction

The SA Operating Plan identifies how the River Murray in South Australia may be operated under a number of potential water availability scenarios to optimise the benefits to all water users, including water for the environment.

The SA Operating Plan identifies the objectives and outcomes sought under a range of climate and inflow scenarios. Where actions to achieve these objectives and outcomes fall within normal operating parameters, they will be undertaken routinely. Where a proposed action falls outside normal operating parameters, additional approvals will be sought from the relevant authority. Some actions within normal operating parameters may also require approval.

The actual conditions that eventuate during 2019-20 may differ from the scenarios described in the SA Operating Plan, therefore river operations may vary from the projections in this document. The actual pattern of environmental water delivery during 2019-20 is uncertain, which may significantly change the distribution pattern provided in the scenarios. Nevertheless, the scenarios provide a useful indication of potential river flows in 2019-20. Ongoing decisions made during the year regarding river operations within South Australia will be consistent with the SA Operating Plan and current operating policies and procedures as agreed under South Australia's Prerequisite Policy Measures approved by the MDBA.

For water allocation decisions, South Australia has adopted the extreme dry inflow scenario for water availability to South Australia in 2019-20 as provided by the MDBA. This is to ensure, as much as possible, that water allocations do not decrease as the year progresses. Under the extreme dry inflow scenario, South Australia will not receive its full Entitlement Flow of 1 850 GL. Advice from the MDBA at 1 July 2019, was that the extreme dry inflow scenario would provide South Australia with a minimum Entitlement Flow of 1 050 GL in 2019-20. This volume provided a minimum water allocation of 31% for River Murray Water Access Entitlement Holders. As a result, private carryover was made available to eligible water users from South Australia's Storage Right. SA Water may also require water to be delivered from the Storage Right to provide for critical human water needs (CHWN), subject to inflows to the Mount Lofty Ranges storages. The main focus of the SA Operating Plan is to guide key processes to achieve the best outcome for the State (economic, environmental and social); deliver a portion of South Australia's deferred water for CHWN and private carryover, seek opportunities to defer additional water should the conditions improve and have regard for Basin Plan targets and outcomes.

The SA Operating Plan is consistent with the MDBA Annual Operating Outlook. The MDBA will provide monthly water resource updates to the Basin Officials Committee (BOC) and the WLWG and undertake a midyear review. The SA Operating Plan will be updated if necessary, for example if there are significant changes in water resource conditions.

If dry conditions cause the water level in the River Murray below Lock 1 to fall below 0.4 metres (m) Australian Height Datum (AHD), River Murray operations in South Australia will be consistent with the MDBA's *Drought Emergency Framework for Lakes Alexandrina and Albert (June 2014)* to the extent that is practicably possible.

Goal

The SA Operating Plan seeks to integrate and optimise the delivery and management of water to, and within, South Australia to:

- accommodate the needs of all water users within system constraints to the extent that is practicably possible;
- outline preferred environmental watering priorities and urban and irrigation water delivery requirements, under a range of inflow and water availability scenarios;
- balance the requirement to deliver water during 2019-20, deliver the appropriate portion of deferred and stored water and possibly defer a portion of South Australia's Entitlement Flow for use in future dry years (should the water resource conditions significantly improve);
- provide for operational arrangements to underpin the security of supply and water quality for all consumptive uses;
- ensure that the requirements are fulfilled under the:
    - *Murray-Darling Basin Agreement 2008* (Cwlth)(the Agreement);
    - *Water Act 2007* - Basin Plan 2012 (Basin Plan) – in particular Chapters 5, 8, 9 and 11;
    - MDBA Annual Operating Outlook;
    - Basin Officials Committee (BOC) *Objectives and Outcomes for River Operations in the River Murray System*; and
- provide a documented and transparent rationale for South Australian River Murray operational decisions to be made in 2019-20.

Hume Dam 2019 (courtesy Kimberley Williamson)

1 Objectives and Outcomes

The SA Operating Plan is developed with regard to the objectives of the ***Basin Plan.*** It will contribute to the achievement of Basin Plan objectives in South Australia and assist in meeting the South Australian Government's obligations under the Basin Plan. The SA Operating Plan also has regard for the annual environmental priorities in the *SA River Murray Annual Environmental Watering Plan 2019-20*. It will also aim to achieve the best economic, social and ecological outcomes for South Australia.

The operating objectives and key outcomes sought by the SA Operating Plan for 2019-20 (in no particular order) are:

- optimise (where practicably possible) water accessibility for all users;
    - provide the appropriate quantity of water to all users; and
    - align delivery of consumptive water for all users with anticipated timing of demands.
- to manage water quality (refer to targets in **Tables 6 and 7**), including salinity levels, for environmental, social, cultural and economic activity in the South Australian portion of the River Murray;
- in accordance with s. 8.06 (3)(c) and (d) of the Basin Plan to ensure 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
    - ensure that tidal exchanges maintain the Coorong's water quality (in particular salinity levels) within the tolerance of the Coorong ecosystem's resilience.
- to manage water levels in the Lower Lakes in accordance with s. 8.06 (3)(e) of the Basin Plan, to ensure sufficient discharge to the Coorong and Murray Mouth and help prevent riverbank collapse and acidification of wetlands below Lock 1 and to avoid acidification and allow connection between Lakes Alexandrina and Albert, by:
    - maintaining water levels above 0.4 m AHD for 95% of the time, as far as practicable; and
    - maintaining water levels above 0.0 m AHD all of the time.
- maintain seasonal variability in Lower Lakes water levels, between 0.5 m AHD m AHD and 0.85 m AHD, as identified in the *Barrage and Water Level Management Policy 2019*. The upper level of 0.85 m AHD may be breached for short periods to accommodate an action or operation that would deliver positive outcomes for the area, such as exporting salt or diluting salinity, or when conditions limit the release of water from the barrages;
- actively seek opportunities to manage Lake Albert salinity levels below 1 500 electrical conductivity (EC) (will be reliant on unregulated flows or large volumes of environmental water being made available);
- actively seek opportunities to manage Coorong South Lagoon salinity levels to below 100 parts per thousand (ppt);
- implement clause 91 of the Agreement - South Australia's Storage Right;
    - maximise opportunities to defer, store and deliver water; and
    - minimise the risk to CHWN.
- have regard for *South Australia's River Murray Annual Environmental Watering Plan*:
    - coordinate the planning and delivery of environmental water to South Australia to maximise the potential outcomes throughout the South Australian portion of the River Murray;
    - maximise environmental outcomes through the operation of infrastructure where possible (including weir pool manipulations and barrage operations); and
    - optimise the use of unregulated flow for environmental and water quality purposes.
- contribute to the implementation of the MDBA's *Drought Emergency Framework for Lakes Alexandrina and Albert* should the water level in Lakes Alexandrina and Albert be predicted to fall below 0.4 m AHD;
- manage the rate of declining water levels within the River Murray Channel to minimise riverbank collapse, slumping and potential ecological impacts;
- consider the potentially competing needs of floodplain works and flow delivery;
- effectively document knowledge and information with regard to operational decisions;
- effectively communicate and consult with stakeholders with regard to river operations;
- when possible, actively manage the risk of acid drainage water below Lock 1 from the Lower Murray Reclaimed Irrigation Area (LMRIA) by providing sufficient dilution flow over Lock 1; and
- report on the delivery of the objectives and outcomes under the SA Operating Plan.

2 Key Considerations

Some key considerations for River Murray System operations are:

- Considerable variability of inflows and usage;
    - There is great variability in climate across the Murray-Darling Basin. This is evident in the River Murray System where rainfall is highly variable and temperatures range from sub zero to over 50 degrees Celsius. Annual inflows range between less than 1 000 GL in extremely dry years to over 40 000 GL in very wet years;
    - Climate change adds another complexity to operations. In the last two decades, the River Murray System has experienced record-breaking droughts, summer floods and extreme temperatures. There has been a decline in late autumn and early winter rainfall since the mid-1990s. Operational planning has traditionally relied on observed historical inflow and demand patterns as a foundation. These patterns may no longer represent the variability of future seasons;
    - Demand patterns along the River Murray are constantly evolving due to new irrigation developments, changing crop types (particularly in the Lower River Murray around Sunraysia) and environmental water requirements;
    - The water market has become increasingly active in recent years. The impact of trade on the timing and location of water use (South Australia or interstate) will be a consideration when making management decisions;
    - The amount of water carried over from year to year will vary as Water Access Entitlement Holders adapt to variable flow conditions and implementation of the Private Carryover Policy (carryover will not be available in all years);
    - The amount of water available for environmental purposes. Environmental water requirements, timing of delivery and location of use, vary greatly between years depending on ecological needs and natural flow triggers; and
    - Water usage upstream and within South Australia.
- Water quality requirements;
    - Short-term issues that are difficult to foresee but require rapid response create challenges. Some issues affecting river operations may develop within weeks (eg blue-green algal bloom), or within days (eg salinity spike or fish kill due to poor water quality). Some of these issues may be able to be mitigated by river operations, particularly when water is relatively abundant;
    - Emergency river operations may require an immediate response (as per the Department for Health and Wellbeing's Water/Wastewater Incident Notification and Communication Protocol); and
    - In 2019-20, management of the LMRIA will only impact on normal river operations when there is a need to actively mitigate the effects of acid drainage water and heavy metal toxins entering the river. A dilution flow of 2.5 GL/day is required to manage this critical risk over an extended period of time. In particular, this is important during the irrigation season (September to April) when pumping to the main channel is highest. During the 2018-19 irrigation season, short periods (less than a week) of flows below this rate were experienced, with no prevalent water quality issues.
- Water storage volumes across the Basin;
- Long travel times. In the reach between Hume Dam and Lake Victoria, the typical flow time under regulated flow conditions is 22 to 25 days. The typical flow time under these conditions from Lake Victoria to Lock 1 is 10 days;
- Physical delivery considerations such as channel capacity limitations, in particular Barmah Choke, Frenchmans Creek (inlet to Lake Victoria) and Rufus River (outlet from Lake Victoria);
- Murray Mouth openness and the performance of the dredging campaign will need careful monitoring and consideration when making operational decisions during 2019-20;
- Barrage operations, Lower Lakes water levels and Coorong salinity;
- Weir pool operations – raising or lowering weir pool water levels, above or below its normal operating range is becoming more common practice to assist in achieving environmental outcomes;
- Construction activities; and
- Government policy positions such as BOC *Objectives and Outcomes for River Operations in the River Murray System*.

3 MDBA – Potential Water Availability

3.1 System Status – June 2019

In 2018-19, the River Murray System (southern Basin) and the Darling River (northern Basin) experienced below to very much below average rainfall. Temperatures were very much above average, with some areas experiencing temperatures that were the highest on record.

In June 2019, the Bureau of Meteorology's three-month outlook was for below average rainfall with warmer than average temperatures across the Murray-Darling Basin.

In 2018-19, River Murray System inflow (excluding Menindee, Snowy Mountains Scheme, Inter-valley Transfers and environmental water inflow) was approximately 2 810 GL (**Figure 1**), which is in the driest 7% of years on record. This follows low inflows in 2017-18 that were in the driest 13% of years on record. The River Murray System long-term annual average inflow is around 9 200 GL.

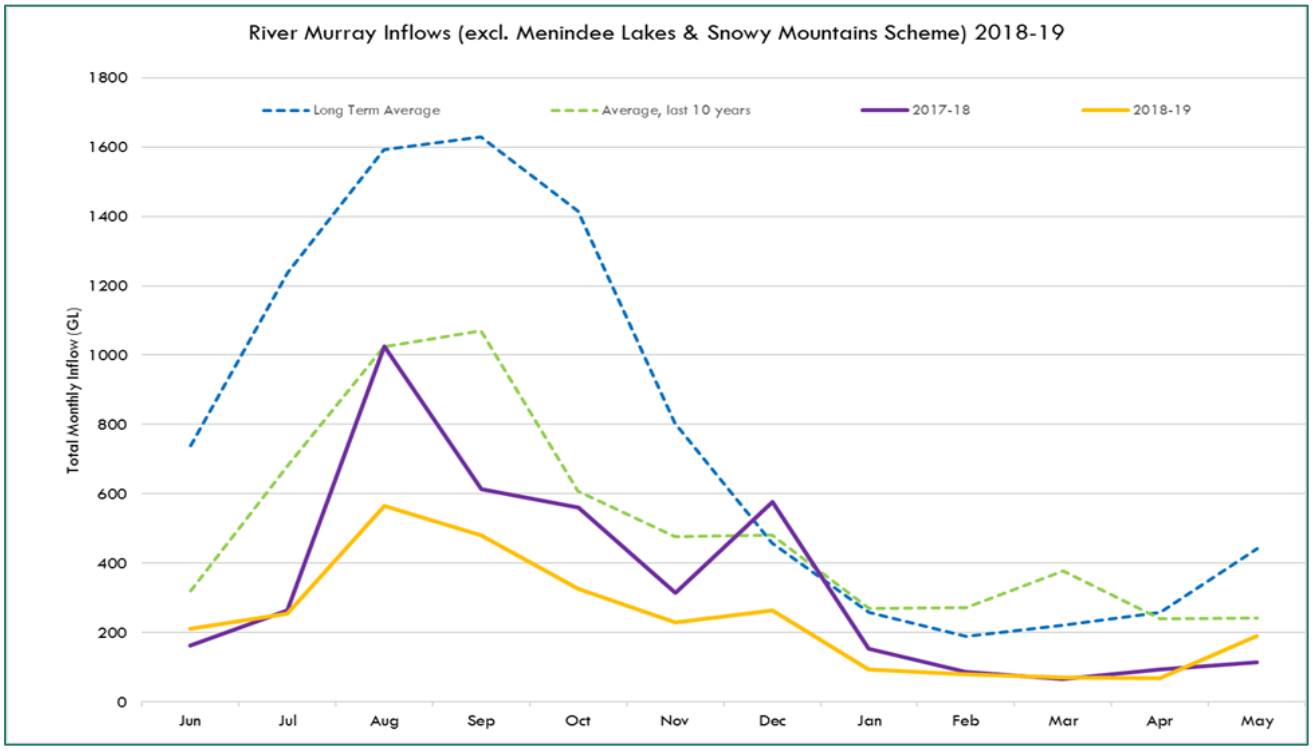

Figure 1. River Murray System Inflow (excluding inflow to Menindee and Snowy Scheme) recent years, long-term average and average over the last 10 years.

In 2018-19, inflow to Menindee Lakes was negligible (close to 0 GL), which is among the driest years on record. Menindee Lakes long-term annual average inflow is around 1 940 GL (**Figure 2**).

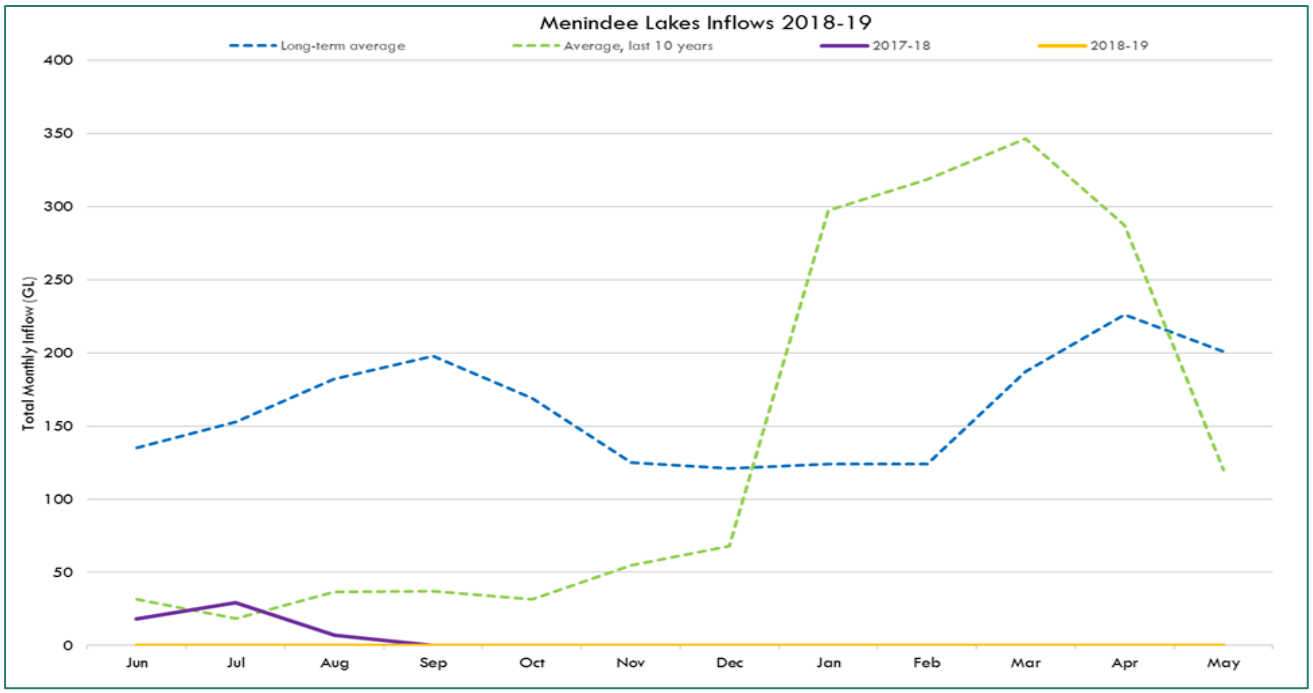

Figure 2. Inflows to Menindee Lakes in recent years, long-term average and average over last 10 years.

3.1.1 MDBA Storages at 1 July 2019

The water availability for the River Murray System and associated catchments (Murrumbidgee, Goulburn and Darling) at 1 July 2019 is identified in **Table 1**.

Table 1. Storage Volumes at 1 July 2019.

	Total Capacity (GL)	Active capacity (GL)	Total water in storage (GL)	Percentage of total capacity %
River Murray Storage (MDBA Controlled)				
Dartmouth Reservoir	3 855	3 785	2 460	64
Hume Reservoir	3 006	2 982	730	24
Lake Victoria	677	577	281	41
Menindee Lakes*	1 731	1 251	15	1
* When Menindee Lakes volume falls below 480 GL the water is controlled by NSW. When the volume next exceeds 640 GL it reverts back to MDBA control.				
Murrumbidgee Storage (NSW Controlled)				
Burrinjuck Reservoir	1 026	1 023	315	30
Blowering Reservoir	1 631	1 607	726	43
Goulburn Storage (Victoria Controlled)				
Eildon Reservoir	3 334	3 234	1 261	38

3.1.2 Critical Human Water Needs and Conveyance Reserve (Normal Water Sharing Arrangements)

The MDBA has declared that the River Murray System is under Tier 1 conditions. This means that normal water sharing arrangements are in place. Tier 1 water sharing operates when enough water is available for CHWN (NSW 61 GL, Victoria 77 GL and South Australia 204 GL) and conveyance water (1 596 GL). Conveyance water is the volume required to physically deliver water to where it is needed for use such as CHWN.

Under Tier 1, a *Conveyance Reserve* of 225 GL is set aside for use in the next year, to ensure CHWN can be met in the following year. The full *Conveyance Reserve* for 2020-21 has been set aside by the Murray-Darling Basin States at the start of 2019-20.

Tier 2 water sharing arrangements are triggered where the worst case planning water resource assessment indicates that conveyance requirements cannot be met for the following year (defined in the Basin Plan) and could be activated in 2020-21, but would not affect CHWN in 2019-20.

The MDBA will closely monitor water resource conditions and liaise with partner governments to monitor risks and adjust operating outlooks accordingly, as drought management and water security is reliant on forward planning and the management of reserves.

3.2 MDBA Hydrological Assumptions and Scenarios for 2019-20

3.2.1 River Murray System

The overall water availability for the River Murray System is determined by the MDBA at the start of each water year (1 June, which is different to South Australia's water year, which starts 1 July) and then at least monthly during the year. Throughout the year, the overall water availability is calculated using data, models and assumptions agreed by each of the jurisdictions. It is likely that water availability assessments will be prepared twice monthly to assist with water allocation announcements by the States.

Each determination of annual water availability needs to take into account the available water that is in storage at the time, water in transit, the amount of water used in that water year to date, estimates of future inflows (regulated and unregulated) and the losses that may be experienced in delivering water along the length of the River Murray System for the remainder of the year.

3.2.2 River Murray System Scenarios for 2019-20

It is not possible to accurately determine inflows to the River Murray System in advance, so the MDBA Annual Operating Outlook defines six different scenarios that cover, in broad terms, the likely range of conditions that may be experienced during 2019-20. These scenarios are then used to provide guidance as to general river operations and management actions that may be undertaken.

Each scenario includes in-built assumptions regarding releases from the Snowy Scheme, inflows to Hume Reservoir, inflows to Dartmouth Reservoir and inflows from the tributaries, including the Kiewa, Ovens, Goulburn, Murrumbidgee and Darling Rivers, conveyance requirements, storage evaporation and assumed diversion patterns. River Murray System inflow scenarios are included in the SA Operating Plan because they form the basis of the outlook for flow to South Australia. The River Murray System inflow scenarios:

- are based on information available at 1 June 2019 (eg water held in storages); and
- include the impacts of rainfall up to 1 June 2019 (eg catchment condition and flow in transit).

The scenarios include assumptions on consumptive use and environmental water use.

The pattern of environmental water demand is varied and different to historical consumptive demand (eg irrigation). Changes are also occurring in consumptive demand across the Basin, with crop expansion and changes in location of irrigation industries. This variability in demand presents a new challenge for annual operations planning. The assumptions

on environmental water demand included in each of the scenarios are based on discussions with Environmental Water Holders. Differences between assumed and actual use have the ability to significantly alter river operations.

At each assessment point throughout the water year, the volume of water available under the extreme dry and very dry scenarios will be progressively allocated to the States. The other scenarios are used to provide indicative quantities of water available to the States to assist in annual planning and management by water managers and customers, should those wetter scenarios eventuate.

The worst-case inflow scenario, as determined under the Basin Plan modelling, is 650 GL. This scenario has not been included in the possible scenarios for 2019-20, as extreme dry conditions would need to persist for two consecutive years to achieve the worst-case inflows. It is possible that if extreme dry conditions are experienced during 2019-20, the MDBA may include the worst-case scenario for operational planning in 2020-21.

The six 2019-20 River Murray System scenarios in the MDBA Annual Operating Outlook are summarised below:

1. **extreme dry scenario** (100% AEP*), assumes a total annual River Murray System inflow of about 1 000 GL, which is comparable to the lowest inflow on record of about 914 GL in 2006-07;
2. **very dry scenario** (95% AEP), assumes a total annual River Murray System inflow of about 2 100 GL, which is comparable to the 5th driest year on record in 2008-09;
3. **dry scenario** (90% AEP), assumes a total annual River Murray System inflow of about 3 000 GL, which is comparable to the 10th driest year on record in 2015-16;
4. **moderate scenario** (75% AEP), assumes a total annual River Murray System inflow of about 4 300 GL, which is comparable to the 25th driest year on record in 2014-15;
5. **near average scenario** (50% AEP), assumes a total annual River Murray System inflow of about 7 300 GL, which is comparable to inflow the 50th driest year on record in 2012-13; and
6. **wet scenario** (25% AEP), assumes a total annual River Murray System inflow of about 13 400 GL, which is comparable to the 25th wettest year on record in 2011-12.

*Annual Exceedance Probabilities (AEP) represents the percentage likelihood of a particular inflow, or greater inflow, occurring based on the historic record (ie percentage of years with a greater inflow).

3.2.3 Conveyance Water and Reserve

Under Tier 1 Water Sharing, the full *Conveyance Reserve* of 225 GL has been set aside for use in 2020-21 by the Murray-Darling Basin States.

The volume of water set aside for conveyance requirements in South Australia, includes losses due to evaporation and seepage along the river system and varies between scenarios. The conveyance losses (under regulated conditions) along the River Murray in South Australia upstream of Wellington are included as part of South Australia's 696 GL Dilution and Loss entitlement. For extreme dry scenario planning purposes, it is assumed that about 50% of the 696 GL is consumed by the environment between the border and Wellington and the other 50% flows into the Lower Lakes. The proportion will vary depending on a range of factors including evaporation and local rainfall.

3.2.4 South Australia's Storage Right

On 1 July 2019, South Australia had a total of 341.6 GL of water deferred and stored (0 GL in Lake Victoria, 0 GL in Hume Reservoir and 346.1 GL in Dartmouth). The 341.6 GL is divided between CHWN (239.5 GL) and private carryover (102.1 GL) for use in future dry years (refer to **Table 2**).

Table 2. Storage Right Volumes at 1 July 2019.

	Lake Victoria (GL)	Hume (GL)	Dartmouth (GL)	Total (GL)
CHWN	0.0	0.0	239.5	239.5
Private Carryover	0.0	0.0	102.1	102.1
Total	0.0	0.0	341.6	341.6

At 1 July 2019, the MDBA's advice was that under the extreme dry inflow scenario (100% AEP), South Australia is entitled to receive approximately 1 050 GL of Entitlement Flow during 2019-20. As a result, a portion of the water that has been deferred and stored will be required to be delivered during 2019-20 for private carryover and possibly to top-up CHWN (this will depend on SA Water's pumping requirements and inflows to the Mount Lofty Ranges). This total volume could be around 50 GL (unless inflows significantly improve).

South Australia will not pursue opportunities to defer any of its reduced Entitlement Flow in 2019-20. However, if water resource conditions significantly improve, South Australia may consider deferring a portion of its full Entitlement Flow to reinstate up to the volume that has been delivered. This will maintain, not increase, the volume of water held in the Storage Right.

The volume of deferred and stored water is adjusted for net evaporation losses and spills until it is delivered to South Australia. If a spill occurs in a reservoir that holds South Australia's stored water, it is South Australia's water that spills first.

3.2.5 Additional Dilution Flow (ADF)

It is very unlikely that ADF will be triggered in 2019-20. ADF could be triggered under the wet scenario.

The ADF rules were developed in 1989 using modelled historical inflow sequences (prior to the most recent drought sequence) with the aim of reducing River Murray salinities in South Australia. The intent of the rule is a 'use it or lose it' principle whereby additional water is delivered to South Australia rather than lost as evaporation from Menindee Lakes. The ADF rules have a set of triggers described below.

South Australia will receive 3 GL/day above the daily equivalent of the monthly Entitlement Flow, whenever both of the following conditions are satisfied:

- the storage volume in Menindee Lakes exceeds the volumes within the given month as listed under Trigger Storage below (**Table 3**); and
- the combined storage volume in Hume and Dartmouth Reservoirs exceeds 2 000 GL.

Table 3. Volume (GL) in Menindee Lakes required to trigger ADF.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 300	1 300	1 300	1 300	1 300	1 650	1 650	1 500	1 300	1 300	1 300	1 300

3.2.6 Menindee Lakes

In December 2017, the storage volume in the Menindee Lakes decreased to below 480 GL. This means the MDBA is unable to direct releases to supplement water availability in the River Murray. Releases from Menindee Lakes are now under the control of New South Wales. When the Menindee Lakes volume exceeds 640 GL the MDBA will be entitled to direct releases.

The ability to direct releases from the Menindee Lakes could switch to the MDBA if significant flooding occurs in the upper Darling River. This may occur under the wet scenario.

If the MDBA reverts back to directing releases from the Menindee Lakes in 2019-20, the storage will be operated in conjunction with Lake Victoria to reduce evaporation losses while minimising the chance of spill from Lake Victoria. Generally, regulated release rates from Menindee Lakes will be below 5 GL/day at Weir 32 (to minimise river losses).

Menindee Lakes flood releases are directed by the NSW Office of Water and will generally pass inflows while the Menindee Lakes are close to maximum surcharge level.

3.2.7 Flow to South Australia

3.2.7.1 Entitlement Flow

South Australia would only receive its full Entitlement Flow in the near average (50% AEP) and wet (25% AEP) scenarios.

For Entitlement Flow delivery, South Australia has adopted the dry (90% AEP) inflow scenario for 2019-20, as provided by the MDBA on 10 May 2019 (MDBA's water year starts on 1 June). AEP is the probability that an annual inflow will be exceeded in any one year based on historical records ie 90% AEP is a dry year. On 1 June 2019, under the 90% AEP inflow scenario, South Australia would be provided with an Entitlement Flow of 1 450 GL in 2019-20, noting this is likely to increase as the year progresses.

In 2019-20, South Australia's Entitlement Flow will be:

- increased by approximately 27 GL due to late season trade into South Australia during 2018-19;
- adjusted for trade in to, or out of, South Australia during 2019-20;
- increased by the volume of water delivered to South Australia from the Storage Right; and
- decreased by the volume that South Australia defers during 2019-20 (under the current water resource conditions, SA is proposing to defer 0 GL).

Note: For water allocations, South Australia adopted the extreme dry inflow scenario (100% AEP) for 2019-20 (at 1 July 2019) as this would ensure that water allocations do not decrease as the year progresses. For Entitlement Flow delivery, South Australia adopted the dry inflow scenario (90% AEP) for 2019-20 (at 10 May 2019) to ensure that it receives the maximum possible monthly volume of Entitlement Flow. If South Australia adopted the extreme dry inflow scenario for water delivery and then flows improved, it would not be able to recover the reduced monthly Entitlement Flow for the months that had passed. This carries a small risk to flow delivery in the later months of the year.

3.2.7.2 Environmental Water

In 2019-20, environmental water will be delivered to South Australia under all scenarios, ranging from 550 GL in the extreme dry scenario to 950 GL in the near average scenario. These volumes are in addition to environmental water held on licence as part of South Australia's Entitlement Flow.

3.2.7.3 Unregulated Flow

Unregulated flow generally occurs in response to high rainfall events upstream of South Australia. Unregulated flow cannot be allocated to consumptive purposes. Therefore, when an unregulated flow event occurs, the additional water provides environmental benefits and is protected from other users.

Under the extreme dry, very dry and dry scenarios, unregulated flow is not expected to occur. In the moderate scenario, modest volumes of unregulated flow may result through small inflow events from upstream. In the near average and wet scenarios, large upstream inflow events may result in prolonged unregulated flow. Under the wetter scenarios, there could be a significant flood along the River Murray in South Australia.

3.2.7.4 Additional Dilution Flow

In 2019-20, it is unlikely that ADF will be triggered. ADF could be triggered under the wet scenario.

Menindee Lakes

3.2.8 Flow at Lock 1 (consideration)

The flow rate over Lock 1 is managed to maintain a flow rate above 2.5 GL/day for reasonable periods of time. This is done to dilute acid drainage water, in particular during periods of high irrigation use. Under the MDBA's extreme dry, very dry and dry scenarios, the flow over Lock 1 will not be able to be managed to maintain the flow rate above 2.5 GL/day for reasonable periods of time.

Since the Millennium drought when this problem was observed and managed, the flow rate at Lock 1 has been maintained above 2.5 GL/day, with the exception of a few days and one week in January 2018. There were no prevalent water quality issues in the River Murray channel when the flow rate was less than 2.5 GL/day for these short periods. It should be noted that problems were observed during extended periods of sustained low flow during the Millennium Drought.

Under the moderate, near average and wet scenarios, there should be sufficient flow to dilute any major impacts of acid drainage water.

3.2.9 Flow at Murray Mouth (consideration)

A volume of:

- at least 2 GL/day is required to minimise sand ingress into the Murray Mouth;
- approximately 20 GL/day can be sufficient to prevent sand ingress inside the Murray Mouth; and
- at least approximately 75 GL/day for around two months is required to substantially scour and remove sand that has already been deposited. This generally requires an extended duration of unregulated flow.

Under the extreme dry, very dry and dry scenarios, barrage releases will need to be managed very carefully. During periods of low or no barrage releases, tidal currents are the primary factor controlling the morphology of the Murray Mouth. The overall potential for tide-driven sediment infill of the Murray Mouth is greatest when barrage releases cannot be maintained above 2 GL/day between May and November, due to the increased frequency of storm events.

Murray Mouth

4 Flow Rates, Volume and Timing of Flow to South Australia

The flow to South Australia will be managed in close cooperation between DEW, MDBA and SA Water. When environmental water is being delivered to South Australia, additional stakeholders such as the CEWO will be engaged as key participants.

The overall water availability for the River Murray System is initially determined by the MDBA at the commencement of each water year (1 June)* and then subsequently at either fortnightly or monthly intervals during the year. Normal water sharing arrangements (Tier 1) apply to distribute the available water between jurisdictions in accordance with the Agreement. Water availability is estimated in accordance with the water sharing arrangements using recorded data, models and assumptions that have been agreed by each of the jurisdictions and each determination considers:

- inflow above minimum levels;
- estimates of future inflow (regulated and unregulated);
- available water in storage;
- amount of water used;
- other commitments, such as minimum reserve and conveyance reserve; and
- observed and future losses (conveyance through the River Murray System).

At 10 May 2019, the MDBA's advice was that during 2019-20 South Australia would receive approximately 1 450 GL of Entitlement Flow under the dry inflow scenario (90% AEP).

For water allocations, South Australia adopted the extreme dry inflow scenario (100% AEP) for 2019-20 (at 1 July 2019) as this would ensure that water allocations do not decrease as the year progresses. For Entitlement Flow delivery, South Australia adopted the dry inflow scenario for 2019-20 to ensure that it receives the maximum possible monthly volume of Entitlement Flow. If South Australia adopted the extreme dry inflow scenario for water delivery and then flows improved, it would not be able to recover the reduced monthly Entitlement Flow for the months that had passed.

A volume of 1 050 GL will not support 100% water allocation for all River Murray Water Access Entitlement Holders from 1 July 2019. As a result, private carryover has been made available to eligible Class 3 water access entitlement holders. Private carryover will be delivered from water that has been deferred and stored in the Storage Right.

Depending on SA Water's pumping demands and the inflows to the Mount Lofty Ranges storages, some water may also be delivered from the Storage Right to top-up CHWN. SA Water's preference is to take the minimum requirement from the Storage Right.

Due to the reduced Entitlement Flow, South Australia will not defer any of its Entitlement Flow in 2019-20. However, if water resource conditions improve significantly and South Australia receives its full Entitlement Flow, it may consider deferring water for use in future dry years.

Any proposed changes to the delivery of monthly Entitlement Flow to South Australia, and the use of South Australia's Storage Right under Schedule G, will be identified through the Deferred Water Storage and Delivery Plan, which is updated on a monthly basis (**refer to Chapter 7**).

South Australia elected to deliver its full monthly Entitlement Flow in June and July 2019, which will maximise the flow to South Australia should water resource conditions improve. This carries a small risk if water resource conditions do not improve. The delivery pattern for the remaining volume will be delivered in the remaining ten months based on a historical demand profile and sufficient flow at Wellington to ensure the river flows into the Lower Lakes. Flows into the Coorong are dependent on environmental water during extremely dry years.

Under conditions where South Australia receives an annual Entitlement Flow of 1 850 GL, the monthly distribution pattern is detailed in clause 88 of the Agreement (**Table 4 full Entitlement Flow**). Under the dry inflow scenario (90% AEP)

provided by the MDBA on 10 May 2019, the reduced monthly Entitlement Flow pattern for 2019-20 is outlined in **Table 5**, with an Entitlement Flow of 1 450 GL/year. Variations to monthly delivery patterns will be undertaken by notifying the MDBA using a clause 128 variation.

South Australia's full Entitlement Flow of 1 850 GL/year is comprised of the following (**Table 4**):

1. Dilution and Loss Entitlement of 696 GL/year, which is provided at a rate of 58 GL/month; and
2. Non-dilution (consumptive) Entitlement of 1 154 GL/year, with monthly totals as per the Agreement.

Table 4. Delivery Pattern for full Entitlement Flow of 1 850 GL/year.

Month	Dilution and Loss (GL/Month)	Consumptive (GL/Month)	Total Entitlement (GL/Month)	Entitlement Flow Rate (GL/day)
Jun	58	32.0	90.0	3.0
Jul	58	50.5	108.5	3.5
Aug	58	66.0	124.0	4.0
Sep	58	77.0	135.0	4.5
Oct	58	112.5	170.5	5.5
Nov	58	122.0	180.0	6.0
Dec	58	159.0	217.0	7.0
Jan	58	159.0	217.0	7.0
Feb	58	136.0	194.0	6.69
Mar	58	128.0	186.0	6.0
Apr	58	77.0	135.0	4.5
May	58	35.0	93.0	3.0
Total	696	1 154.0	1 850.0	

Note: The MDBA water year starts on 1 June, which is different to South Australia's water year, which starts 1 July. **Table 4** and **Table 5** reflect the MDBA water year.

Construction of an environmental regulator

Under the dry inflow scenario (90% AEP), South Australia would receive a reduced Entitlement Flow of 1 450 GL (**Table 5**).

Table 5. Delivery Pattern for reduced Entitlement Flow of 1 450 GL/year.

Month	Dilution and Loss (GL/Month)	Consumptive (GL/Month)	Total Entitlement (GL/Month)	Entitlement Flow Rate (GL/day)
Jun	54.4	35.6	90.0	3.0
Jul	78.5	30.0	108.5	3.5
Aug	38.2	40.8	79.0	2.5
Sep	45.2	54.8	100.0	3.3
Oct	56.7	70.3	127.0	4.1
Nov	72.3	83.2	155.5	5.2
Dec	77.3	102.7	180.0	5.8
Jan	76.1	111.9	188.0	5.8
Feb	65.5	94.5	160.0	5.5
Mar	56.7	67.3	124.0	4.0
Apr	42.0	39.0	81.0	2.7
May	33.1	23.9	57.0	1.8
Total	**696**	**754.0**	**1 450.0**	

Note: if conditions significantly improve as the year progresses, a different Entitlement Flow will be delivered to South Australia.

Note: The MDBA water year starts on 1 June, which is different to South Australia's water year, which starts 1 July. **Table 4** and **Table 5** reflect the MDBA water year.

Adjustments for late season trade are made to Entitlement Flow from September to April in the following year.

In 2018-19, there was a net inward late season trade of approximately 27 GL. Therefore, South Australia's Entitlement Flow will be increased by this volume (using a monthly ratio) between September 2019 and April 2020. The inward late season trade may have been to cover higher water use in 2018-19 and for private carryover purposes.

At the commencement of this plan, South Australia is not receiving ADF (3 GL/day) as both triggers are not currently activated. It is unlikely that ADF will be triggered in 2019-20. ADF could be triggered under the wet scenario.

Barmah Choke - physical constraint to water delivery to SA

5 Delivery of Water for Consumptive Purposes

DEW is responsible for overseeing the delivery of water to meet consumptive demands for non-environmental purposes. These consumptive demands include providing water for:

- SA Water supply to Metropolitan Adelaide and Country Towns;
- Irrigation extractions;
- Stock and Domestic;
- Recreational; and
- Industrial and mining activities.

Management of River Murray water to meet these consumptive demands can require active day-to-day operational management decisions, particularly when low flow conditions are being experienced. River Murray operational considerations include:

- flow rates, volumes and timing of flow at critical locations;
- salinity targets;
- timing of any operations; and
- minimum flow rates and weir pool levels for operation of wetland regulators and drainage basin infrastructure.

South Australia has elected to base its water allocations on the extreme dry inflow scenario (100% AEP), which would provide a reduced Entitlement Flow of approximately 1 050 GL. The restricted Entitlement Flow will require restrictions to SA Water, irrigation, recreational, environmental and industrial use.

South Australia has elected to receive its full Entitlement Flow in June and July and the remaining ten months based on a historical demand profile and sufficient flow at Wellington to ensure the river flows into the Lower Lakes. Flows into the Coorong are dependent on environmental water during extremely dry years. This distribution pattern aligns with the anticipated water requirements during the warmer summer months, particularly for irrigation purposes. This delivery profile would also maximise the volume of water delivered to South Australia, should the water resource conditions improve.

Note: If conditions significantly improve as the year progresses, a different Entitlement Flow will be delivered to South Australia.

5.1 Critical Human Water Needs

The Murray-Darling Basin jurisdictions have agreed that delivery of water for CHWN will be the highest priority. The River Murray will be operated to guarantee suitable water quality for CHWN and, where possible, connectivity with the majority of infrastructure off-takes.

At 10 May 2019, the MDBA's advice is that under the dry inflow scenario (90% AEP), South Australia is entitled to receive approximately 1 450 GL of Entitlement Flow during 2019-20. This volume, with the possible delivery of water from the Storage Right to top-up CHWN (if required), will provide security for the full provision of water for CHWN.

5.2 Irrigation

At 1 July 2019, South Australian irrigators had access to 26% water allocation, which increased to 31%. Allocations increased again on 15 July to 38% and on 1 August increased to 50%. South Australia has elected to base water allocations on the extreme dry inflow scenario (100% AEP) to ensure that water allocations do not decrease as the year progresses. Water allocations will increase as water resource availability to South Australia improves.

South Australian irrigators will receive 100% water allocation when South Australia is entitled to receive at least 1 496 GL/year of Entitlement Flow.

Private carryover is a useful product for irrigators in dry years when water allocations are restricted. As River Murray water access entitlement holders had access to less than 50% water allocation at the commencement of 2019-20, private carryover was made available to eligible Class 3 water access entitlement holders.

The SA Operating Plan and associated operational decisions will balance the impacts of weir pool manipulations within South Australia on irrigated agriculture, while acknowledging and exploring other opportunities to manage irrigation extractions within more flexible river management regimes.

Irrigation extraction below Lock 1 requires the weir pool level to be maintained above +0.50 m AHD to generally retain access by irrigation pumping or diversion infrastructure although, at this level, water quality may deteriorate around the Lower Lakes.

Oranges at Waikerie

Dairy Cows at Tailem Bend

6 Storage and Delivery of Deferred Water for Critical Human Water Needs and Private Carryover

The *Schedule to Account for South Australia's Storage Right* (Schedule G) of the Agreement, Schedule 1 of the *Water Act 2007* (Cwlth) defines the rules for giving effect to, and accounting for, South Australia's right to defer, store, manage and subsequently deliver Entitlement Flow for CHWN and private carryover (including environmental water) under clause 90 of the Agreement. Schedule G came into effect on 1 September 2011. The principle requirements of Schedule G are as follows:

- South Australian deferred water should cause no effect on the water availability of Victoria or NSW (the Upper States), or in the case of water stored for private carryover, their storage access;
- If South Australia's deferred water spills from storage, it should be, where possible, re-regulated for subsequent use by South Australia;
- Water stored for private carryover spills before water for CHWN; and
- Water stored by South Australia will be subject to incremental net evaporation losses only.

Based on the above, access to storage capacity is limited to the unused capacity of the major upstream storages (Lake Victoria, Menindee Lakes, Hume and Dartmouth Reservoirs). South Australia has no preferential access to storage capacity. For practical and water accounting purposes, South Australian deferred water floats on top of water held by New South Wales and Victoria (including environmental entitlements owned by those States, MDBA and Commonwealth Environmental Water). It is therefore first to spill or to be pre-released, if required for flood mitigation purposes.

Schedule G provides South Australia with additional flexibility to manage the timing and delivery of Entitlement Flow for CHWN and private carryover. Use of the Storage Right requires the South Australian BOC member to provide a Deferred Water Storage and Delivery Plan to the MDBA, New South Wales and Victoria on the first day of each month.

The Deferred Water Storage and Delivery Plan is the mechanism by which South Australia can defer (store) and deliver deferred Entitlement Flow (for CHWN and private carryover). It is a rolling (at least) 12 month plan that is prepared and revised each month in consultation with the MDBA and must consider a range of water availability scenarios.

Specifically, for each month, the Deferred Water Storage and Delivery Plan must:

- detail when Entitlement Flow is to be deferred and the proportions to be deferred as CHWN and private carryover;
- detail where the deferred water should be stored, with regard for the unused capacity of the major storages;
- detail how much deferred water should be delivered and from which storages;
- nominate any preferred downstream transfers or volumes to be substituted upstream; and
- not provide for deferred water to be delivered in the same month that water became deferred.

Under the current State policy position, South Australia is required to defer 140 GL/year on confirmation from the MDBA that the full Entitlement Flow (1 850 GL) will be received. South Australia is not required to defer 140 GL/year when it is expected to receive less than 1 850 GL.

At 10 May 2019, the MDBA's advice is that under the dry inflow scenario (90% AEP), South Australia would be entitled to receive 1 450 GL in 2019-20. As a result, South Australia will not defer any of its reduced Entitlement Flow during 2019-20. If water resource conditions significantly improve as the year progresses, South Australia may consider deferring a portion of its full Entitlement Flow to reinstate up to the volume that has been delivered. This will maintain, not increase, the volume of water held in the Storage Right.

Deferral and storage of Entitlement Flow will only be undertaken if conducive to do so. It will be necessary to balance the needs of all water users.

In 2019-20, South Australia will deliver enough water to meet private carryover requirements and any shortfall in SA Water's pumping demands for CHWN. Private carryover requirements will be determined in September 2019. SA Water's shortfall in pumping demand will be determined as the year progresses. SA Water would prefer not to deliver water from the Storage Right for CHWN until absolutely necessary.

On a monthly basis, the RMOWG will consider the draft Deferred Water Storage and Delivery Plan before it is forwarded to the South Australian BOC member, who will forward it to the MDBA, NSW and Victoria.

At 1 July 2019, the balance in the MDBA account for CHWN is 239.5 GL and private carryover is 102.1 GL. Volumes stored are adjusted for net evaporation losses and spills until delivered to South Australia.

Apricots in Riverland

7 Water Quality and Salinity

The SA Operating Plan will ensure that the water quality and salinity objectives and targets included in Chapter 9 of the Basin Plan, *Water Quality and Salinity Management Plan*, are taken into consideration when making operational decisions for the River Murray in South Australia. This includes the objective of providing water of suitable quality for the environment, CHWN and irrigation.

The *Water Quality and Salinity Management Plan* (contained within the Basin Plan) is aimed at maintaining appropriate water quality and salinity for environmental, social, cultural and economic activity in the Murray-Darling Basin.

Included below are Basin Plan and South Australian Department for Health and Wellbeing (DHW) water quality and salinity targets that will need to be considered when making flow management decisions. If it is anticipated that water quality parameters are likely to exceed the target limits (as defined in **Table 6** and **Table 7**), management actions to improve water quality will be considered.

7.1 Targets for Managing Water Flows (Basin Plan – 9.14)

The *Water Quality and Salinity Management Plan* requires the MDBA, Murray-Darling Basin Ministerial Council, BOC, CEW Office and the Basin States to have regard to the water quality targets included in **Table 6** when making certain management policies or decisions relevant to flow management.

Prior to undertaking actions under the SA Operating Plan that may affect water quality, the following will be considered:

- That the decision is consistent with relevant operational and environmental watering plans and policies including:
    - South Australian Annual Environmental Watering Priorities;
    - MDBA's River Murray System Annual Operating Outlook 2019-20; and
    - BOC Objectives and Outcomes for River Operations in the River Murray System.
- The risk that a flow decision may result in either salinity, dissolved oxygen or cyanobacteria exceeding target values, after considering:
    - potential impacts from the water flow decision*;
    - current in-stream conditions (including upstream of the South Australian border);
    - forecast flow conditions; and
    - available mitigation strategies.

*If likelihood of the impact is high, further detailed assessment may be required.

- The need to undertake monitoring and evaluation of the implementation of the flow management decision to assess actual changes to relevant water quality parameters (before and after using existing or event based monitoring) and to determine long-term trends.
- The need to complete relevant notification requirements. This may include:
    - a River Murray Action Request form to DEW, Water Delivery Unit; and
    - community notification through appropriate channels when required.
- The need to put in place appropriate reporting arrangements, including:
    - documentation of decision making process and how targets for managing water flows (9.14) were considered; and
    - processes to allow provision of monitoring information and documentation on how targets were considered to the DEW Basin Plan reporting coordinator.

Table 6. Basin Plan Targets for Managing Water Flows (9.14 (5)).

Location	Value	Timeframe
Lock 6	Less than 580 EC	95% of the time
Morgan	Less than 800 EC	95% of the time
Murray Bridge	Less than 830 EC	95% of the time
Lower Lakes at Milang	Less than 1 000 EC	95% of the time
All	Maintain dissolved oxygen at a target value of at least 50% saturation #	100% of the time
	Fresh recreational water bodies should **not** contain: ≥10 µg/L total microcystins; ≥50 000 cells/mL toxic *Microcystis aeruginosa*; or biovolume equivalent of ≥4 mm3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume; or ≥10 mm3/L for total biovolume of all cyanobacterial material where known toxins are not present; or cyanobacterial scums consistently present.	100% of the time

Saturation of dissolved oxygen is based on standard assumptions of pressure at one atmosphere and water temperature at 25^{O}C. At these assumptions 50% oxygen saturation is equivalent to approximately 4.13 mg/L.

Dissolved oxygen is an important parameter for determining overall water quality. Low dissolved oxygen levels reflect high levels of biological activity and can create anaerobic conditions. Anaerobic conditions contribute to the release of nutrients and heavy metals in sediments into the water body.

7.2 Objectives for Raw Water for Treatment for Human Consumption (Basin Plan - 9.05)

The Basin Plan outlines objectives for raw water for treatment for human consumption in section 9.05, Chapter 9. South Australia has developed a set of CHWN water quality targets for raw water for treatment for human consumption to assist in the achievement of the Basin Plan objective. The targets are defined in Table 7. Exceeding targets in Table 7 may trigger mandatory public notification protocols, refer to the Department for Health and Wellbeing's *Water/Wastewater Incident Notification and Communication Protocol* (the Protocol).

The Protocol has been adapted from the *Australian Drinking Water Guidelines 2011* (ADWG) and also meets the *Safe Drinking Water Act 2011* requirements for an approved incident identification and notification protocol. The ADWG is also a key consideration for the Basin Plan - 5, 9.14, 11.02, 11.05 and 11.16.

The Protocol classifies water quality incidents into three categories:

1. **Priority Type 1 Incidents** - likely to require immediate interagency meetings to consider responses and issue public advice. Priority Type 1 incidents are to be reported immediately by direct voice contact to the Water Incident Coordinator (WIC) and are reportable to the Minister for Health and Wellbeing and the Minister for Environment and Water.
2. **Type 1 Incidents** are either:
   - **Health** – an incident that without appropriate intervention could cause serious risk to human health; or
   - **Environmental** – an incident that without appropriate intervention could cause, or threaten to cause, serious or material environmental harm.

Type 1 incidents require immediate notification to the defined agencies (EPA and DHW), WIC, Minister for Health and Wellbeing and the Minister for Environment and Water.

3. **Type 2 Incidents** are either:
   - **Health** – an incident that without appropriate intervention represents a low risk to human health; or
   - **Environmental** – incidents that without appropriate intervention could cause environmental harm but are not of a high impact or on a wide-scale.

   In the absence of appropriate intervention and remediation, Type 2 incidents have the potential to escalate to Type 1 or Priority Type 1 Incidents. Type 2 incidents require notification within 24 hours to defined agencies (EPA and DHW), but are not required to be routinely reported to the WIC, Minister for Health and Wellbeing or the Minister for Environment and Water.

Table 7. Water Quality Targets for Raw Water for Treatment for Human Consumption.

Purpose	Location	Parameter	Target		
Raw water for treatment for human consumption	Water Treatment Plant Inlets	Salinity	Less than 500 mg/L for 95% of the time		
		Dissolved Organic Carbon	Less than 10 mg/L		
		Alkalinity	Greater than 40 mg/L		
		Turbidity	Less than 100 NTU		
		Soluble Manganese (Mn)	Less than 0.1 mg/L		
		Combine soluble MIB/Geosmin	Less than 10 ng/L		
			Priority Type 1✪	Type 1✪	Type 2✷
		Microcystin *Microcystis aeruginosa* *Microcystis flos-aquae*	≥13µg/L toxin⌘ ≥65 000 cells/mL	≥1.3µg/L toxin⌘ ≥6 500 cells/mL	N/A
		Nodularin *Nodularia spumingena*	≥13µg/L toxin⌘ ≥400 000 cells/mL	≥1.3µg/L toxin⌘ ≥40 000 cells/mL	N/A
		Saxitoxin(s) *Dolichospermum circinale* (*Anabaena circinalis*)	≥3µg/L toxin⌘ ≥20 000 cells/mL	≥1µg/L toxin⌘ ≥2 000 cells/mL	N/A
		Cylindrospermopsin(s) *Cylindrospermopsis raciborskii* *Chrysosporum ovalisporum*	≥10µg/L toxin⌘# ≥150 000 cells/mL	≥1µg/L toxin⌘# ≥15 000 cells/mL	N/A
		Health-related organic or inorganic chemicals		Any exceedance of health values prescribed in the ADWG	Detection equivalent to ≥ 10% of the health values prescribed in the ADWG

✪ Priority Type 1 and Type 1 are DHW notifiable threshold limits. Incidents are triggered immediately and are reportable to the Minister for Health and Aging and the Minister for Environment and Water.

✷ Type 2 incidents are to be notified to the EPA and DHW within 24 hours.

⌘ This is a product of cyanobacteria. In the absence of toxicity data refer to the cell count (cells/mL).

Prior to triggering an incident for health related chemicals, individual results are rounded to the same number of significant figures as the guideline value in the ADWG eg for Microcystin toxin results in the range 13.1-13.4 µg/L are rounded to 13 µg/L (not Priority Type 1) and 13.5-13.9 µg/L are rounded to 14 µg/L (Priority Type 1).

To oversee the management of the risks associated with heavy metals discharged from LMRIA acid drainage water, an interagency working group has been established between DEW, SA Water, EPA and DHW. The group meets as required. Flow management is the primary tool used to manage the risks around mobilising heavy metals in the River Murray downstream of LMRIA drainage outfalls, where SA Water treatment plant intakes are located.

7.3 Water Quality Targets for Water Resource Plans (Basin Plan- 9.16 to 9.18)

The *Water Quality and Salinity Management Plan* identifies water quality targets for irrigation water, water used for recreational water and fresh water-dependent ecosystems, that must be included in water resource plans by Basin States.

The water quality target for irrigation water set out in Basin Plan section 9.17 (3) is that salinity is maintained below 833 EC for 95% of the time over each 10 year period ending at the end of a water accounting period at sites in the Murray-Darling Basin where water is extracted by an irrigation infrastructure operator for the purposes of irrigation.

7.4 Salt Load Objective (Basin Plan- 9.09)

The Basin Plan salt export objective is to ensure adequate flushing of salt from the River Murray System into the Southern Ocean. The objective is expected to be achieved by the discharge of a minimum of 2 million tonnes of salt from the River Murray System into the Southern Ocean each water accounting period (MDBA responsibility).

The MDBA must assess the export of salt annually by comparing the estimated number of tonnes of salt per year averaged over the preceding 3 years against the indicative figure of 2 million tonnes of salt per year.

7.5 Salt Interception Schemes

The Murtho, Pike, Bookpurnong, Loxton, Waikerie and Woolpunda Salt Interception Schemes (SIS) will be operated in accordance with Operations and Maintenance manuals or any agreed SIS responsive management trial under the *Basin Salinity Management 2030* strategy. Salinity risk predictive tools will be progressively developed and SIS responsive management trial performance will be reported.

Salinisation in the Riverland

Salt Interception

8 Weir Pool Manipulations

Manipulation of weir pool water levels may be implemented for a number of reasons including:

- for environmental benefit including the wetting and drying of riparian areas and adjacent wetlands and floodplains;
- the need to supply downstream water requirements when there are very hot conditions and demands are high;
- to minimise evaporation rates;
- to temporarily store water rather than allow it to pass downstream;
- for construction and maintenance programs; and
- to provide variation in water levels to minimise bank erosion.

Weir pool water levels are operated within a normal operating range, which is identified in **Table 8**. In the event that weir pool water levels need to be raised or lowered outside their normal operating range, then jurisdictional representatives would be notified via the WLWG. The public would be notified through the MDBA River Murray Weekly Report, South Australia's River Murray Flow Report, media releases, radio, letters and local newspapers where appropriate.

Table 8. Weir Pool Water Levels - Normal Operating Range.

Weir	Normal Pool Level (NPL) (m AHD)	Normal Operating Range (m AHD)	SA Water's current minimum allowable level (m AHD)	SA Water's current maximum allowable level (m AHD)
Lock 6 - Murtho	19.25	19.17 - 19.50	19.17	≈ 19.67
Lock 5 - Renmark	16.30	16.13 - 16.43	16.03	16.80
Lock 4 – Bookpurnong	13.20	13.16 - 13.50	13.16	13.50
Lock 3 - Overland Corner	9.80	9.77 - 10.02	9.77	10.02
Lock 2 – Waikerie	6.10	5.90 - 6.40	5.90	6.65
Lock 1 – Blanchetown	3.20	3.10 - 3.40	3.10	# 3.40

≈ Lock 6 raising above 19.67 m AHD is dependent on conditions and observations at the time

\# Lock 1 raising is currently limited to 3.40 m AHD, as this is the maximum height the structure has been tested since remedial works were completed

Lock 5

Table 9 identifies potential weir pool manipulations that are being considered to be undertaken during 2019-20 to achieve environmental outcomes including detail of potential water levels, timing and duration. It also identifies the required flow rate at the South Australian border before a decision would be made to commence the event.

Table 9. Potential Weir Pool Manipulations 2019-20.

Weir Pool	Manipulation (m)	Level (m AHD)	Flow Trigger at SA border (GL/day)	Timing	Duration # (days)	Normal Pool Level (m AHD)	Normal Operating Range (m AHD)
Lock 1	No lowering or raising					3.20	3.10 - 3.40
Lock 2	Raise up to 0.52 Raise up to 0.75	6.62 6.85	>3.7 >10	Aug - Nov 2019 Jul - Oct 2019	up to 115 up to 105	6.10	5.90 - 6.40
Lock 3	No lowering or raising					9.80	9.77 - 10.02
Lock 4	No lowering or raising		-	-	-	13.16	13.16 - 13.50
Lock 5	No lowering or raising					16.30	16.13 - 16.43
Lock 6	Raise 0.42 Raise up to 0.59 Raise 0.60 in conjunction with Chowilla Operations	19.67 19.84 19.85	>3.7 >10 >30	Aug - Nov Jul - Oct 2019 Jul - Dec 2019	up to 115 up to 105 up to 157	19.25	19.17 - 19.50

Duration includes the time required to raise and lower the weir pool, which will be undertaken at a rate of approximately 0.02 to 0.05 m/day. The duration is not the time that the weir pool will be held at the maximum raised, or lowered, water level.

Weir pool manipulations that raise or lower water levels outside the normal operating range will require written instruction from the Minister's delegate (Director, Water Infrastructure and Operations) to instruct SA Water to raise or lower the water level outside the current normal operating range. Decisions regarding operations within the normal operating range are undertaken by Water Delivery Unit and SA Water River Murray Operations Unit (RMOU).

Weir pool manipulations are becoming an increasingly common and important feature of routine river operations. They aim to achieve ecological outcomes, including improved lateral connectivity between the River Murray and the floodplain fringe, seedling recruitment of River red gums, lignum and understorey vegetation, native fish condition and temporary inundation of River red gum, black box and ephemeral wetlands. Preceding and/or following, weir pool raising with a weir pool lowering will provide specific benefits to biofilm nutritional value and littoral vegetation abundance and diversity.

Under high flow or flood events many structures may be inundated or removed and, in such circumstances, the ability to undertake weir pool manipulations would be limited.

9 Delivery of Water for Environmental Outcomes

Environmental water in South Australia will be available from the following sources:

1. Commonwealth Environmental Water Holder (CEWH);
2. MDBA – The Living Murray (TLM) and River Murray Increased Flows (RMIF);
3. Victorian Environmental Water Holder (VEWH);
4. South Australian Government; and
5. Non-government organisations.

Under all the scenarios, volumes of environmental water, ranging from 550 GL under the drier scenarios to 950 GL under the near average scenario are expected to be delivered to South Australia during 2019-20 in addition to environmental water held as part of South Australia's Entitlement.

Environmental watering provides water to priority environmental assets for ecological benefit and contribution to a healthy, working river. Environmental watering ensures that important values of the South Australian River Murray, its wetlands and floodplains, Lakes Alexandrina and Albert and the Coorong are maintained and that environmental objectives are achieved.

Environmental watering in South Australia, in conjunction with unregulated flow, aims to meet the environmental water requirements of all key environmental assets and functions. Environmental water requirements include the timing, frequency, magnitude and duration of preferred flows for a range of biota.

The annual environmental watering priorities include a range of actions proposed for three priority environmental assets (PEAs):

- South Australian River Murray Channel (includes weir pool manipulations);
- South Australian River Murray floodplain (includes Chowilla, Pike and other South Australian floodplain areas and wetlands); and
- Coorong, Lower Lakes and Murray Mouth.

The environmental watering priorities for the South Australian River Murray for 2019-20 have been developed in accordance with Basin Plan requirements and are consistent with the Long-Term Environmental Watering Plan for the South Australian River Murray Water Resource Plan area.

Six water resource availability scenarios (**Figure 3**) were used to develop the environmental watering priorities for 2019-20. The environmental watering priorities were developed using the MDBA's Annual Operating Probabilities (AOP) provided in February 2019. The six scenarios are 100% (worst case), 95% (very dry), 90% (dry), 75% (moderate), 50% (near average) and 25% (wet).

Four of these six scenarios have been identified for priority watering actions in 2019-20. The four scenarios are 90% (dry); 75% (moderate), 50% (near average) and 25% (wet).

The percentages refer to the likelihood of exceeding different water resource availability based on the analysis of historical inflows, current storage volumes and operational considerations during 2019-20. These percentages closely align (but are not the same) with AEPs used elsewhere in the SA Operating Plan.

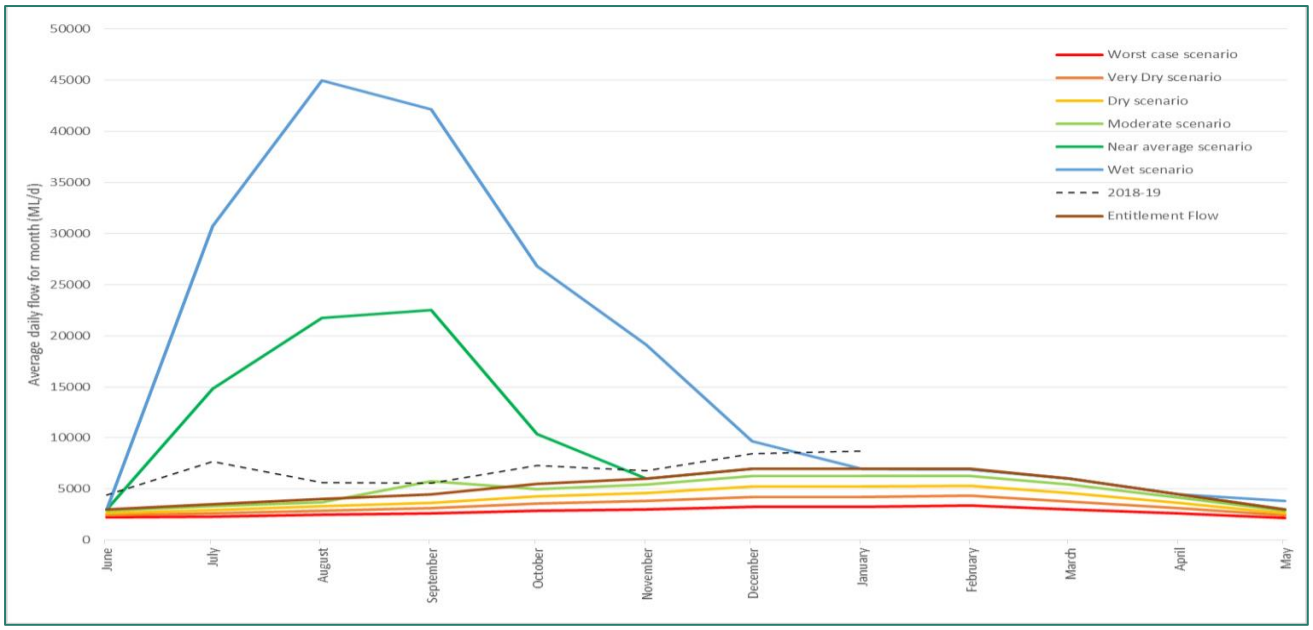

Figure 3. Annual operating probabilities (at SA border) provided by MDBA in February 2019 for the purpose of informing environmental water planning for 2019-20.

9.1 Annual Environmental Watering Priorities 2019-20

Enhanced water delivery during spring and early summer is a priority for assets under all scenarios. This is consistent with the modelled natural hydrology for the lower River Murray. Sustained lower level delivery during the remainder of the year is also a priority for maintaining barrage releases.

In the dry to moderate scenarios, the focus is on in-channel, low floodplain and localised Coorong and Lower Lakes outcomes.

In the wetter scenarios, it is proposed to enhance and prolong flows to support in-channel functions related to flow hydraulics and to maintain the condition of areas of the floodplain and wetlands that have not been inundated since the high flow event in 2016. This will also provide higher barrage releases during spring and early summer to support outcomes in the Lower Lakes, Coorong and Murray Mouth (LLCMM).

All of the proposed actions are scalable and will be managed to further enhance the benefits of water delivered for system-scale floodplain, channel and LLCMM outcomes.

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

The Priorities are presented in **Tables 10-13** (**Table 10** 90% AOP, **Table 11** 75% AOP, **Table 12** 50% AOP and **Table 13** 25% AOP). The volume of environmental water required for a priority action in the following tables is often used at multiple sites eg if environmental water is provided for an action at Chowilla a large volume of the water will return to the river and could be used for actions at Pike, other wetlands, channel and floodplain, weir pool manipulations and LLCMM.

Table 10. 90% AOP (dry scenario) Environmental Watering Priorities for SA in 2019-20.

90% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
LLCMM	Inundate of fringing Lower Lakes wetlands by raising water level to 0.8 m AHD Barrage releases	Sep-Dec 120 days	Improve Lower Lakes fringing and submerged vegetation to provide habitat for recruitment of threatened fish and frog species Enable upstream migration for young-of-year congolli and common galaxias Provide a localised estuary for estuarine fish, macroinvertebrates and waterbirds Maintain Lower Lakes water levels ~0.8 m AHD Oct to Dec	457
	Continuous barrage releases	Jul-Aug and Jan-Jun 240 days	Provide continuous fishway and barrage releases Provide localised estuarine conditions Enable downstream movement and recruitment of congolli and galaxias Enable upstream migration and recruitment of lamprey Provide continuous connectivity between river and estuary Maintain lake levels >0.5 m AHD	322
Channel and Floodplain	Target a spring pulse flow to SA of 10 GL/day with minimum 60 day duration and incorporate a minimum 20 day peak >15 GL/day	mid-Oct to mid-Dec 60 days	Provide 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 Provide a 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	No weir pool manipulations are proposed under this dry scenario	N/A	N/A	0
Chowilla	Pump water to priority wetlands (up to 8 wetlands)	Sep-Nov 90 days	Provide fringing vegetation to 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 Provide breeding opportunities for frogs including Southern bell frogs (nationally threatened)	8
	Pulse flow through Chowilla anabranch via Pipeclay and Slaney Creek weirs	Oct-Feb 140 days	Provide fast flowing habitat for large bodied fish Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial	0

90% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
			and invertebrate pathways to higher trophic levels (fish water birds) Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates	
Pike	Pulse flow through Tanyaca via Margaret Dowling and Deep Creek inlets	Dec-Feb 90 days	Provide fast flowing habitat for medium and large bodied fish by generating a 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 invertebrate	0
	In-channel rise up to 0.45 m (15.0 m AHD) at Pike Environmental Regulator and up to 0.66 m (15.41 m AHD) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlet	Jan-Feb 42 days	Re-instate variability in hydraulic conditions (depth, velocity, turbulence) Reduce salinity of near-bank groundwater Reduce soil salinity and improved soil moisture availability in inundated and adjacent zones Improve biofilm quality Improve 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
Wetlands	Deliver water via pumping or gravity-fed at up to 22 priority wetland sites located along the River Murray from the border to the Lower Lakes	Sep-Feb (pumped to wetlands) Jul-Jun (gravity-fed to wetlands)	Support known populations of Murray hardyhead (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 Provide breeding opportunities for Southern bell frogs (nationally threatened) Support Regent parrot (nationally threatened) populations	8
	Operate infrastructure to implement a range of hydrological phases (including drying, refilling, pool level and flow through) at 38 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 wetland sites by Non-Government Organisations	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. Support population of Regent parrot (nationally threatened) at Banrock	10-15

Table 11. 75% AOP (moderate scenario) Environmental Watering Priorities for SA in 2019-20.

75% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
LLCMM	Inundation of fringing Lower Lakes wetlands by raising water level to 0.8 m AHD Barrage releases	Sep-Dec 120 days	Improve Lower Lakes fringing and submerged vegetation to provide habitat for recruitment of threatened fish and frog species Enable upstream migration for young-of-year congolli and common galaxias Provide a localised estuary for estuarine fish, macroinvertebrates and waterbirds Maintain Lower Lakes water levels ~0.8 m AHD Oct to Dec Provide habitat for Southern Bell frog and small threatened fish recruitment	432
	Continuous barrage releases	Jul-Aug and Jan-Jun 240 days	Provide continuous fishway and barrage releases Provide localised estuarine conditions Enable downstream movement and recruitment of congolli and galaxias Enable upstream migration and recruitment of lamprey Provide continuous connectivity between river and estuary Maintain lake levels >0.5 m AHD	320
Channel and Floodplain	Target a spring pulse of flow to SA >10 GL/day with minimum 60 day duration and incorporate a minimum 20 day peak >15 GL/day	mid-Oct to mid-Dec 60 days	Provide 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 Provide a 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	Raise weir pool 6 up to 0.42 m above NPL Raise weir pool 2 up to 0.52 m above NPL	Aug-Nov 115 days	Provide water level variability upstream of the weirs, generating: • Growth and expansion of littoral vegetation including Juncus, *Cyperus gymnocaulos* and river clubrush *Schoenoplectus validus* • Understorey plant community sustained and productive • Diverse and productive biofilm and macroinvertebrate communities • 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 flow during drawdown in late spring to assist in delivering water to the LLCMM and	23.3 (includes return flow of 18.6)

75% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
			maintaining Lock 1 flow target when climate conditions are become hotter and drier	
Chowilla	Pump water to priority wetlands (up to 8 wetlands)	Sep-Nov 90 days	Provide fringing vegetation to 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 Provide breeding opportunities for frogs including Southern bell frogs (nationally threatened)	8
	Pulse flow through Chowilla anabranch via Pipeclay and Slaney Creek weirs	Oct-Feb 140 days	Provide fast flowing habitat for large bodied fish Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds) Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates	0
Pike	Pulse flow through Tanyaca via Margaret Dowling and Deep Creek inlets	Dec-Feb 90 days	Provide fast flowing habitat for medium and large bodied fish by generating a 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 invertebrate	0
	In-channel rise up to 0.45 m (15.0 m AHD) at Pike Environmental Regulator and up to 0.66 m (15.41 m AHD) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlet	Jan-Feb 42 days	Re-instate variability in hydraulic conditions (depth, velocity, turbulence) Reduce salinity of near-bank groundwater Reduce soil salinity and improved soil moisture availability in inundated and adjacent zones Improve biofilm quality Improve vegetation growth in riparian zone Calibration of surface water model	1
Wetlands	Deliver water via pumping or gravity-fed at up to 22 priority wetland sites located along the River Murray from the border to the Lower Lakes	Sep-Feb (pumped to wetlands) Jul-Jun (gravity-fed to wetlands)	Support known populations of Murray hardyhead (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 Provide breeding opportunities for Southern bell frogs (nationally threatened) Support Regent parrot (nationally threatened) populations	8
	Operate infrastructure to implement a range of hydrological phases (including drying, refilling, pool level and flow through) at 38 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

75% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
	Additional delivery of water to temporary wetland sites by Non-Government Organisations	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 Support Regent parrot (nationally threatened) populations at Banrock	10-15

Table 12. 50% AOP (near average scenario) Environmental Watering Priorities for SA in 2019-20.

50% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
LLCMM	Extend high flow through spring and into early summer for Coorong North Lagoon outcomes	Oct-Jan 120 days	Provide estuarine conditions throughout North Lagoon Raise Lower Lakes levels >0.8 m AHD in spring Provide for fish migration and connectivity Enable upstream migration for young-of-year congolli and common galaxias Improve North Lagoon habitat for benthic macroinvertebrates, migratory birds and adult estuarine fish Enable spawning and recruitment of black bream and greenback flounder Provide feeding habitat for migratory waders	514
	Continuous barrage releases	Feb-Jun 150 days	Provide continuous fishway and barrage releases Provide localised estuarine conditions Enable downstream movement and recruitment of congolli and galaxias Enable upstream migration and recruitment of lamprey Provide continuous connectivity between river and estuary Maintain Lower Lake levels >0.5 m AHD	301
Channel and Floodplain	Target a median flow to SA of 20 GL/day with minimum 60 day duration	Sep-Nov 90 days	Provide abundant fast flowing habitat (>0.25 m/s) Improve soil water availability and reduce soil salinity Inundate temporary wetlands to provide for growth of emergent aquatic plants Improve 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 Improve survival of Murray cod and catfish larvae	490
Weir pool manipulation	Raise weir pool 6 up to 0.59 m above NPL Raise weir pool 2 up to 0.75 m above NPL	Jul-Oct 105 days	Inundate wetlands Improve connectivity and production Improve health, growth and reproduction of floodplain vegetation Provide 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 flow of 20.7
Chowilla	Pump water to priority wetlands (up to 8 wetlands)	Sep-Nov 90 days	Provide fringing vegetation to 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 Provide breeding opportunities for frogs including Southern bell frogs (nationally threatened)	8

50% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
	Pulse flow through Chowilla anabranch via Pipeclay and Slaney Creek weirs in conjunction with raising weir pool 6	Oct-Feb 140 days	Provide fast flowing habitat for large bodied fish Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds) Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates	0
Pike	Pulse flow through Tanyaca via Margaret Dowling and Deep Creek inlets	Dec-Feb 90 days	Provide fast flowing habitat for medium and large bodied fish by generating a 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 invertebrate	0
	In-channel rise up to 0.45 m (15.0 m AHD) at Pike Environmental Regulator and up to 0.66 m (15.41 m AHD) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek inlet	Jan-Feb 42 days	Re-instate variability in hydraulic conditions (depth, velocity, turbulence) Reduce salinity of near-bank groundwater Reduce soil salinity and improved soil moisture availability in inundated and adjacent zones Improve biofilm quality Improve vegetation growth in riparian zone Calibration of surface water model	1
Wetlands	Deliver water via pumping or gravity-fed at up to 22 priority wetland sites located along the River Murray from the border to the Lower Lakes	Sep-Feb (pumped to wetlands) Jul-Jun (gravity-fed to wetlands)	Support known populations of Murray hardyhead (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 Provide breeding opportunities for Southern bell frogs (nationally threatened) Support Regent parrot (nationally threatened) populations	8
	Operate infrastructure to implement a range of hydrological phases (including drying, refilling, pool level and flow through) at 38 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 wetland sites by Non-Government Organisations	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 Support Regent parrot (nationally threatened) populations at Banrock	10-15

Table 13. 25% AOP (wet scenario) Environmental Watering Priorities for SA in 2019-20.

25% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
LLCMM	Extend high flow through spring and into early summer for Coorong North Lagoon and Coorong South Lagoon outcomes	Oct-Jan 120 days	Support Ruppia tuberosa germination and recruitment Provide salinity benefits to North and South Lagoons Enable estuarine fish to use both North and South lagoons for growth and recruitment Provide for adequate food availability in North and South lagoons for all guilds of waterbirds Assist in maintaining an open Murray Mouth and exportation of salt and nutrients Increase the abundance and extent of macroinvertebrates	701
	Continuous barrage releases	Feb-Jun 150 days	Provide continuous fishway and barrage releases Provide localised estuarine conditions Enable downstream movement and recruitment of congolli and galaxias Enable upstream migration and recruitment of lamprey Provide continuous connectivity between river and estuary Maintain Lower Lake levels >0.5 m AHD	210
Channel and Floodplain	Target a median flow to SA of 50 GL/day	Sep 30 days	Provide abundant fast flowing habitat (>0.25 m/s) Improve soil water availability and reduce soil salinity Inundate temporary wetlands to provide for growth of emergent aquatic plants Improve 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 Improve survival of Murray cod and catfish larvae Inundate the SA River Murray Floodplain Recruit large Murray cod recruitment Support large-scale breeding by eight riparian frog species	165
	Target a median flow to SA of 40 GL/day	Sep-Nov 90 days	Inundation of the entire SA River Murray Channel Heterotrophic productivity becomes dominant Connect significant areas of temporary wetland to the River Support the growth, condition and recruitment of native vegetation from emergent, amphibious and flood-dependent functional groups across the entire elevation gradient of the SA River Murray Channel	311
Weir pool manipulation	Raise weir pool 2 up to 0.75 m above NPL	Jul-Nov 135 days	Inundate wetlands Improve connectivity and production Improve health, growth and reproduction of floodplain vegetation Provide access for aquatic fauna to floodplain and wetland habitats, particularly during key breeding and foraging periods Transfer of particulate organic matter from the	21.8 includes return flow of 17.6

25% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
			floodplain to the river channel	
Chowilla	Operate Chowilla Regulator to generate a maximum floodplain inundation. Chowilla Regulator 19.85 m AHD Lock 6 – 19.85 m AHD	July-Dec 157 days	Potentially test regulator and ancillary structures to higher operating levels Improve soil moisture availability conducive to active tree growth to reduce potential for loss of tree condition and support progressive improvement of long-lived vegetation Generate an increase in the proportion of trees for which condition scores are above the Ecological Target – specifically targeting re-watering mid-level elevation Black Box to consolidate benefits from 2016 managed inundation and unregulated flow event Re-instate connectivity to mid-elevation floodplain and all key wetlands Contribute to ensure long-term sustainability of floodplain tree community by support ongoing growth of seedlings and saplings of River Red Gum, Black Box and Cooba Improve condition of Lignum in inundated areas Provide breeding habitat for waterbirds, amphibians and invertebrates. Create conditions conducive to germination and growth of flood dependent and flood responsive vegetation Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds) Improve condition of floodplain habitat for dependent species including reptiles, woodland birds and mammals	110.8
Pike	Pulse flow through Tanyaca via Margaret Dowling and Deep Creek inlets	Dec-Feb 90 days	Provide fast flowing habitat for medium and large bodied fish by generating a 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 invertebrate	0
	In-channel rise up to 0.45 m (15.0 m AHD) at Pike Environmental Regulator and up to 0.66 m (15.41 m AHD) at Tanyaca Creek Regulator via increased flows through Margaret Dowling and Deep Creek	Jan-Feb 42 days	Re-instate variability in hydraulic conditions (depth, velocity, turbulence) Reduce salinity of near-bank groundwater Reduce soil salinity and improve soil moisture availability in inundated and adjacent zones Improve biofilm quality Improve vegetation growth in riparian zone Support ongoing growth of seedlings and saplings of river red gum, black box and cooba	1
Wetlands	Deliver water via pumping or gravity-fed at up to 5 priority wetland sites located along the River Murray from the border to the Lower Lakes	Sep-Feb (pumped to wetlands) Feb-Jun (gravity-fed to wetlands)	Support the maintenance of long lived vegetation: black box, River red gums, lignum and River cooba Provide habitats and food resources for waterbirds Provide breeding opportunities for Southern bell frogs (nationally threatened). Support regent parrot (nationally threatened) populations	2

25% AOP Priorities				
Asset	**Priority Action**	**Timing and Duration**	**Objectives**	**~Volume (GL)**
	Operate infrastructure to implement a range of hydrological phases (including drying, refilling, pool level and flow through) at 38 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, water dependent birds Ensure fringing long lived vegetation is maintained	37.5
	Additional delivery of water to temporary wetland sites by Non-Government Organisations	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 Support Regent parrot (nationally threatened) populations at Banrock	10-15

10 Operations When Flow Conditions Are Outside Expected Flow Range

As flow to South Australia increases above 60 GL/day (typically), river operators have progressively less ability to influence or mitigate flows through operation of river infrastructure (upstream and within South Australia). This is due to the removal of structures such as weirs and the filling of flood detention storage in dams. In the case of high flow, or flood events, the River Murray will break-out of the channel onto the floodplain, fill backwaters and wetlands and flow unimpeded down to the Murray Mouth.

Should high flow or flooding occur, considerations by the RMOWG (for Terms of Reference refer to Appendix 1) would include, but not be limited to, the appropriate flow and weir pool manipulation to minimise the implications of salinity spikes from the movement of groundwater derived salt and salt stored in floodplain soils (from the recession of event) into the river channel and the risk of blackwater events.

Should extremely dry conditions occur, it may be necessary to make changes to river operations to conserve water for summer months or for other purposes such as CHWN. This may result in the minor lowering of some weir pools between the border and the barrages, which may impact on some water users.

Information concerning any changes to river operations that may affect water users will be provided to the community in advance to minimise potential impacts due to access and water quality.

10.1 Management of River Murray High Flow and Flood Events

To improve the health and resilience of the River Murray floodplain, to the extent that is practicably possible, the Government of South Australia is committed to increasing the frequency and duration of flows at the border through changed river operations upstream of South Australia and the use of environmental water holdings. This was central to South Australia's negotiations for the Basin Plan to achieve greater floodplain inundation frequencies.

With a River Murray flow rate at the border of:

- approximately 35 GL/day, some access roads and infrastructure in low-lying areas at South Punyelroo become inundated; and
- approximately 60 GL/day, the low lying shack areas located on the floodplain below Cadell begin to be at risk of inundation.

These flow rates are important for floodplain health and resilience.

If the MDBA forecasts a flow of greater than 60 GL/day at the South Australian border under normal river operating conditions, the Government of South Australia is usually able to provide shack owners and other potentially affected parties, with four to six weeks of advance warning to take the necessary precautions. Past experience has demonstrated that affected parties acknowledge that these events are an unavoidable consequence of development on the floodplain.

South Australia is currently working with the other Basin jurisdictions and the MDBA to deliver constraints measures as part of Basin Plan implementation. The broad objectives are to increase environmental flows up to 80 GL/day at the South Australian border to enhance floodplain environmental outcomes and improve risk management for low lying land and infrastructure. This involves undertaking further planning, designs and engagement to refine mitigation scope and costs in close collaboration with communities. Mitigation measures currently being considered include upgrades to bridges, roads and culverts and land management arrangements. These targeted works and measures will complement existing notification and communication processes and other preparation, management and response activities before, during and after high flow events. When the infrastructure works are completed, it will change the way the River Murray is managed from 2024 as there will be greater flexibility for river operators and environmental water managers to manage flows for environmental watering outcomes.

The South Australian State Emergency Services (SES) is the control agency for flood under the State Emergency Management Plan and is currently responsible for the delivery of flood warnings and messaging for the River Murray in South Australia. The SES has developed a draft River Murray Flood Response Plan. The information in **Table 14** and **Table 15** reflect the information in the SES Plan.

DEW is the Hazard Leader for Flood and is responsible for providing advice to the SES on flow conditions for the River Murray in South Australia to enable public warnings to be developed and issued by the SES. The flood forecasting and warning arrangements for the River Murray are currently under review. Recommendations regarding any changes are expected in 2019. If there are changes to flood forecasting and warning arrangements, the SA Operating Plan will be updated accordingly.

DEW also issues a weekly River Murray Flow Report, which contains detailed information on river operations and flow conditions in South Australia. The River Murray Flow Report will include a section on High Flow Advice when applicable as shown in **Tables 15 and 16**.

A set of triggers and guidelines for River Murray flood warnings are identified in **Tables 14, 15 and 16**.

Table 14. Flood level descriptions adopted for the River Murray in South Australia.

Flow at Border GL/day	SA River Murray	Shack Areas only downstream of Cadell (Excluding River Murray towns)
200 or more	Major Flood	Major Flood
130 to 200	Moderate Flood	Moderate Flood
100 to 130	Minor Flood	Minor Flood
60 to 100	High Flow	Minor Flood
40 to 60	High Flow	
40 or below	Normal Flow Range, no warnings	

Flow Ranges

<40 GL/day
Flows below 40 GL/day at the border do not trigger the requirement to issue any warnings, although some access roads and infrastructure in some low-lying areas at South Punyelroo become inundated.

40 – 60 GL/day
For flows of 40 - 60 GL/day there are no significant consequences regarding inundation of shacks in the low lying areas. At 60 GL/day there are expected to be less than 10 (in 2016, there were four) shacks where the water starts to reach the foundations and some access roads and local council infrastructure are affected. Flows within this range are not generally considered to cause any significant inundation of property or infrastructure.

60 – 100 GL/day
Where possible, management of flows in this range requires careful consideration due to the uncertainty around the effects of inundation as river levels rise with flow rates between 60 – 100 GL/day.

> 100 GL/day
Flows greater than 100 GL/day will cause minor to major flooding for the entire River Murray in South Australia.

Table 15. Communication product corresponding to flow at the SA Border.

Flow at Border GL/day	SA River Murray	Shack Areas only downstream of Cadell (Excluding River Murray towns)
200 or more	Flood Emergency Warning - River Murray	Flood Emergency Warning - River Murray
130 to 200	Flood Watch and Act - River Murray	Flood Watch and Act - River Murray
100 to 130	Flood Advice - River Murray	Flood Advice - River Murray
60 to 100	High Flow Advice - River Murray (section in River Murray Flow Report)	Flood Advice - Shack Areas
40 to 60	High Flow Advice - River Murray (section in River Murray Flow Report)	

Table 16. Timing for issuing public warnings.

Predicted flow GL/day	0-1 week from border	1-2 weeks from border	2-3 weeks from border	3-4 weeks from border	4 weeks from border or more
40 or >	High Flow Advice (section in RM Flow Report)	High Flow Advice (section in RM Flow Report)	High Flow Advice (section in RM Flow Report)	None	None
60 or >	Flood Advice - Shack Area High Flow Advice - River Murray (section in RM Flow Report)	Flood Advice - Shack Area High Flow Advice - River Murray (section in RM Flow Report)	Flood Advice - Shack Area High Flow Advice - River Murray (section in RM Flow Report)	None	None
100 or >	Flood Advice - River Murray	Flood Advice -River Murray	Flood Advice - River Murray	Message - Flood Advice expected in future	Message - Flood Advice expected in future
130 or >	Flood Watch and Act - River Murray	Flood Watch and Act - River Murray	Flood Watch and Act - River Murray	Flood Watch and Act - River Murray	Message - Flood Watch and Act expected in future
200 or >	Flood Emergency Warning – River Murray	Flood Emergency Warning – River Murray	Flood Emergency Warning – River Murray	Flood Emergency Warning – River Murray	Flood Emergency Warning – River Murray

10.2 Management of River Murray under Low Flow and Drought Conditions

If dry conditions cause the water level in the River Murray below Lock 1 to fall below 0.4 m AHD, River Murray operations in South Australia will be consistent with the MDBA's Drought Emergency Framework for Lakes Alexandrina and Albert (June 2014).

During years where South Australia is expected to receive less than its full Entitlement Flow of 1 850 GL, it will follow the water allocation framework in the River Murray Water Allocation Plan. During 2019-20, the worst possible inflow scenario is extreme dry.

During dry years where Class 3 Water Access Entitlement Holders receive an opening water allocation of less than 50%, private carryover will be made available to eligible water users. In 2019-20, private carryover was made available. Deferred water is made available for delivery to meet private carryover and CHWN if required.

11 Implementation

Under regulated conditions, River Murray flow within South Australia will be managed in accordance with established operating rules (such as the Lake Victoria Operating Strategy), procedures, prior practice and in accordance with the Agreement and the Basin Plan. Day to day operational issues and changes that are in accordance with established operating rules will be made between SA Water and DEW (Water Delivery Unit). Input from other teams, agencies, RMOWG and the MDBA will be sought where necessary.

Actions to be undertaken that may have associated third party risks, or are outside of the SA Operating Plan, will require a River Murray Action Request form to be completed and forwarded to the Water Delivery Unit for assessment. All River Murray Action Requests are forwarded to the RMOWG for consideration. The purpose of completing the River Murray Action Request form is to provide a complete picture of all actions proposed to be undertaken and to determine the combined impacts of all actions. A River Murray Action Request should provide sufficient information to make a prompt decision to modify, undertake, or not undertake a proposed action.

Further discussion and consideration is required by the RMOWG (and other groups as necessary) for proposals that result in:

- changes to weir pool levels outside their normal operating range (refer to **Table 8** *Weir Pool Levels – Normal Operating Range*);
- negative impacts on the distribution of South Australia's Entitlement Flow;
- negative impacts to water quality;
- negative impacts to the environment; and
- delivery of environmental water that may trigger other events, such as the opening of disposal basins, which may have a negative impact on water quality and other downstream water users etc.

When changes to river conditions require a change to established operating rules, a written proposal must be forwarded to the RMOWG for consideration and a recommendation to the Executive Director, Water and River Murray for consideration and determination. If necessary, more frequent meetings of the RMOWG will be convened, or other arrangements will be made, to consider proposals in a timely manner.

The MDBA will be involved in this process and SA Water will be advised in writing of any material change to river operations (ie alteration of flow timing or magnitude by more than 10%).

River Murray Shack area below Morgan - High flow event December 2016

12 Risks

Decisions to adaptively manage River Murray operations, within the limits of the SA Operating Plan, will be undertaken by assessing the level of potential risks to River Murray water users by Water Delivery Group and SA Water.

Risks associated with specific events or operations (eg weir pool raising or lowering) are detailed in the individual event implementation plans.

Before a River Murray action is undertaken (actions that may have associated third party risks, or are outside of the SA Operating Plan) a River Murray Action Request form is required to be completed. The request is considered by the RMOWG. The process associated with a River Murray Action Request is a risk management tool.

The risks associated with implementing the integrated and adaptive management approach mainly relate to the potential adverse impacts on some individual water users, landholders and specific floodplain or wetland sites. For example, some private infrastructure may be inundated or isolated as a result of river operations that seek to enhance river flows to achieve greater improvements in floodplain health. Generally, the integrated and adaptive management approach will be implemented in a way that seeks to achieve significant improvements in the South Australian River Murray channel, floodplain, wetlands, Lower Lakes, Coorong and Murray Mouth while managing adverse impacts on third parties.

Many of the potential risks associated with implementing this approach will be minimised through effective communication and information programs to ensure that water users, landholders and other stakeholders are provided with comprehensive and timely information necessary to manage the potential impacts of changed river operations.

The risks of implementing a suitably integrated and adaptive management approach to river operations will be balanced with the considerable risks associated with not implementing this type of approach. The main risks of not implementing adaptive management operations include:

- inability to address the impacts of identified risks to the condition, or continued availability, of Basin water resources;
- continuing deterioration of environmental condition of nationally and internationally important ecosystems through inadequate environmental watering and lack of variability in flow and water level;
- increasing frequency of adverse events affecting water quality or availability with serious impacts on all extractive water uses and on local communities;
- failure to meet international environmental obligations; and
- inability of the South Australian Government to effectively implement the Basin Plan and other Basin initiatives.

Riverbank Collapse – Long Island Marina 2009

13 Delivery Considerations

13.1 Construction Activity

Along the River Murray in South Australia there are a number of construction, maintenance and improvement works planned during 2019-20 for the Riverine Recovery Program (RRP), South Australian Riverland Floodplain Integrated Infrastructure Program (SARFIIP), environmental water delivery projects and maintenance projects. Many of these works can only be undertaken while flows are below a specific limit. The works will be considered on a real-time basis when making decisions to augment flows.

13.2 Riverine Recovery Program and SA Riverland Floodplain Integrated Infrastructure Program

The construction works identified in **Table 17** are proposed to be undertaken for the RRP in 2019-20 and in **Table 18** for the SARFIIP in 2019-20. The impact of changes to water levels and flows will be considered and amendments may be made to river operations. As the River Murray flow approaches the limits identified in the tables, the RMOWG will need to consider the risks and benefits of enhancing flows above these limits ie an environmental watering event. A decision to achieve the best outcome for the State will need to be agreed and implemented. If agreement cannot be reached by the RMOWG, the issue will be escalated to the Director, Water Infrastructure and Operations and possibly Executive Director, Water and River Murray for determination.

Table 17. RRP works for 2019-20.

Location	Limit (GL/Day)	Duration
Below Lock 1		
Teal Flat	20	Jul-Sep 2019
Lock 3-4		
Putjeda Creek	5 (Outlet) 30 (Inlet)	Jul-Sep 2019
Lock 4-5		
Bollenhagen Road – Gurra Gurra	25	Jul-Sep 2019
Lock 5-6		
Causeway Road	10 (+ raise weir pool by 0.45 m)	Jul-Aug 2019
Woolenook Bend	20	Jul-Sep 2019

Table 18. SARFIIP works for 2019-2020.

Location	Limit (GL/Day)	Duration
Lock 4-5		
Katarapko Floodplain	35	Jul 2019-Jun 2020
Pike Floodplain	50	Jul – Dec 2019

13.3 Watering Policy

Multi-site environmental watering trials have been undertaken over the last decade (coordinated by the MDBA). These trials have helped identify and understand several policy delivery considerations associated with environmental flow delivery. These include:

- limited ability to deliver environmental water during unregulated flows and enhance a natural flow peak;
- risk of re-regulation of environmental water as it travels through the system if it is not traded;
- need to balance the risk of the potential for third party impacts against the environmental benefit of higher flows;
- trade restrictions; and
- channel capacity, particularly in summer.

DEW currently identifies a flow of 60 GL/day at the South Australian border as an indicator of a minor flood risk for shack properties between Cadell and Morgan.

13.4 Acid Drainage Water

Prior to 2017, limited studies had been undertaken to determine the impacts of acid drainage water entering (discharged into) the River Murray channel below Lock 1. A critical minimum mixing and dilution flow of 2.5 GL/day was recommended to manage the higher risk regional impacts of acid drainage water and soluble metal releases into the River Murray. In particular, during the irrigation season (usually September to April) when discharging water back into the River Murray Channel is at its highest.

During 2017, with funding from the MDBA, the University of Adelaide and Environment Protection Authority initiated a project to assess the ecological and sediment risks from acid drainage water entering the River Murray channel below Lock 1. The project assessed the presence and extent of ecological effects of acidic drainage water entering the River Murray using:

- macroinvertebrate surveys;
- in situ eco-toxicological tests; and
- core sediment sampling of the river bed in discharge areas to determine contamination.

The results indicated that the impacts of acid drainage water are mainly localised in the surface water quality and the macroinvertebrate community in the receiving waters of the River Murray. In reference to metal precipitates, the results concluded very localised contamination, which was proposed to be due to:

- rapid neutralisation of pH and metal precipitation and deposition in the localised discharge area; and/or
- dilution of any metal precipitates entering the main channel with natural river sediments; and/or
- flushing of precipitates downstream during higher flow conditions (as occurred in late 2016).

The risk assessment identified that several LMRIA drains remained acidic and metal concentrations remained high (not recovered from the previous drought) and that discharge plumes are highly likely to increase in size under low flow rate conditions. It also identified the need for further continuous monitoring and a more robust model. In the meantime, it is recommended that during periods where discharge is high (hot and dry periods), that the flow rate be maintained above 2.5 GL/day.

13.5 Riverbank Collapse

The risk of riverbank collapse downstream of Lock 1 is increased by low water levels and the rate and height of drawdown (reduction in water level) as referenced in the report *Mechanisms and Processes of the Millennium Drought Riverbank Failures: Lower Murray River, South Australia*.

13.5.1 Lower River Murray Pool Level

A decrease in pool level during 2008-10 resulted in widespread riverbank collapse events below Lock 1 at Blanchetown. During this period the resisting forces that the water was applying against the banks decreased, resulting in areas of riverbank collapsing into the river. In some cases, property, infrastructure (roads, buildings and pump stations), vehicles, boats and trees collapsed into the river or suffered damage.

Engineering advice suggests that the pool level below Lock 1 be maintained as close to the normal operating range as possible to prevent further collapse events being triggered. It is recommended that the River Murray pool level below Lock 1 be maintained at or above a minimum level of +0.4 m AHD.

Maintaining the pool level below Lock 1 above +0.4 m AHD is also necessary to maintain access to water for consumptive use.

13.5.2 River Level Rate of Drawdown

The engineering reports (refer to Sinclair Knight Merz report *Riverbank Collapse Hazard, Lower Reaches River Murray Stability Risk Management, Murray View Estates, Tailem Bend 2014*) into riverbank collapse note that a drawdown in River Murray water levels by 1.0 metre within 28 days can also increase the risk of riverbank collapse. An example of this was observed in 2011 near Morgan (above Lock 1) when riverbanks slumped as the water level decreased by approximately 1.0 metre over the course of one month.

13.5.3 Triggers and Actions

The aim is to maintain River Murray water levels below Lock 1 at or above a minimum of +0.4 m AHD to minimise the risk of riverbank collapse. The following triggers and actions (**Table 19**) should be considered by DEW to reduce the possibility of injury or fatality as a result of riverbank collapse below Lock 1.

Planning for, responding to, and recovering from, Riverbank collapse incidents is now the responsibility of the local authorities in the Murray and Mallee Zone.

Table 19. Riverbank Collapse Triggers and Actions.

Riverbank Collapse Triggers	Actions
If River Murray water levels reach +0.25 m AHD on a downward trend	Advise the Murray and Mallee Zone Emergency Management Committee (ZEMC) of the increased risk of riverbank collapse downstream of Lock 1, as water levels are +0.25 m AHD and on downward trend. Advise the Murray and Mallee ZEMC to request the public (people living in the area or using the river) to report cracking along riverbanks. Advise the relevant councils to consider resuming monitoring at Caloote, East Front Road, Walker Flat and Woodlane Reserve.
If River Murray water levels drop 1.0 m within 28 days	Advise the Murray and Mallee ZEMC of the increase risk of riverbank collapse due to rapid drawdown. Advise the Murray and Mallee ZEMC to request the public (people living in the area or using the river) to report cracking along riverbanks (if not already happening).

13.6 River Murray Regulation

Table 20 (based on information provided by SA Water) identifies delivery considerations along the River Murray from Lake Victoria to the Murray Mouth. The table identifies a broad r ange of flow delivery considerations that will be taken into account when implementing changes to river operations.

Table 20: River Murray Regulation Delivery Considerations.

Structure	Delivery Considerations	Other Details
Lake Victoria	Inlet	
	Inlet capacity is 10 GL/day depending on the water level in Lake Victoria	
	Opening - restrict increase of 1.5 GL/day per change, with maximum of two changes per day	To prevent dumping water on dry soil and causing erosion
	Closing - restrict to 0.5 GL/day reduction per change max three changes per day	Erosion prevention or exposure of wet bank to stock - prevent bogging and reduce likelihood of bank slumping
	Outlet	
	Outlet capacity is 8.5 GL/day depending on river and Lake Victoria water levels	To minimise erosion in Rufus River channel, flows may need to be maintained below 7 GL/day
	Opening - Erosion of Rufus Channel - Dependent on River Murray flow, head difference between Lake Victoria, Rufus River and River Murray	Releases from Lake Victoria are not just based on outlet capacity but also River Murray flow and the head difference between Lake Victoria, Rufus River and the River Murray
	Closing - Slumping in Rufus Channel - Dependent on River Murray flow, head difference between Lake Victoria and Rufus River	
Lock 9	Raising	
	0.15 m above pool - water bypasses through Gantry	Above this level, water bypasses the lock delivering water to lower pool through creeks around the lock. Weir pool maintained at 0.1 m below normal pool level due to seepage problems at Carr's 2 Weir.
	Water over road crossings - Stoney and Sandy - Lock 9 access road	
	Carr's 1 and 2 - Water bypassing Lock 9	Water over fixed crest weir at around 0.2 m above pool causing erosion
	Goose Neck banks - damage	
	Increase Inlet flow capacity	
	Lowering	
	0.1 m below pool - Lake Cullulleraine pump	

Structure	Delivery Considerations	Other Details
	During normal flow, cause problems with Lock 10 lower pool - Structural safety	
	Reduce Inlet Regulator flow capacity	
Lock 8	Raising	
	0.8 m above pool - water damage to gantry	Bypassing weir pool in flood runners
	Cut access to Lock 8 NSW side - 25.50 m AHD not affected by weir pool raising, only high water conditions	24.6 m AHD upper pool level
	Lowering	
	Lowering to 1.0 m below pool is now acceptable (with approval from MDBA)	
Lock 7	Raising	
	Raising to 0.5 m above pool is now acceptable	Mullaroo Creek flow is controlled by operation of new regulator
	Access to Gantry Lock 8 - Potterwalkagee	
	Lowering	
	Lowering to 0.4 m below pool is now acceptable (with approval from MDBA). This level will be confirmed after next lowering.	Mullaroo Creek flow is controlled by operation of new regulator. Flow rate to be greater than 0.6 GL/day - Mallee Catchment Management Authority requirement.
	Higher salinity in Lindsay Creek	
Lock 6	Raising	
	Potential diversion around Pipeclay Creek at >0.5 m Raising by up to 0.62 m above pool in conjunction with Chowilla Regulator	
	Lowering	
	Reduces flow to Chowilla anabranch	Potential impacts from increase River Murray salinity
	Potential impacts for irrigation pumps to access water when Lock 6 is lowered by more than 0.1 m	
	Navigation problems - D/S Lock 7, Warrakoo	
Lock 5	Raising	
	Increased Pike River inflows Raising to 0.50 m above pool is acceptable	
	Paringa bridge clearance for House boats	

Structure	Delivery Considerations	Other Details
	Lowering	
	Town water supply - suction problems	Affected by more than 0.2 m lowering
	Irrigation Pump Stations - suction problems	Affected by more than 0.2 m lowering
	Irrigators - problems with access to water	Affected by more than 0.2 m lowering
	Houseboat mooring areas	Affected by more than 0.2 m lowering
	Navigation through Ral Ral, Groynes below Lock 6	Affected by more than 0.2 m lowering
Lock 4	Raising	
	Berri Marina closure	
	Lowering	
	Lyrup Ferry	
	Increase salinity - draw water out of Gurra and other wetlands	
	Problems with navigation - Settler's Bend	
	Irrigation Pump stations - suction problems	
	Pike River domestic and irrigation suction problems	
Lock 3	Raising	
	Loxton Caravan Park	Outfall can't get rid of stormwater
	Lowering	
	Increase salinity by drawing saline water out of wetlands, Lake Bonney etc.	Move water out of wetlands with salinity levels of 8 000-15 000 EC to main channel
	Reduce flow down Katarapko Creek	Fixed weir - less water through wetland
	Problems with navigation - Loxton	Sand Bars towards end of weir pool
	Irrigation Pump Stations - suction problems	
	Private Irrigators - suction problems	
Lock 2	Raising	
	Raising to 0.75 m above pool is now acceptable (with approval from MDBA)	Raising up to 0.75 m above pool during high flow events Raising up to 0.50 m above pool during normal flow periods
	Lowering	
	Waikerie Ferry	
	Increased salinity by drawing saline water out of wetlands	

Structure	Delivery Considerations	Other Details
	Irrigation Pump Stations - suction problems	
	Private Irrigators - suction problems	
Lock 1	Raising	
	Access to shacks/Council roads from 35 GL/day	
	Lowering	
	Cadell Ferry	
	Morgan Ferry	
	Increase salinity by drawing saline water out of wetlands	
Below Lock 1 and Barrages		
	Lake Alexandrina upper Limit of 0.85 m AHD	High water levels can cause foreshore erosion, damage to roads and infrastructure.
	Lake Alexandrina upper Limit of 0.85 m AHD	To limit damage to revegetation and erosion of foreshore. There is a delivery consideration if the Coorong water level is too high as the ability to discharge water is restricted. Barrage releases need a head difference between Lower Lakes and Coorong.
	Causeway from Boundary Creek Barrage to Ewe Island Barrage Causeway from Ewe Island Barrage to Tauwitchere Barrage	High water level in Lake Alexandrina or Coorong may damage the causeways and may be an operational hazard
	Lower Limit 0.4 m AHD (aim to maintain water levels above 0.5 m AHD)	Below 0.4 m AHD, acid sulfate soil and riverbank stability problems. Not all irrigators can adapt to a water level below 0.4 m AHD.

Glossary of Terms Used

Additional dilution flow (ADF): is released to South Australia at a rate of 3 GL/day once storage volumes in Hume and Dartmouth and the Menindee Lakes Scheme exceed specified triggers. Delivery of ADF continues while the trigger levels are maintained.

Annual Exceedance Probabilities (AEP): represents the percentage likelihood of a flow, or greater flow, occurring based on the historic record

Annual Operating Probability (AOP): represents the likelihood of exceeding various water resource availability to South Australia scenarios, based on the analysis of historic inflows, current storage volumes and operational considerations for the coming year. AOPs align closely to AEPs.

Blackwater: as organic matter decays, oxygen in the water is consumed, which results in low dissolved oxygen and the water turning black

Conveyance Reserve: for a year, means water set aside by the MDBA to supply conveyance water for the following year, determined in accordance with clause 102 D of the *Murray-Darling Basin Agreement 2008*

Critical human water needs (CHWN): are the minimum amount of water required to meet core human consumption requirements in urban and rural areas; and those non-human consumption requirements that a failure to meet would cause prohibitively high social, economic or national security costs

Cyanobacteria: also known as blue-green algae. Of particular interest are those species producing health impacting cyanotoxins such as Microcystin, Nodularin, Saxitoxin and Cylindrospermopsin

Deferred water: South Australia requests the Murray-Darling Basin Authority to not deliver a portion of its Entitlement flow in any month and to store that water in the interstate storages (deferred water). South Australia can request this water to be delivered in a subsequent dry year

Entitlement Flow: minimum monthly River Murray flow to South Australia specified in clause 88 of the Murray-Darling Basin Agreement 2008

Entitlement Holder: a natural person or body corporate that holds the right to a share of the consumptive pool for the River Murray Prescribed Watercourse

Environmental Flow: any change to the flow regime that is intended to maintain and improve river health. It seeks to make better use of the water currently available in the system, as well as any new water made available, for the environment

Gigalitre (GL): 1 gigalitre is a thousand million (1 000 000 000) litres or 1 000 megalitres. 1 gigalitre would cover Adelaide oval to a depth of 50 metres (about a 15-storey building)

MDBA Annual Operating Outlook: Murray-Darling Basin Authority's *River Murray System Annual Operating Outlook 2019-20*

Megalitre (ML): 1 megalitre is one million litres (about half an Olympic swimming pool)

Minimum Reserve: minimum volume to be held at the end of each May (towards SA's Entitlement Flow for use in following year) as determined by the MDBA in accordance with the *Water Act 2007* (Cwlth), clause 103

Nephelometric Turbidity Unit (NTU): is used to describe turbidity. Nephelometric refers to the way how much light is scattered by suspended particles in the water – the greater scattering, the higher turbidity, the lower water clarity

Private Carryover: means a volume of allocation made available in a year for use under an entitlement and not used in the year, but that may be made available to the holder of the entitlement for use in a subsequent dry year. (MDBA Agreement clause 2)

Salinity: concentration of salts in soil or water, usually sodium chloride

SA Storage Right: South Australia's limited right to defer a portion of its Entitlement Flow and store it in the Murray-Darling Basin storages for delivery in a future dry year

SA Operating Plan: South Australia's River Murray Annual Operating Plan 2018-19

Temporary Wetland: a wetland that is located above normal pool level and is inundated naturally when river levels increase due to unregulated flow

The Agreement: the Murray-Darling Basin Agreement 2008 (Water Act 2007 (Cwlth))

Unregulated flow: flow that is not able to be captured (regulated) by the Murray-Darling Basin storages. Unregulated flow cannot be allocated to consumptive use in South Australia.

Weir pool: water that is held back by the presence of a weir

Wetland: land inundated with temporary or permanent water that is usually slow moving or stationary, shallow and either fresh, brackish or saline

Glossary of Acronyms Used

ADF	Additional Dilution Flow
AEP	Annual Exceedance Probabilities
AHD	Australian Height Datum
AOP	Annual Operating Probability
BOC	Basin Officials Committee
CEWH	Commonwealth Environmental Water Holder
CEW	Commonwealth Environmental Water Office
CHWN	Critical Human Water Needs
cm	Centimetre
DEW	Department for Environment and Water
DHW	Department for Health and Wellbeing
EC	Electrical Conductivity
FSL	Full Supply Level
GL	Gigalitre
LLCMM	Lower Lakes, Coorong and Murray Mouth
LMRIA	Lower Murray Reclaimed Irrigation Area
NTU	Nephelometric Turbidity Unit
m	metres
MDBA	Murray-Darling Basin Authority
MDBA Annual Operating Outlook	MDBA's River Murray System Annual Operating Plan 2018-19
NOR	Normal Operating Range
NPL	Normal Pool Level
mg/L	milligrams per litre = 0.001 grams per litre (parts per million)
ML	Megalitre
ng/L	nanograms per litre = 0.000000001 grams per litre (parts per trillion)
PEA	Priority Environmental Assets
PIRSA	Primary Industries and Regions South Australia
ppt	Parts per thousand = 1 gram per litre
RMOWG	River Murray Operations Working Group
RRP	Riverine Recovery Project

SARFIIP	South Australian Riverland Floodplain Integrated Infrastructure Program
SA Operating Plan	South Australia's River Murray Annual Operating 2019-20
SA Water	South Australian Water Corporation
SCBEWC	Southern Connected Basin Environmental Watering Committee
TLM	The Living Murray
µg/L	micrograms per litre = 0.000001 grams per litre (parts per billion)
WIC	Water Incident Coordinator
WLWG	Water Liaison Working Group
ZEMC	Zone Emergency Management Committee

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Appendix 1

River Murray Operations Working Group - Terms of Reference

Role

The role of the South Australian River Murray Operations Working Group is to:

- coordinate a range of inputs to manage River Murray operations effectively;
- provide advice on River Murray policy and operational matters; and
- share information on River Murray operational matters to optimise operations.

Responsibility

In undertaking this role, the group's responsibility is to:

Coordinate

- Contribute to the integration and optimisation of River Murray water resources management outcomes.
- Assist in preparing South Australia's River Murray Annual Operating Plan (updated annually).
- Contribute to oversight of operation of the River Murray in accordance with South Australia's River Murray Annual Operating Plan.
- Have regard for requirements in legislation, policies and agreements.
- Contribute to oversight of management of specific flow events within the guidelines of South Australia's River Murray Annual Operating Plan to optimise the use of water resources to deliver environmental, economic and social outcomes.
- Consider River Murray Action Requests as required.

Provide Advice

- Provide advice as required to the South Australian Basin Officials Committee member (through the Manager Water Resource Operations, Department of Environment, Water and Natural Resources) as required on the operation of the river to meet the agreed operational outcomes within South Australia's River Murray Annual Operating Plan.
- Provide advice to the Murray-Darling Basin Coordinating Committee and seek direction from Executive Director Water and River Murray, if the agreed river operational outcomes cannot be met within the timeframes, flow rates, pool levels and diversions specified in the scope of South Australia's River Murray Annual Operating Plan.
- Provide comment on the Deferred Water Storage and Delivery Plan for the management of South Australia's Storage Right.

Share Information

- Share information within the group regarding plans, projects, operations, resource scenarios and outlook.

Governance

The River Murray Operations Working Group is not a decision making body; however, a majority agreement may be sought on matters under consideration. Where a majority agreement cannot be achieved, the matter will be escalated to the Director Water Infrastructure and Operations for a decision. In the event that a material disagreement remains, the matter will be referred to the Executive Director Water and River Murray.

Membership

The River Murray Operations Working Group membership will be at the senior officer level. Some agencies may require more than one representative to ensure that the appropriate range of responsibilities and local knowledge are covered. Other staff may be invited to attend as an observer to ensure a process of capacity building is undertaken.

The agencies represented are:

- Department for Environment and Water;
- SA Water;
- Primary Industries and Regions SA;
- South Australian Research and Development Institute; and
- Environment Protection Authority.

Meeting Frequency

The River Murray Operations Working Group will meet monthly (3rd Tuesday every month) or more frequently if required. A sub–group of the River Murray Operations Working may be established to address issues as required.

Quorum

Depending on the issues being considered, it may not be necessary for the full membership of the River Murray Operations Working Group to attend every meeting (particularly during the management of specific flow events). A quorum of not less than 50% of the membership must be present at a meeting for the business of the meeting to be transacted. Proxies may attend on behalf of a designated member but must be at the senior officer level. Meetings of the group may be in person, by teleconference, or videoconference.

Executive Officer

The Executive Officer will provide secretariat support to the River Murray Operations Working Group. The Executive Officer will ensure meeting agendas and supporting papers are circulated (after approval from the Chair) as soon as possible before the meeting. The Executive Officer will also:

- prepare and maintain minutes of meetings;
- seek approval by the Chair before circulating the minutes;
- forward the minutes of River Murray Operations Working Group meetings to the group and the Murray-Darling Basin Coordinating Committee within an appropriate timeframe (recognising actions that need to be undertaken); and
- request officers to undertake actions (including outstanding actions).

Administrative Arrangements

Agendas and supporting papers will be circulated to the group as soon as possible before the meeting (at least 2 working days before meeting).

Meeting minutes will be prepared as soon as possible after a meeting. The minutes will be forwarded to the group within an appropriate timeframe (recognising actions that need to be undertaken). A copy of the minutes will be provided to the Murray-Darling Basin Coordinating Committee for information.

Review of Terms of Reference

The River Murray Operations Working Group will review the Terms of Reference as necessary or at least every two years. The Director Water Infrastructure and Operations will approve the Terms of Reference.

Appendix 2

Assignment of SA Entitlement Flow

At 1 July 2019, under the extreme dry inflow scenario (100% AEP), where South Australia would be entitled to receive 1 050 GL of Entitlement Flow during 2019-20, the volumes of water were assigned as follows.

If there are improvements to water resource conditions as the year progresses, increases will be applied to the:

- *Volume of water available for allocation* and
- *Water allocation rate as a % of nominal maximum water allocation*.

Consumptive Pool	**Classes**	**Volume of water available for allocation**	**Water Access Entitlement**	**Water allocation rate as % of nominal maximum water allocation Rate of 1 kL/unit share**
		kL	unit share	(%)
Metropolitan Adelaide	Class 6	37,700,000	130,000,000	29
All Purpose	Class 1	8,368,662	8,368,662	100
	Class 2	34,000,000	50,000,000	68
	Class 3	158,027,535	607,798,212	26
	Class 5	5,568,841	5,568,841	100
	Class 8	5,772,000	22,200,000	26
All Purpose	**Sub Total**	**211,737,038**	**693,935,715**	
Wetland	Class 9	38,953,915	38,953,915	100
Environmental	*Class 9	7,244,800	7,244,800	100
	Total	**295,635,753**	**870,134,430**	

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