Basin Salinity Management 2030

South Australia's 2021 Comprehensive Report

Government of South Australia
Department for Environment and Water

Acknowledgements

This report has been compiled by the Department for Environment and Water (DEW) with contributions from other organisations and branches within DEW.

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- Water Science and Monitoring Branch
- Water Infrastructure and Operations Branch
- Murraylands and Riverland Landscape Board
- SA Water.

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Executive Summary

Murray-Darling Basin governments renewed their commitment in 2015 to manage salinity through the adoption of the Basin Salinity Management 2030 (BSM2030) strategy. The BSM2030 strategy builds on previous investments in salinity management as part of the Salinity and Drainage Strategy (1988-2000) and the Basin Salinity Management Strategy (2001-2015). The BSM2030 strategy maintains the existing accountability framework and management arrangements, while addressing contemporary issues such as the effects of environmental watering and exploring ways to optimise the operation of salt interception schemes (SIS).

This is South Australia's third comprehensive report and covers implementation of the BSM2030 strategy in 2019-20 and 2020-21. South Australia's key achievements and outcomes over the past two years are outlined below against each of the key elements of the BSM2030 strategy.

Salinity accountability framework

- South Australia remains compliant with Schedule B of the Murray-Darling Basin Agreement with a Salinity Register net credit balance of $7.492 million.
- Results from salinity assessments for actions undertaken as part of the South Australian Riverland Floodplain Integrated Infrastructure Program (SARFIIP) at Pike and Katarapako indicate that the combined impact of actions are likely to result in a net reduction in salt load to the River Murray of approximately 70 tonnes per day averaged over 100 years.

Management of salt interception schemes

- SIS located in South Australia intercepted more than 675,000 tonnes of salt over the past two years.
- The Pike groundwater management scheme, designed to enhance the ecological benefits of inundation of the Pike and Katarapko floodplains, has been completed and is operational.

Flow management

- Salinity levels remained below the target levels in 2019-20 and 2020-21 at all South Australian End-of-Valley Target sites and Basin Plan reporting sites other than Milang, which had a short exceedance above 1,000 EC.
- During 2019-20 and 2020-21 DEW considered the salinity and water quality risks associated with 142 separate requests to undertake environmental watering and river operations actions as part of the approval process.
- Murray-Darling Basin Authority (MDBA) modelling estimates that salt export from the Murray-Darling Basin was 430,000 tonnes in 2019-20.
- The Murray Mouth remained open 100 percent of the time due to dredging operations and delivery of environmental water.

Salinity management in catchments

- Under the Commonwealth funded Basin Plan Efficiency Measures program to recover water towards 450 GL – over 90 projects from South Australian irrigators have been approved, which will return more than 2.5 GL of water to the environment.

Efficient governance

- The Loxton to Bookpurnong, Pyap-Kingston and Berri-Renmark groundwater models were accredited by the Murray-Darling Basin Authority and used to update existing salinity register entries.
- A review of the Morgan to Wellington groundwater model and accountable actions commenced and was substantially completed in 2020-21.

Strategic knowledge improvement

- South Australia has undertaken a project to improve the understanding of the water and salt balance in lower River Murray floodplains under environmental watering activities.
- South Australia has commenced the development of a tool to estimate short-term changes in salinity in the River Murray resulting from multiple environmental watering actions. This tool will support annual planning and operational decision-making.

Community engagement and communication.

- Significant community engagement has been carried out as part of the SARFIIP projects at Pike and Katarapko, and as part of Project Coorong.
- DEW continues to publish weekly River Murray Flow Reports and a monthly Water Resources Update, which are distributed to over 1,000 recipients online.

Introduction

The 2021 comprehensive report provides an update on South Australia's progress against the key elements of the Basin Salinity Management 2030 (BSM2030) strategy. The strategy reflects the contemporary understanding of salinity risk in the Murray-Darling Basin and includes efficient governance arrangements for comprehensive and status reporting completed in alternate years.

The report addresses the requirements of Schedule B of the Murray-Darling Basin Agreement (Schedule 1 of the *Water Act 2007*) and has been structured in accordance with the Basin Salinity Management reporting procedure that has been endorsed by the Basin Salinity Management Advisory Panel (BSMAP). The report has been considered by the Independent Audit Group (IAG) for Salinity as part of their audit of implementation of the BSM2030 strategy and the obligations set out in Schedule B to the MDB Agreement.

South Australia remains committed to the ongoing delivery of salinity management obligations under Schedule B and implementation of the BSM2030 strategy. The ongoing management of salinity in the Murray-Darling Basin is critical to continue to protect the environment, irrigated agriculture, industry and critical human water supplies from adverse effects of high salinities.

This report has been compiled by the Department for Environment and Water (DEW) and provides South Australia's key achievements and outcomes over the past two years against the following key elements of the BSM2030 strategy:

- **Salinity Accountability Framework** – the maintenance of the salinity registers and management of accountable actions.
- **Salinity accountability for environmental water management –** creating transparency through accounting for environmental watering salinity impacts and dilution flows.
- **Responsive management of salt interception schemes** – a new salt interception scheme management regime being trialled by the Murray-Darling Basin Authority (MDBA).
- **Flow management –** supporting the implementation of Basin Plan salinity targets for managing water flows through a coordinated management approach.
- **Salinity management in catchments** – reporting on End-of-Valley Targets and implementing cost-effective measures to improve salinity outcomes.
- **Efficient governance** – risk-based register management, maintaining monitoring networks, streamlining annual reporting and independent auditing.
- **Strategic knowledge improvement** – involvement in improving our understanding of the priority areas of Mallee legacy of history impacts, environmental watering impacts, predictive salinity forecasting, and responsive SIS.
- **Community engagement and communication** – maintaining community engagement, relevant media releases and continuing consultation at community meetings.

1.Salinity Accountability Framework

1.1. South Australia's Salinity Register Balance

Under Schedule B of the Murray-Darling Basin Agreement, South Australia is accountable for actions that will change salinity in the River Murray. Actions such as irrigation development, which increase river salinity, result in a debit on the Salinity Register, whereas actions such as salt interception and improved irrigation efficiency, which decrease salinity impacts, result in credits on the Salinity Register. A comprehensive list of South Australia's 2021 Salinity Register entries is included in Table 1.

Based on the 2021 Salinity Register South Australia maintains a positive credit balance of $7.492 million (Table 1) and remains compliant with Schedule B. South Australia's Salinity Register balance is projected to go into debit prior to 2100 due to the estimated salinity impact of irrigation development. The decline into debit is partially due to the use of the accredited SIMRAT model as an interim assessment of irrigation salinity impacts (register entries 52 and 53).

Recent model reviews have demonstrated that it is likely that SIMRAT is overestimating the salinity impacts from irrigation as South Australia's overall register balance is projected to improve once SIMRAT interim assessments (register entries 52 and 53) are replaced by outputs from MODFLOW groundwater models as they are reviewed and accredited (register entry 51).

Due to the significant over-estimates of irrigated area and salinity impacts using the SIMRAT model, South Australia is no longer updating register entries 52 and 53. South Australia is instead updating register entry 51 utilising irrigated area data for the Lower Murray-Darling region of Victoria, New South Wales and South Australia collected and collated as part of a MDBA project.

Table 1. Summary of South Australia's Salinity Register entries

Register Number	Accountable Action	Estimated impact on Morgan 95%ile Salinity (EC)	Salinity Cost Effect ($M)
REGISTER A			
AUTHORISED WORKS OR MEASURES			
NA	SA Component of Salinity and Drainage Strategy Joint Works	26	0[1]
NA	SA Component of Basin Salinity Management Strategy Joint Works	23	0.967
	REGISTER A - JOINT WORKS TOTAL		**0.967[2]**
SOUTH AUSTRALIAN STATE ACTIONS			
51	SA Irrigation Development Based on Footprint Data	26	-1.944
52	SA Irrigation Development Due to Water Trade	-1	-0.116
53	SA Irrigation Development based on Site Use Approvals	0	-0.070
54	SA Component of Bookpurnong SIS	-3	0.249
55	SA Component of Loxton SIS	0	0.016
56	SA component of Waikerie Lock 2 SIS	-1	0.026
57	SA Improved Irrigation Efficiency and Scheme Rehabilitation Register A	-45	3.355
58	Qualco Sunlands Ground Water Control Scheme	-8	0.392
59	Pike Stage 1 SIS	-6	0.509
60	SA Component of Murtho SIS	0	0.033
	REGISTER A – WORKS AND MEASURES TOTAL		2.451
	REGISTER A TOTAL		3.419
REGISTER B			
79	SA Mallee Legacy of History	3	-0.288
80	SA Mallee Legacy of History – Irrigation	41	-2.787
81	SA Improved Irrigation Efficiency and Scheme Rehabilitation Register B	-73	5.093
NA	Transfers from Register A		2.055
	REGISTER B TOTAL		**4.073**
	TOTAL		**7.492**

[1] South Australia component of Salinity and Drainage Strategy works or measures were set aside to improve River Murray salinity and contribute to net salinity reduction.

[2] The total excludes transfers to Register B

1.2. New and Proposed Accountable Actions

South Australian Riverland Floodplain Integrated Infrastructure Program

In accordance with Schedule B of the Murray-Darling Basin Agreement, the South Australian Government has notified the MDBA that actions proposed to be undertaken as a part of the South Australian Riverland Floodplain Integrated Infrastructure Program (SARFIIP) are likely to have a Significant Effect (as defined in Schedule B sub clause 18(3)).

SARFIIP works at the Pike and Katarapko floodplains will manage the surface water and groundwater to improve the environmental health and resilience of wetlands and floodplains in the Riverland region. Surface water management includes environmental regulators and levee banks. The regulators will periodically raise the level of River Murray anabranches, and the levee banks will guide the inundation of the floodplain. Groundwater management includes pumping in both highland and floodplain groundwater management schemes (GMS).

Groundwater models for the Pike and Katarapko floodplains have been developed by DEW to assess the potential salinity impacts to the River Murray from the construction and operation of environmental regulators, levee banks and groundwater management schemes as part of SARFIIP.

The Pike Floodplain groundwater model was initially developed in 2016 to summarise current knowledge, improve conceptual understanding of hydrogeological processes in the floodplain, and to simulate management scenarios. It has since evolved into three variants which meet different objectives:

- Assess the groundwater salinity impacts to river of climate-dependent SARFIIP actions for the MDBA salinity register.
- Investigate changes in groundwater (salinity and depth to groundwater) due to SARFIIP actions which may have ecological impacts.
- Investigate the short-term instream salinity impacts of SARFIIP actions (referred to as 'real-time salinity').

The Salinity Management Measures (SMM) Project within the SARFIIP examined the potential impacts from five management actions to be undertaken at the Pike Floodplain. These are:

- Action 1: Surface water infrastructure changes
- Action 2: Tranche 1 highland well field
- Action 3: Tranche 2 highland well field
- Action 4: Operation of surface water infrastructure
- Action 5: Operation of floodplain groundwater management.

These actions can be considered as having either climate-independent or climate-dependent impacts. Climate-independent impacts occur continuously in a system that is minimally influenced by short-term (sub-yearly) dynamic processes. Climate-independent actions were assessed using the Pike-Murtho Salinity Register Model using a method consistent with the existing salinity register scenario methodology. Climate-dependent impacts may occur as either a short-term action (such as flood inundation) or as a longer-term action within a dynamic environment (such as groundwater pumping within the floodplain). Climate-dependent actions were assessed using the Pike Floodplain Groundwater Model using a new methodology.

It is difficult to compare the results from the climate-independent and climate-dependent actions as they are derived from very different sets of assumptions. However, an attempt has been made to compare the 100-year impact of climate-independent actions with the long-term average of the climate-dependent actions (Table 2). This analysis indicates that the net long-term impact of the actions under SARFIIP would be an approximately 72 t/day long-term decrease in salt load to the river.

Table 2. 100-year average salt load impact summary for all Pike scenarios (t/day)

Action 1: Surface water infrastructure changes	Action 2: Tranche 1 highland well field	Action 3: Tranche 2 highland well field	Action 4: Operation of surface water infrastructure	Action 5: Operation of floodplain groundwater management	Net Impact
-17	-51.8	-1.2	7.6	-9.8	-72.2

The Katarapko Floodplain groundwater model has been developed by DEW to estimate salinity impacts (positive and negative) on the River Murray from the construction and operation of SARFIIP at Katarapko. Surface water management is the main action being undertaken at Katarapko Floodplain, and it includes environmental regulators and levee banks. The regulators will periodically raise the level of River Murray anabranches, and the levee banks will allow the inundation of large areas of floodplains.

The Model was developed to summarise current knowledge, improve conceptual understanding of hydrogeological processes in the floodplain, and to simulate management scenarios. Specifically, the model aims to estimate the long-term salinity impacts to the River Murray of infrastructure and management actions at Katarapko Floodplain.

The management scenario and impact investigated involve changes to the management of surface water in the Katarapko floodplain through the operation of infrastructure. The management scenario used the 2,750 GL surface water flows described in the Basin Plan over a 25-year period and implemented a management plan around the natural flows. This was repeated four times to create a 100-year management scenario.

The key measure for understanding risk was the rate of salt movement from groundwater to the river (the salt load). The methodology used to determine the salt load impact on Katarapko Creek due to management is similar to that used in the current salinity register models, which also have been developed to meet the requirements of the BSM2030 strategy.

The predicted additional salt load to the river as a result of the management action investigated compared to baseline (no management) is 52,460 tonnes over a period of 100 years, an average of 1.4 t/d over this period.

Independent peer reviews of the Pike and Katarapko floodplain groundwater models to evaluate the suitability of the platforms to estimate long-term salinity impacts for the Salinity Register has been completed by CDM Smith. The reviews support the development and application of the Pike and Katarapko floodplain models as being sufficiently robust tools to estimate the salinity impacts of the SARFIIP project at Pike and Katarapko. DEW is currently finalising the relevant reports to enable the salinity impacts to be provided to BSMAP for consideration prior to the actions being included on the Salinity Register.

2. Management of Salt Interception Schemes

2.1. Management and Operation Salt Interception Schemes in South Australia

The Bookpurnong, Loxton, Murtho and Waikerie Lock 2 SIS were constructed as part of the 61 EC joint works program for Basin Salinity Management Strategy (BSMS). These SIS complement the Woolpunda and remainder of Waikerie SIS constructed under the Salinity and Drainage Strategy and the Qualco-Sunland's and Pike SIS and Pike Groundwater Management Scheme (GMS) which are South Australian state actions.

The SIS in South Australia diverted an estimated 332,705 tonnes of salt in 2019-20 and 343,521 tonnes in 2020-21. The SIS provide a significant contribution to the achievement of the Basin Salinity Target and the maintenance of acceptable salinity levels during low-flows. The annual performance of each scheme is presented in Table 3 below.

Table 3. Annual performance of salt interception schemes in South Australia

Salt Interception Scheme	2019–20			2020–21		
	Volume Pumped	Salt Load Diverted	Average Salinity	Volume Pumped	Salt Load Diverted	Average Salinity
	(ML)	(Tonnes)	(EC)	(ML)	(Tonnes)	(EC)
Pike	254	10,730	57,452	281	12,987	58,662
Pike GMS	1,774	81,864	68,519	2,751	108,404	61,568
Murtho	1,304	32,777	39,353	1,115	29,548	40,659
Bookpurnong	774	17,996	36,077	891	19,152	35,682
Loxton	808	9,589	23,431	624	7,473	21,328
Woolpunda	5,083	102,748	32,230	4,659	97,964	33,388
Waikerie	4,486	77,001	29,101	3,789	67,993	30,391
Total	**14,483**	**332,705**	**N/A**	**14,110**	**343,521**	**N/A**

2.2. Pike Groundwater Management Scheme

The SMM project incorporates a GMS to enhance the ecological benefits of inundation of the Pike and Katarapko floodplains. The SMM project was undertaken in two stages with the construction of 24 production wells, 30 observation/monitoring wells, 29.6 km of buried pipeline, and approximately 11 km of power (mostly buried), in and around the Pike Floodplain. The groundwater management wells pump the salty water away from the floodplain to a disposal basin located at Noora.

The surface water and groundwater infrastructure were designed to be operated in parallel, to enhance the ecological benefits and reduce the risks of the managed inundations. In particular, the floodplain scheme is designed to protect the low salinity lens surrounding Tanyaca Creek and support a valuable population of river red gum, from the groundwater head differential resulting from inundating the upstream side of the blocking bank while river levels are lower.

The groundwater response from both the pumping and the managed inundation is expected to be relatively slow and refining the operational requirements will rely on monitoring observations.

3.Salinity Management

3.1. Flow-Based Management

The Basin Plan establishes the Water Quality and Salinity Management Plan (WQSMP), which sets out key causes of water quality degradation, water quality objectives for Basin water resources and water quality targets. The WQSMP includes provisions governing how certain entities must 'have regard to' water quality targets when making decisions about flow management and the use of environmental water.

The salinity targets for managing water flows (Basin Plan 9.14) that are relevant to South Australia are:

- River Murray at Lock 6 – 580 EC
- River Murray at Morgan – 800 EC
- River Murray at Murray Bridge – 830 EC
- Lower Lakes at Milang – 1,000 EC

In 2019-20 and 2020-21 salinity levels remained below the salinity targets for managing water flows for the majority of the period. However, daily average salinity at Milang exceeded 1,000 EC for 5 percent of the days in the 2019-20 and 2020-21 reporting period. All other sites remained well below target levels as illustrated in Figure 1.

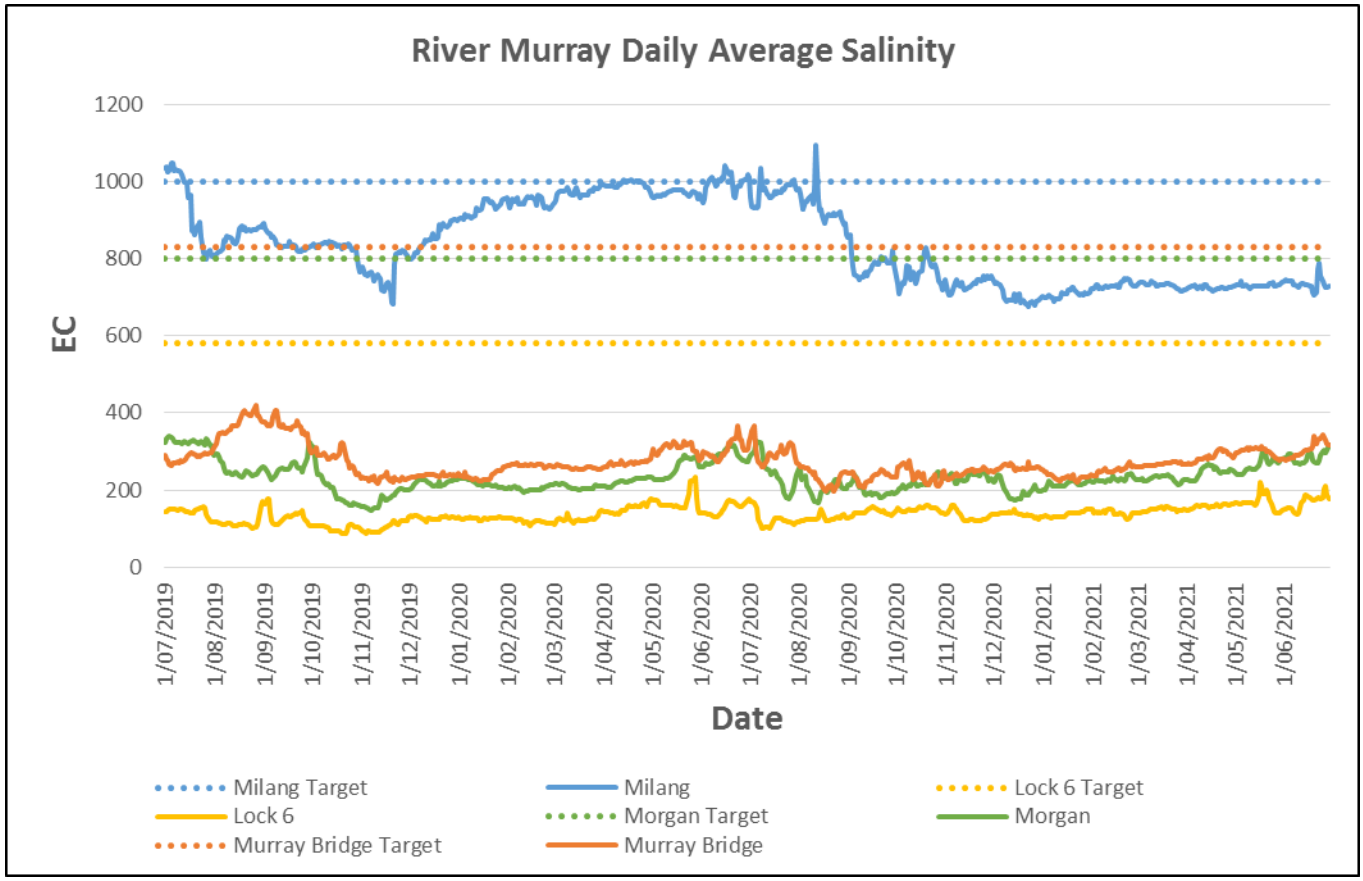

Figure 1. South Australian River Murray Daily Average Salinity

The Objectives and Outcomes for Operating the River Murray in South Australia, South Australian River Murray Operating Plan and the Annual Environmental Watering Plan guide transparent and coordinated River Murray operational decisions in South Australia, in a manner consistent with, and which has regard for, Basin Plan objectives. The plans document the objectives and outcomes sought under a range of climate and inflow scenarios, describe how the desired outcomes are proposed to be delivered and identify how the River Murray in South Australia may be routinely operated under a number of potential water availability scenarios.

During 2019-20 and 2020-21, flow management and environmental watering decisions were made on a daily basis by DEW, consistent with the objectives and outcomes of these plans. Actions to be undertaken that may have associated water quality risks, or are outside of an agreed operating plan, require a River Murray Action Request.

The purpose of the River Murray action request is to capture specific details of all actions being undertaken and enable the impacts of the action (or cumulative actions) to be considered, such as risks to water quality. River Murray action requests provide sufficient information to make a prompt decision to undertake, modify, or not undertake a proposed action, given the conditions in the river at the time the event is proposed.

During 2019-20 and 2020-21, a total of 142 River Murray action requests were submitted to DEW relating to wetland management, increasing flows through regulators, floodplain management and weir pool raising and lowering. All requests were assessed for their individual and cumulative impacts on the River Murray and downstream users.

Exporting Salt from the Murray-Darling Basin

There is approximately 100 billion tonnes of salt in groundwater in the Murray-Darling Basin and an additional 1.5 million tonnes of salt is deposited each year by rainfall. Unless salt is exported from the basin it will accumulate, potentially leading to salinisation of wetlands and floodplains. In average flow years, environmental water plays a vital role in salt export from the Murray-Darling Basin to the Southern Ocean.

Over the three-year period July 2018 to June 2021, the MDBA has estimated that the annualised rate of salt export over the barrages was 0.47 million tonnes per year. This is less than the Basin Plan's indicative figure of two million tonnes per year. The contribution that environmental water has on salt export has been modelled through the Commonwealth Environmental Water Office's Long-Term Intervention Monitoring Project in the lower River Murray. Environmental flows substantially increase salt export out of the Basin, reduce salt import into the Coorong and reduce salinity concentrations in the Coorong. Flows have prevented around 5.5 million tonnes of salt building up in the Coorong from 2017 to 2020, avoiding catastrophic impacts that would have been reminiscent of those experienced during the Millennium Drought.

Maintaining an open Murray Mouth is also vital to ensure adequate flushing of salt from the River Murray system into the Southern Ocean. When the flow to South Australia and barrage releases are low, sand deposits may occur inside the Murray Mouth causing restrictions and increasing the risk of closure. Barrage releases of greater than 2 GL a day are required to minimise the risk of Murray Mouth closure. In 2019-20 connectivity between the river, Coorong estuary and Southern Ocean was maintained with continuous flows through the barrages to the Coorong.

To maintain connectivity (exchange of water) and to ensure salt export between the Coorong and the Southern Ocean it has been necessary for dredging operations to be undertaken at the Murray Mouth in the absence of adequate flow. In 2019-20 and 2020-21 two dredges operated in the Goolwa Channel and the Murray Mouth to remove approximately 2.6 million cubic meters of sand. These operations combined with the delivery of environmental water have enabled the Murray Mouth to remain open for 100 percent of the time over the reporting period.

3.2. Land Based Management

Water Quality Management Plans

A key element of Basin Plan implementation in South Australia is the development and implementation of Basin Plan compliant water resource plans for each of the State's three water resource plan areas. Water resource plan requirements are set out in Chapter 10 of the Basin Plan, with specific water quality management plan provisions included in Part 7.

DEW has three water resource plans covering the South Australian part of the Murray-Darling Basin that have been accredited by the Commonwealth Minister responsible for water. The Basin states are required to evaluate progress towards water quality targets outlined in Chapter 9 every five years. South Australia completed and published its first

report on progress towards water quality targets in 2020 (www.environment.sa.gov.au/environment/docs/south-australian-matter-12-rep.pdf).

An overall exceedance assessment of each of the characteristics within the relevant water quality targets has been undertaken. Targets were assessed annually, with the level of exceedance for each target at each site assessed.

The assessment found that the water quality targets for managing water flows, irrigation water, recreational water and the salinity targets for the purposes of long-term salinity planning and management were rarely exceeded. The water quality targets for fresh water-dependent ecosystems as set out in Schedule 11 of the Basin Plan, were exceeded on several occasions and this is likely due to the targets not being appropriate for the very ephemeral and estuarine water-dependent ecosystems prevalent in South Australia.

Basin Plan Efficiency Measures

Efficiency measures are an agreed component of the Basin Plan to recover 450 GL of water. This water aims to deliver enhanced environmental outcomes throughout the Murray system, including floodplains in New South Wales and Victoria, and is particularly important for maintaining the health of the Coorong and Lower Lakes.

Efficiency measures projects improve water use practices and save water for the environment. They are part of the Basin Plan's Sustainable Diversion Limit Adjustment Mechanism, which is in place to benefit the environment and communities across the Murray-Darling Basin.

As part of the agreement under the Murray Darling Basin Plan, $1.5 billion is available from the Australian Government to improve water efficiency and return 450 GL of water to the environment by 2024. As well as benefiting irrigators, communities and the environment, this funding better prepares irrigators and communities to manage the impacts of a changing climate by improving water use practices and saving water.

Under Commonwealth funded programs to recover water for the 450 GL – over 90 projects from South Australian irrigators have been funded which will return more than 2.5 GL of water to the environment. These projects have implemented the latest irrigation technology on farms to reduce the volume of water pumped to meet the crop requirements, which results in reduced root zone drainage and contributes to a reduction in discharge of saline groundwater to the River Murray.

Project Coorong

The Australian and South Australian governments announced the next $22.2 million of funding to help get the Coorong back on track for a healthy future in February 2020. The funding will deliver key works including detailed feasibility assessments and scientific investigations which will lead to longer-term management solutions and more effective delivery of water.

Project Coorong will contribute to managing the Coorong for ecological health, and support the Coorong, Lakes Alexandrina and Albert Wetland Ramsar site to be a healthy, productive and resilient wetland system. The key ecological features of the Coorong that made it a unique and valuable place were still present after the Millennium Drought but the system is in a vulnerable state.

This new phase of funding will support scientific trials and detailed feasibility assessments to improve long-term environmental outcomes for the region. In addition the Coorong Partnership, a community governance model will provide local communities and groups with an opportunity to help shape the work to be undertaken. The partnership includes members with expertise in conservation, recreation, science, tourism, fishing, agriculture and heritage, as well as First Nations and local government representatives.

Sustaining Riverland Environments

The Sustaining Riverland Environments (SRE) program was announced by the Commonwealth in September 2020. Projects delivered through the SRE program will support delivery of Basin Plan objectives and maximise the benefits from previous investment in Riverland programs, particularly the benefits being delivered through SARFIIP.

The overarching objective of the SRE program is to implement a range of projects to sustain Riverland environments and improve the condition of the lower River Murray channel, floodplain and wetland ecosystems, with a focus on recovering

native fish populations and flow on benefits for South Australian Riverland communities. The SRE program will directly build on earlier work delivered through SARFIIP, with added emphasis on generating beneficial outcomes for native fish across three project localities at Lock 3, Lock 6 and Bookmark Creek.

Within the Lock 3 reach infrastructure upgrades at priority floodplain and wetland sites will seek to improve asset functionality and enable integrated operations with weir pool manipulation and future high flows, leading to improved environmental outcomes and better management of salinity risks associated with Lake Bonney and Loch Luna.

3.3. End of Valley Outcomes

The BSM2030 strategy retains the End-of-Valley Targets to preserve Basin-wide monitoring and to inform the assessment of salinity risk to the shared water resources and within-valley assets.

As part of the BSM2030 strategy, salinity must be monitored at each End-of-Valley Target site and reported annually. The monitoring results for the Basin Salinity Target and the three South Australian End-of-Valley Target sites are presented in Table 4.

In 2019–20 and 2020–21 monitored daily salinity remained below the target levels at all sites. The program of salinity controls implemented to date, including SIS and improved irrigation system and on-farm practices, in addition to the delivery of environmental flows, have contributed to the maintenance of in-river salinity levels below target levels.

Table 4. End-of-Valley Target Monitoring Results

Valley	End-of-Valley Target (as % of baseline)	Valley Reporting Site	2019–20		2020–21	
SA Border	412 EC (80 %ile)	Murray at SA Border (A4261022)	EC (Max) EC (Avg) EC (80 %ile)	265 130 149	EC (Max) EC (Avg) EC (80 %ile)	309 152 175
Berri	543 EC (80 %ile)	Murray at Berri (A4260537)	EC (Max) EC (Avg) EC (80 %ile)	275 163 198	EC (Max) EC (Avg) EC (80 %ile)	247 172 182
Basin salinity target	800 EC (95%ile)	Murray at Morgan (A4260554)	EC (Max) EC (Avg) EC (95 %ile)	335 234 318	EC (Max) EC (Avg) EC (95 %ile)	323 226 287
Below Morgan	770 EC (80 %ile)	Murray at Murray Bridge (A4261162)	EC (Max) EC (Avg) EC (80 %ile)	424 285 322	EC (Max) EC (Avg) EC (80 %ile)	388 262 294

4. Efficient Governance

4.1. Basin Wide Core Salinity Monitoring Network

The BSM2030 strategy requires partner governments and the MDBA to nominate their core salinity monitoring network and make a commitment to the operation, maintenance and reporting on the delivery of monitoring at these sites for the life of the strategy.

The Basin-wide Core Salinity Monitoring Network includes monitoring sites considered critical to underpin the models that quantify register entries, evaluate trends at End of Valley Target sites, assess compliance with the Basin Plan, improve knowledge in priority areas and support management of the river, salt interception schemes and environmental flows.

South Australia nominated 435 groundwater bores in October 2017 that are monitored by DEW. A further 475 groundwater bores that are monitored to support the SIS program in South Australia have been nominated by the MDBA. The MDBA have also nominated 66 surface water sites in South Australia for inclusion in the monitoring network that are funded by the joint programs.

No changes have been made to the sites included in the Basin-wide core salinity monitoring network for which the Government of South Australia is responsible for in 2019-20 or 2020-21.

4.2. Review of Salinity Register Models and Entries

Reviews of accountable actions and delayed salinity impacts are undertaken on a regular basis to ensure that approved models or methods and corresponding register entries remain up to date and are based on the best available information. South Australia uses a series of accredited groundwater models that span the length of the River Murray in South Australia (see Figure 2). The models underpin the estimation of salt loads entering the River Murray from the South Australian border to Wellington and are the basis for authorised works and measures and South Australian state action entries on the salinity registers.

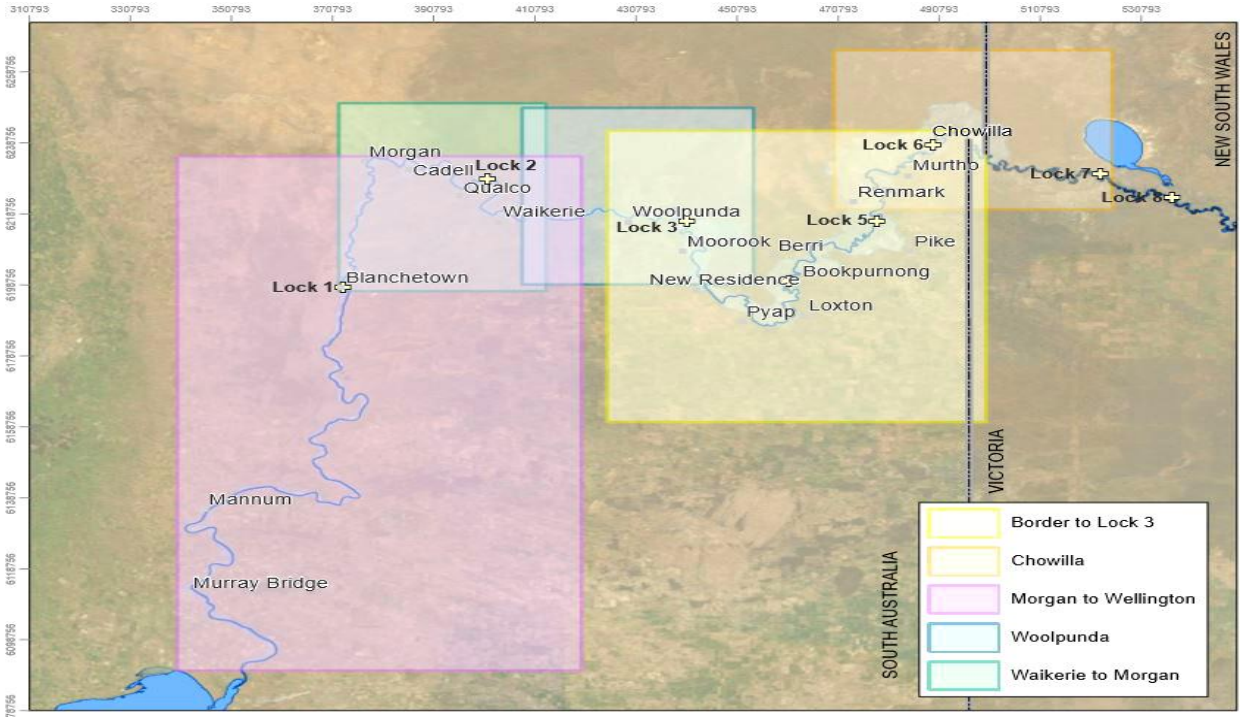

Figure 2. Coverage of South Australian Accredited Regional Numerical Groundwater Models

Review of Loxton to Bookpurnong Groundwater Model and Accountable Actions

The Loxton and Bookpurnong irrigation areas are adjacent to the River Murray in the Riverland region of South Australia. Land clearance and irrigation have increased the flow of water through the soil profile to the groundwater table, creating pressure which increases the rate at which the highly saline groundwater moves towards the River Murray and its floodplain.

A review of the Loxton to Bookpurnong numerical groundwater model and accountable actions was completed in 2020 in conjunction with an independent peer review of the model which was undertaken concurrently. The salinity impact of the relevant accountable actions in the modelled area was last assessed in 2011 using the Border to Lock 3, 2rd generation numerical groundwater model.

Since 2011, further studies have been undertaken, including reviews of the stratigraphy and irrigation history. These studies have improved the understanding of both the region's aquifer systems and irrigation, which influence the saline groundwater entering the River.

The aim of the review was to upgrade the existing Border to Lock 3 model in the Loxton–Bookpurnong area to reflect this new knowledge in consultation with an inter-jurisdictional project steering committee. This included evaluating salt loads resulting from actions such as land clearance, irrigation area development, changes in irrigation practice and the construction of SIS.

The upgraded model was used to estimate salt loads to the River Murray for different scenarios required for the salinity registers. The review included evaluating salt loads resulting from accountable actions such as land clearance, irrigation area development, changes in irrigation practice and the construction of SISs. The 2019 model provides different salt load results from the 2011 model, mainly at the Bookpurnong reach.

Refinement of recharge estimates resulting from the MDBA Transfer Function Project did not occur due to the timing of the numerical groundwater model review. However, learnings from the Transfer Function Project were considered by the DEW Groundwater Modelling Team responsible for the Loxton to Bookpurnong numerical groundwater model review.

The MDBA appointed independent peer assessor conducted an impartial peer review of the Loxton-Bookpurnong model and found the review of Loxton-Bookpurnong groundwater model to be "fit-for-purpose" to revise the salinity registers for various South Australian state actions and the joint component of the Loxton and Bookpurnong salt interception schemes.

The report includes comprehensive information on the model design, model inputs, and model outputs. The key outputs are estimated annual salt loads for the different scenarios, which have been used by the MDBA to update relevant salinity register entries following accreditation of the model and consideration by BSMAP at meeting 45 on 19 February 2020.

Review of Pyap-Kingston and Berri-Renmark Groundwater Model and Accountable Actions

The Berri–Renmark and Pyap-Kingston irrigation areas are located within the Riverland region of South Australia. The salinity impact of accountable actions in the region was last assessed in 2007 and 2008 using the Berri–Renmark 2008 and Pyap-Kingston 2008 groundwater models.

A review of the Pyap-Kingston and Berri-Renmark groundwater models and accountable actions was completed in 2020 in consultation with a project steering committee and in conjunction with an independent peer review of the model which was undertaken concurrently.

The review updated the existing Border to Lock 3 model in the Berri–Renmark and Pyap-Kingston areas to reflect new knowledge. This includes evaluating salt loads resulting from local, accountable actions such as land clearance, irrigation area development, and changes in irrigation practice.

The model was used to estimate salt loads to the River Murray for different scenarios required for the salinity register. In general, the 2020 Berri-Renmark and Pyap-Kingston models provide similar salt load results to the Berri–Renmark 2008 and Pyap to Kingston 2008 groundwater models.

The MDBA appointed independent peer assessor conducted an impartial peer review of the Berri-Renmark and Pyap-Kingston models and found that the models are "fit-for-purpose" to revise the salinity registers for various South Australian state actions. The key outputs are estimated annual salt loads for the different scenarios, which have been used

by the MDBA to update relevant salinity register entries following accreditation of the model and consideration by BSMAP at meeting 50 on 19 May 2021.

Review of Morgan- to Wellington Groundwater Model and Accountable Actions

The Morgan to Wellington numerical groundwater flow model is part of a suite of South Australian groundwater models for estimating the salt load impacts of accountable actions under BSM2030. The salinity impact of accountable actions in the modelled area was last assessed in 2009 and 2010 using the Morgan to Wellington 2009 and 2010 groundwater models.

Since 2010, further studies have been undertaken, including reviews of the stratigraphy and irrigation history. These studies have improved the understanding of both the region's aquifer systems and irrigation development, which influence the saline groundwater entering the River.

The existing Morgan to Wellington model was upgraded to reflect new knowledge in 2021. This includes evaluating salt loads resulting from local, accountable actions such as land clearance, irrigation development and changes in irrigation practices.

The Morgan to Wellington groundwater model 2021 review and upgrade was undertaken in consultation with a project steering committee and has undergone an independent peer review which was completed in September 2021. The final report and model results for accreditation and entry onto salinity registers are still to be considered by BSMAP, and as such the relevant salinity register entries have not been updated in the 2021 salinity registers.

4.3. Progress Towards 2019 IAG Salinity Recommendations

South Australian progress towards implementation of the 2019 IAG Salinity recommendations is discussed below.

Recommendation 1
The MDBA immediately add a provisional register entry of 6 EC debit to account for the 5,800 ha of irrigation development in the NSW Sunraysia region as this is an accountable action under Schedule B of the MDB Agreement (Water Act (2007)).

This recommendation was not relevant to South Australia.

Recommendation 2
NSW urgently increase resources to meet the BSM2030 Schedule B contractual agreement to complete the register entry and model reviews and reduce the uncertainty of the salinity impacts from the expected new development in the high salinity risk areas of Sunraysia.

This recommendation was not relevant to South Australia.

Recommendation 3
The MDBA and Contracting Governments develop a common risk assessment and management framework that is consistent with AS ISO 31000 and develop a risk profile for the basin-wide program.

South Australia provided input into a MDBA led project to develop a basin-wide risk assessment and management framework. The risk assessment tool which is in the final stages of development will assist in prioritising resources to address both short and long term salinity risks across the Murray-Darling Basin.

Recommendation 4
The Commonwealth and State Contracting Governments continue to work with environmental water holders to understand the basin-wide salinity risk and the cumulative debit impacts from environmental watering of sites.

South Australia has developed numerical groundwater models to estimate the salt loads that may be generated from environmental watering actions at Chowilla, Pike and Katarapko floodplains and is developing tools to estimate short-term salinity in the River Murray resulting from in-channel flows and multiple environmental watering actions. South Australia will continue to work with Contracting Governments to integrate this information into a basin-wide estimate of the cumulative salinity impacts of environmental watering.

Recommendation 5
The Queensland Government assess the risk to basin rivers from the brine ponds constructed by the CSG industry.

This recommendation was not relevant to South Australia.

Recommendation 6
In the lead up to the 2026 review of the BSM2030 strategy the following knowledge gaps be explored:

1. *The impact of climate change on the salinity in the shared water resources;*
2. *The economic impacts and opportunities provided to the basin industries and communities from salinity mitigation;*
3. *Revisit the cost function framework of the registers;*
4. *The usefulness of end-of-valley targets for management decisions and consideration be given to other indicators such as trend analysis and mid-valley targets; and*
5. *Review key entries in the registers to reduce uncertainty and provide improved certainty in relation to available credits by 2080.*

South Australia remains committed to actioning these knowledge gaps in the lead up to the 2026 review of BSM2030. South Australia will continue to work closely with the MDBA and Basin governments to develop a forward work plan to ensure that these priority areas are actioned in a timely manner while giving consideration to resourcing constraints.

5. Strategic Knowledge Improvement

The BSM2030 strategy has identified four priority areas for strategic knowledge improvement. These are:

- Mallee legacy of history – improving our understanding of dryland clearing impacts and the impacts of past irrigation practices pre-1988.
- Environmental water management – improving our understanding of the salinity impacts of environmental watering and cumulative system scale salinity impacts.
- Predictive forecasting for in-river salinity – to reduce risks associated with responsive SIS and to inform other management actions.
- Responsive SIS management – improving our understanding of the floodplain and in-river response to reduced SIS operations to reduce operating costs.

Trial of responsive SIS

A trial of Responsive Management of SIS was initiated in 2016 with the objective of informing a new operating regime for SIS assets. Six-month forecasts of salinity risk, prepared using the Source model, inform decisions about changes to the level of SIS operations. The responsive management trial incorporates monitoring activities such as groundwater monitoring, vegetation monitoring and unmanned aerial vehicle flights across targeted floodplains to identify any detrimental impacts on floodplain health from reduced pumping rates. Sites in South Australia include Clark's Floodplain, Thiele's Floodplain and Ramco Floodplain.

The responsive management trial has been extended until 2025 by the Basin Officials Committee to provide a more meaningful dataset to inform the knowledge gap investigations and ultimately improve the responsive SIS management decision making process and align with the timing for implementing the other BSM2030 knowledge priorities. South Australia continues to contribute to the knowledge gap investigations being undertaken as part of the trial.

Recharge and Drying in an Environmental Watering Site on the Lower Murray

DEW has undertaken a project to improve the understanding of the water and salt balance in lower River Murray floodplains under environmental watering activities, with a suite of methods including fieldwork, laboratory experiments and numerical modelling. The outcomes of the work are expected to provide guidance for environmental watering so that the utilised water is efficiently used for reviving the local ecosystem, posing minimum risks of increasing salt loads back to the River Murray and to improve understanding of the floodplain dynamics in a heavy clay setting.

The fieldwork was designed to monitor the hydrological, geochemical and ecological impacts of environmental watering. The hydrological influence was assessed by tracing the water used for environmental watering, specifically, the amount of water: removed by evapotranspiration; infiltrated and held into the ambient floodplain soils, and recharged to the groundwater underneath. The geochemical influence was analysed by regularly sampling and analysing the chemistry of the groundwater and the pond at the monitoring site, and the adjacent River Murray. The ecological impacts were evaluated by characterising the response of the flora, and observing the fauna activities around the site before, during and after the e-watering activities.

This project was funded by DEW as part of SARFIIP, to improve the watering and management of River Murray floodplains in South Australia's Riverland with support from MDBA under BSM2030. The planning and delivery of the environmental watering of the study site wetland were undertaken by the Floodplains and Wetlands team from the Murraylands and Riverland Landscape Board. The environmental water was provided by the Commonwealth Environmental Water Holder to achieve environmental outcomes at the sites and also enable us to undertake this study.

Cumulative Impacts from Environmental Water Management

DEW has commenced the development of a tool to estimate short-term changes in salinity in the River Murray resulting from multiple environmental watering actions and support annual planning and operational decision-making. The tool will inform river operation by ensuring environmental watering and other management decisions have appropriate regard to the cumulative impact to river salinity. The project stems from existing assessment of high-level knowledge gaps and

model development required to address cumulative risks, which has been identified in the SARFIIP Environmental Pathways Program Investment Proposal.

The tool will inform river operations by ensuring environmental watering and other management decisions have appropriate regard to the cumulative impact to river salinity. In addition, it needs to predict Basin Plan EC targets at Morgan and Lock 6, with consideration of floodplains, wetlands and irrigation offtakes. Salinity impacts need to be examined at a lock to lock scale, with the potential for additional local-scale information at key locations where salt loads are more significant (such as irrigation offtakes and major water pipelines, floodplains and wetlands).

The long-term aim is to develop tools for estimating the groundwater salinity impacts of potential management actions. In this project, the objectives are:

- For the reach Lock 6 and 3, construct a new numerical groundwater model which can predict potential short-term salt loads to the main River Murray channel resulting from weir pool manipulation events
- For the reach between Locks 2 and 3, collate data which may be used to develop models at a later time.

The groundwater model will deliver a time series of salt loads to the river for scenarios modelled. This data will be used as an input to the River Murray Source model to predict salinity responses at:

- A weir pool scale, with an ability to interpret data to understand locations of elevated salinity loads at a finer scale.
- Daily during environmental watering events.
- Monthly post events.

6. Community Engagement and Communication

Regular Reporting

DEW publishes a weekly River Murray Flow Report and a monthly Water Resources Update. Both documents are emailed to over 1,000 recipients and published on the DEW website. The River Murray Flow Report provides information on the flow across the South Australian border, environmental watering activities, Murray Mouth dredging operations, and barrage and weir pool operations. The monthly Water Resources Update provides additional information on water entitlement, water held in storage and salinity at the Basin Plan Target sites.

Katarapko and Pike Floodplain Ecological Restoration Projects

Extensive community consultation has occurred as part of SARFIIP, which has adopted a partnership approach in regard to project ideas, local knowledge and guidance. Local stakeholders engaged in the project include the Pike Community Reference Committee and the Katfish Reach Steering Group. The First Peoples of the River Murray and Mallee are also being engaged in SARFIIP to draw on their knowledge and protect their cultural heritage.

Project Coorong

As part of the broader Project Coorong initiative, a new Coorong Partnership has been established to provide local communities and groups with an unprecedented opportunity to help shape the work to be undertaken to restore the health, vitality and visitor experience of the Coorong.

The Coorong Partnership comprises a cross section of the community with a broad range of interests and expertise including conservation, recreation, science, agriculture, local government, tourism, fishing, heritage and First Nations culture.

This Coorong Partnership will have a key role in providing ideas and community insights into the development, implementation and performance of the various Project Coorong initiatives.

7. Priorities for Future Work

- Finalise and present reporting for Pike and Katarapko floodplain salinity register modelling to BSMAP and include accountable actions on the salinity register.
- Support the MDBA in the trial of responsive management to inform the BSM2030 strategy review in 2026.
- Continue working with the MDBA and other states to finalise the new Basin Salinity Management Procedures and seek Basin Officials Committee approval.
- Work with the MDBA and Basin States to facilitate the transition to the Source hydrological model and generation of new salinity registers.
- Complete the Pike-Murtho (2022) and Woolpunda (2023) groundwater model and accountable action reviews in accordance with the BSM2030 approved review plan.
- Develop tools and methods to estimate short-term changes in salinity in the River Murray resulting from multiple environmental watering actions and support annual planning and operational decision-making.