BASIN SALINITY MANAGEMENT STRATEGY-SOUTH AUSTRALIA'S ANNUAL REPORT 2012-13

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- SA Water;
- Science, Monitoring and Knowledge Branch;
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Summary

This report documents South Australia's accountability and delivery against the Murray-Darling Basin Authority (MDBA) Basin Salinity Management Strategy (BSMS), and Schedule B of the Murray-Darling Basin Agreement (Schedule 1 of the *Water Act 2007* (Cth)).

Management of River Murray salinity remains a key priority for South Australia. This is due to the State's location on the lower reach of the River Murray, the natural geological structure of the Murray-Darling Basin (MDB) in which the River Murray acts as a drain for salt out of the landscape, and the influence of human development in mobilising salt to the river. Ultimately, elevated salinity has adverse effects on water quality for all users, including critical human water needs, agriculture and environmental assets.

The implementation of the BSMS and its predecessor the Salinity and Drainage Strategy have been successful in driving the coordinated management of salinity across the MDB since 1989. The adoption of the Basin Plan in November 2012 builds on the successes of the MDB salinity strategies including through the introduction of targets for managing water flows and a salt export objective.

The ongoing successful management of salinity will require the continued development and implementation of programs under Schedule B of the Murray-Darling Basin Agreement and the Basin Plan. Failure to protect and build upon the achievements of the current and previous salinity strategies could put the environment, irrigated agriculture and critical human water supplies at risk.

The current MDB reforms, implementation of the Basin Plan and the increasing availability and application of environmental water will potentially have a positive effect on salinity across the MDB. These changes also have the potential to adversely impact real time salinity levels should the risks not be appropriately managed. Further work including modelling and technical assessment is required to fully understand the implications of the Basin Plan on MDB salinity management.

Key salinity management issues for South Australia include implementing the salinity and water quality provisions contained in the Basin Plan, managing and accounting for the potential salinity impacts of environmental water use, providing strategic advice into the 'General Review' of salinity, review of Schedule B and the review of the BSMS.

To support the review of the BSMS South Australia recommends a salinity audit similar to that completed in 1999 and as recommended by the IAG auditors over the last three years is undertaken to provide an agreed future salinity projection. The provision of a robust and defensible document will ensure that future salinity management is based on sound reasoning that can be easily explained to both decision makers and the public.

Key Achievements

Key South Australian salinity management activities and achievements in 2012-13 include:

- Delivery of State obligations under Schedule B, including annual report, update of BSMS Salinity Registers entries and participation in the annual independent audit. The State balance remains in positive credit as at November 2012.
- Analysis and provision of advice on the water quality and salinity management plan chapter of the Basin Plan, in particular work to support the inclusion of salinity operational targets to aid in flow management decisions, and a salt export objective to aid in adequate flushing of salt to sea.

- Groundwater modelling to support annual update of entries on the BSMS Salinity Registers, including peer review of a number of South Australia's models, enabling accreditation of the models and update of the BSMS Salinity Registers.
- Securing funding to implement the South Australian Riverland Floodplains Integrated Infrastructure Program which will include new salt interception schemes infrastructure for Pike and Katarapko floodplains.
- Continued progress on the construction of the Murtho Salt Interception Scheme (SIS) (due for commissioning in the third quarter of 2013).
- Completion of the salinity assessment of operation of the Chowilla environmental regulator, to inform the development of the regulator's operating plan.
- Development of the 2013-14 South Australian River Murray Operating Plan.
- Attracting investment into the South Australian Murray-Darling Basin region on behalf of irrigators to improve irrigation efficiency.
- Development of salinity policy provisions for inclusion in the amended Water Allocation Plan for the River Murray Prescribed Watercourse.

Future Work

In 2013-14, effort will be directed towards:

- Providing strategic policy advice and input to the 'General Review' of salinity as initiated by the Basin Officials Committee.
- Working with the MDBA to explore options for integration of the Basin Plan and Schedule B and extending the BSMS beyond the current 2015 expiry date.
- Implementing the Water Quality and Salinity Management Plan contained within the Basin Plan.
- Working with river operators and the environmental watering program to ensure that operational plans for environmental regulators are cognisant of salinity impacts and contain appropriate options for operational responses.
- Delivering Schedule B reporting requirements (BSMS Annual Report, updates to Salinity Registers entries and Audit) and providing significant input to the mandated review of Schedule B and BSMS.
- Working with the MDBA to develop the accounting framework for BSMS salinity registers assessment of environmental watering actions.
- Commencing the 5-year review of the Pike-Murtho numerical groundwater model to support further updates to BSMS Salinity Registers entries.

1. INTRODUCTION

South Australia is committed to delivering salinity management obligations under the Murray-Darling Basin Authority (MDBA) Basin Salinity Management Strategy (BSMS), and Schedule B of the Murray-Darling Basin Agreement (Schedule 1 of the *Water Act, 2007* (Cth)). South Australia also recognises the importance of salinity management through key State level strategies and plans, including:

- Water for Good (Action 56): Maintain a positive balance on the MDBA's Salinity Register, and continue to implement strategies and actions to ensure the real time management of salinity in the lower reaches of the River Murray so that water quality remains at levels suitable for human consumption;
- South Australia's Strategic Plan (SASP) Target (T.77): River Murray Salinity – South Australia maintains a positive balance on the MDBA's Salinity Register;
- 'Our Place Our Future' State Natural Resources Management Plan, South Australia 2012-2017, guiding Target 6- maintain the productive capacity of our natural resources;
- South Australian River Murray Salinity Strategy 2001-2015;
- Objectives in the River Murray Act 2003; and
- South Australian Murray-Darling Basin Natural Resources Management Plan.

Salinity management in South Australia will require continued effort to manage the long term risk of increased salt loads to the River Murray into the future, partly due to past actions (the legacy of history) and continued irrigation development, but also to manage the short term risk from increased mobilisation of salt that may result from environmental watering.

The adoption of the Murray-Darling Basin Plan on 22 November 2012 now guides the management of water across the Murray-Darling Basin in South Australia, New South Wales, Victoria, Queensland and the Australian Capital Territory. Ensuring actions that may cause adverse impacts on water quality and salinity in South Australia are appropriately managed and, wherever possible, avoided will be part of the implementation of the Basin Plan as well as maintaining the existing obligations for long term salinity management under Schedule B of the Murray-Darling Basin Agreement.

Scientists from the SA Government analysed the 3200 GL scenario modelling prepared by the MDBA and compared outcomes for key environmental and water quality indicators against the draft Basin Plan scenario of 2750 GL. The analysis focused on the South Australian River Murray floodplain (including the Riverland-Chowilla Floodplain Ramsar site) and the Coorong, Lower Lakes and Murray Mouth Ramsar site.

Analysis of the MDBA modelling indicated that recovering 3200 GL of water and relaxing key constraints resulted in considerable environmental benefits for the River Murray compared to the draft Basin Plan 2750 GL scenario, not only in South Australia but also in Victoria and New South Wales. The modelling indicated that recovering more water together with relaxing of key constraints provides the greatest opportunity to improve the health of floodplain environments along the length of the River Murray in South Australia and upstream.

In addition the return of 3200 GL of water to the environment provided improved ecological benefits for the Coorong, Lower Lakes and Murray Mouth. Management of water levels, salinity, Murray Mouth openness and barrage releases were all improved compared to the draft Basin Plan 2750 GL scenario.

Importantly the science analysis indicated that how and when water is delivered to the Coorong, Lower Lakes and Murray Mouth affected environmental outcomes and the management of salinity.

The Department of Environment, Water and Natural Resources (DEWNR) continues to work across programs internally and collaborate with key external stakeholders including the MDBA to maximise the effectiveness of salinity management within the Murray-Darling Basin (MDB).

Context for 2012-13

Higher flows in the River Murray were the dominant factor affecting salinity and salt loads in South Australia during 2012-13. High flows persisted during the mid to latter half of 2012, with 50,000 ML/day recorded in September. Flows then receded to under 20,000 ML/day by the end of October 2012 and returned to entitlement flow in February.

Salinities at the South Australian border remained below 500 EC for the report period, but all downstream stations showed gradually increasing salinities during the latter half of the report period following the return to entitlement flow. The maximum recorded salinity at Morgan was 535 EC with both Murray Bridge and Berri maximums reaching 550 EC. Of particular interest is the significant salinity peak following the high flow decline at both Morgan and Murray Bridge (see Figure 1 for key localities), which is most likely due to the draining of backwaters and anabranches following the decline in river levels.

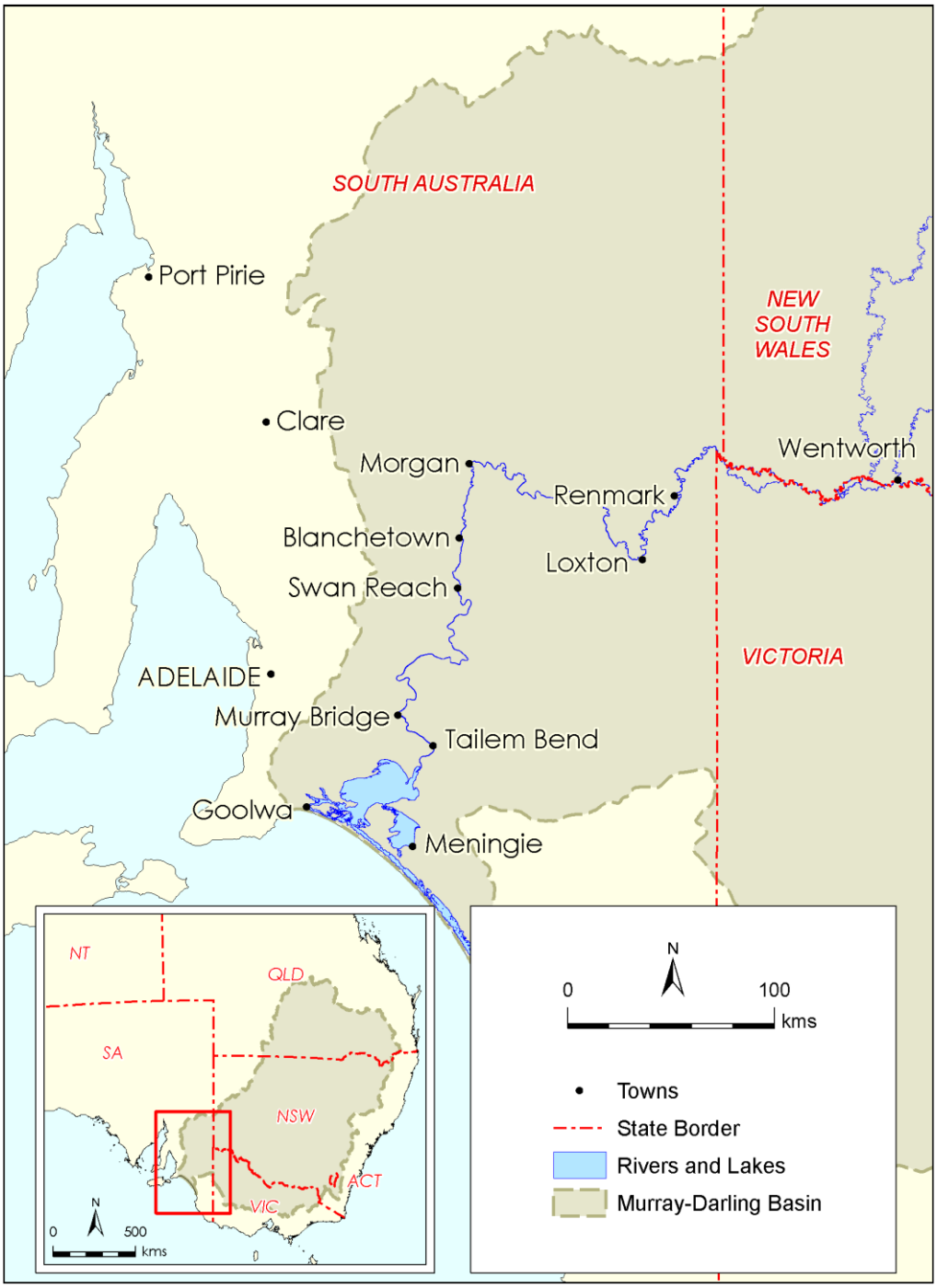

Figure 1 South Australian Murray-Darling Basin

2. NINE ELEMENTS OF THE BASIN SALINITY MANAGEMENT STRATEGY

The following sections highlight actions taken within South Australia in 2012-13 to implement each of the nine elements of the BSMS:

1. ***Developing capacity to implement the Strategy***
2. ***Identifying values and assets at risk***
3. ***Setting salinity targets***
4. ***Managing trade-offs with the available within-valley options***
5. ***Implementing salinity and catchment management plans***
6. ***Redesigning farming systems***
7. ***Targeting reforestation and vegetation management***
8. ***Constructing salt interception works***
9. ***Ensuring Basin-wide accountability: monitoring, evaluating and reporting***

2.1 Developing Capacity to Implement the Strategy

The Commission and partner Governments will administer a comprehensive 'knowledge generation' program to support Basin and within valley planning and implementation.

The partner Governments will assist catchment communities to implement national, Basin and State initiatives by improving access to and use of the knowledge and decision tools generated by investigations and salinity research and development. This process will be supported by further capacity building for catchment planning, including communication and education. *(BSMS 2001–2015)*

Various initiatives are undertaken in South Australia to develop and maintain capacity to implement the BSMS. Developing capacity occurs at different levels including within local communities and groups focused towards on ground actions and within South Australian government agencies.

Groundwater Modelling for Salinity Registers 2012-13

To meet obligations under the BSMS, DEWNR maintains and updates a suite of accredited MODFLOW groundwater models to bring entries forward to the BSMS Salinity Registers. Through the groundwater modelling process, scenarios are established to assist in the determining the origin and volume of salt entering the River Murray from groundwater sources.

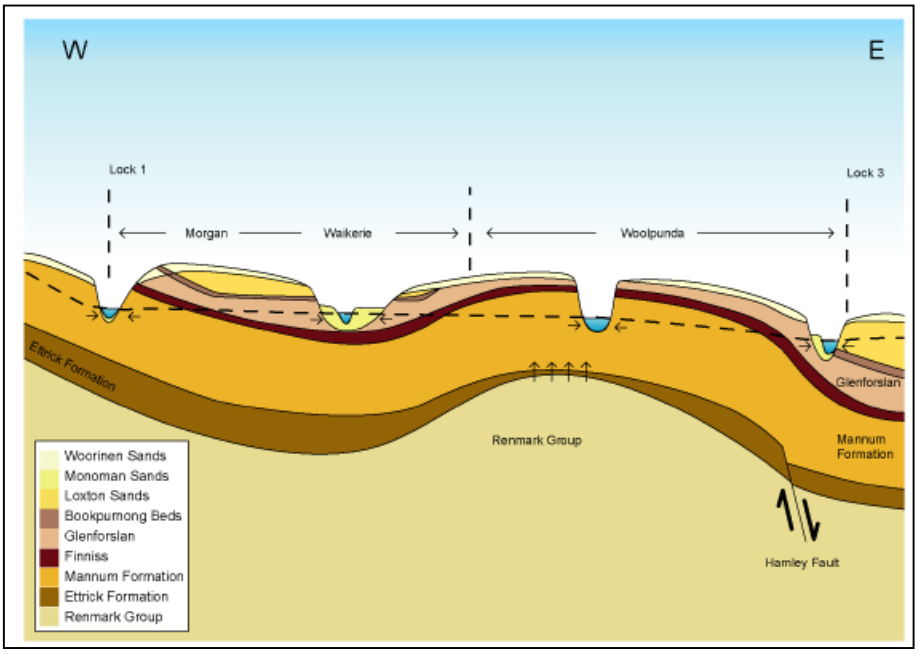

Figure 2 - Lock 3 to Morgan hydrogeological conceptual model (Yan et al 2012)Automatic Weather Monitoring Network

During 2012-13, DEWNR developed a MODFLOW numerical groundwater flow model of the Woolpunda reach. It replaces the previous accredited model (Lock 3 to Morgan (Rural Solutions 2005) and

incorporates the latest hydrogeological information and understanding. The updated Lock 3 to Morgan model spans two distinct hydrogeological regimes with different key aquifers (Figure 2) and salt load mobilisation drivers, so the decision was made to replace it with two separate models, each simulating a different hydrogeological regime: the Waikerie to Morgan model (Yan et al 2012) and the Woolpunda model, as described in this section.

The Woolpunda 2013 model is a significant improvement on the previous model as it is based on improvements in hydrogeological understanding and more detailed datasets (particularly irrigation and SIS operation data), and has been calibrated to more observations. The model improvement is demonstrated by a much closer match of modelled salt load to in-stream salt load estimates (i.e. Run of River) and better calibration performance statistics, compared to the previous model.

Review of SIMRAT Hydrogeological data

The Salinity Impact Rapid Assessment Tool (SIMRAT) is a spatial modelling tool which has informed the development of the River Murray Salinity Zoning Policy. The policy is designed to maximise the potential for further irrigation development along the River Murray by encouraging new development into the low salinity impact zone, in accordance with the Water Allocation Plan for the River Murray Prescribed Water Course.

Improved information and data has become available from monitoring, hydrogeological investigations, and construction of salt interception schemes since the development of the model in 2003. In 2012-13 DEWNR completed a preliminary review of the hydrogeological data in the SIMRAT model. The key input data layers reviewed were:

- depth to regional groundwater;
- aquifer diffusivity; and
- groundwater salinity at the point of discharge.

While key hydrogeological data layers were reviewed as part of the project it was identified that further work is required to review SIMRAT model conceptualisation, governing equations and assumptions to improve confidence in the model. This work should be undertaken as part of the scheduled MDBA review of the SIMRAT model in 2014.

Automatic Weather Monitoring Network

The South Australian Murray-Darling Basin Natural Resources Management Board (SA MDB NRM Board) continued to manage and maintain the regional automatic weather monitoring network during 2012-13. During this period, the dedicated website received over 17,500 visits demonstrating the resource is extensively utilised to inform on-farm decision making.

The automatic weather monitoring network provides irrigators with local real time weather information that assists in making irrigation decisions based on crop water requirements. Through improved decision making it is possible for irrigators to better manage irrigation events and reduce the likelihood of deep drainage events, which in turn has the potential to reduce salt loads to the river.

During 2012-13 the Board has looked into opportunities to value add to the network through the provision of alerts to irrigators to better inform on-farm decision making. The Board is also looking into the potential of providing an evapotranspiration forecast service for irrigators to encourage an adaptive approach to irrigation management.

2.2 Identifying Values and Assets at Risk

The partner Governments will work with catchment communities to identify important values and assets throughout the Basin at risk of salinity, and the nature and timeframe of risk. This Strategy emphasises the triple-bottom-line approach, requiring a balance between economic, environmental and social values. It necessarily recognizes that living with salinity is the only choice in some situations.

(BSMS 2001–2015)

South Australia recognises that management of environmental watering at a Basin scale requires a coordinated whole-of-Basin approach. This is to take into account the need to meet environmental water requirements for system assets and remove salt from floodplains while maintaining river salinity within acceptable salinity levels for all water users, including other downstream assets such as the Coorong and Lower Lakes. In assessing which sites to water, the potential scale of the cumulative salinity impacts, in-stream flow and salinity conditions and availability of water for dilution need to be considered.

Murray-Darling Basin Plan -South Australian Implementation Strategy

The Murray-Darling Basin Plan: South Australian Implementation Strategy 2013 – 2019 will guide the State's implementation of the Basin Plan and related programs. It outlines the key actions that will be pursued during the six-year transition period to ensure the plan is fully integrated into South Australia's ongoing water management arrangements.

A key outcome for Murray-Darling Basin environments and communities, under the implementation strategy is to ensure 'Secure, reliable and good quality water supplies that support healthy and productive industries, communities and ecosystems'.

The implementation of actions under the plan will ensure that existing obligations for long term salinity management under Schedule B of the Murray-Darling Basin Agreement and the BSMS are integrated with water quality and salinity management under the Basin Plan.

Chowilla Icon Site

The Chowilla floodplain is one of the six icon sites under The Living Murray program for which broad-scale environmental watering will be undertaken, once works on the Chowilla environmental regulator are completed.

The Chowilla floodplain is underlain by a shallow highly saline aquifer and is well documented as a source of saline groundwater discharge into the River Murray. It is recognised that managed inundation of the floodplain via operation of the Chowilla environmental regulator will reduce soil salinity, thereby improving vegetation health and providing environmental benefit to the Chowilla region. However, it is understood that the inundation also results in increased discharge of salt into the Chowilla Creek and ultimately to the River Murray.

In December 2009, the MDBA approved construction of the Chowilla environmental regulator. The approval advice from the MDBA requested further work to assess the potential short term (real time) and

long term salinity impacts of regulator operation to inform development of an appropriate regulator operating strategy, prior to operational approvals being granted.

An assessment of the real time salinity impacts of regulator operation was undertaken, including consideration of salt from both groundwater and surface water sources (SKM, 2011). Subsequently work has been completed (Aquaterra, 2012) to upgrade the Chowilla groundwater model (including peer review) in preparation for accreditation in line with procedures set out in the BSMS Operational Protocols. Data from the groundwater model will support the generation of a future BSMS Salinity Register entry for Chowilla.

During 2012-13 the upgraded Chowilla groundwater model and salt and water balance model was used to assess event specific salinity responses to a range of Chowilla environmental regulator operating scenarios (Li, et al, 2012). This work determined potential real-time salinity impacts associated with Chowilla regulator operation scenarios where duration of operation, regulator height and rate of regulator recession were varied. The results will be used to inform potential salinity impact mitigation measures.

Work has continued in 2012-13 on the development of an operating strategy for the Chowilla environmental regulator informed by the real time salinity assessment and groundwater model outputs Possible salinity impact mitigation actions include use of dilution flows, and a stepped draw down of regulator height to control release of saline return flows to river. The operating strategy is expected to be completed in the second half of 2013 and will be further refined before regulator operation commences, estimated to be in 2014.

Pike and Katfish Reach Floodplains Salinity Risk Assessment

In 2012-13 an investigation to estimate the potential salinity impacts of broad-scale inundation/ environmental watering at the Pike and Katarapko-Eckert's Creek (Katfish Reach) floodplains using a risk-profiling approach was completed. The investigation also assessed operational responses, such as dilution flow that may be required to manage the potential salinity impacts of operating proposed environmental watering infrastructure.

A detailed modelling approach was not possible due to insufficient available data, thus the investigation undertook a historical analysis using the available data under the direction of an Expert Panel. The Expert Panel brought together regional, scientific and policy expertise from within DEWNR and the MDBA.

The investigation found that the salinity impact risk profile associated with the operation of the proposed new environmental water regulators was within a manageable range. Most of the operational scenarios build onto natural flow events or have smaller areas of inundation which deliver minimal salinity impacts.

This work has formed the basis for the development of the South Australian Riverland Floodplains Integrated Infrastructure Program (SARFIIP) which includes environmental water regulators and new salinity management infrastructure. Detailed hydrological and hydraulic investigations and predictive modelling will be undertaken during SARFIIP.

South Australian Riverland Floodplains Integrated Infrastructure Program

The $155 million SARFIIP was announced on 26 November 2012 and will be implemented over the next 7 years. The program aims to improve the ecological health and resilience of priority floodplains by completing hydrological management, improving long term and real time salinity management, and enhancing the connection of the floodplain between Lock 3 and the South Australia-Victoria border.

Building on previous and current infrastructure programs in the Riverland region, the program specifically includes investing in:

- Environmental regulating infrastructure in the Pike and Katarapko-Eckert's Creek (Katfish Reach) floodplains to enable up to 1,400 and 1,000 hectares (respectively) of floodplain inundation at low flows into South Australia.
- Completion of the Pike Salt Interception Scheme (SIS) to intercept a total of 167 tonnes of salt per day.
- Extension of the Woolpunda SIS to intercept an additional 17 tonnes of salt per day.
- Wetland management investigations and designs to better link the floodplain between the Banrock Station and Chowilla Ramsar sites.

Murray Futures Coorong, Lower Lakes and Murray Mouth Recovery Project

The Department of Environment, Water and Natural Resources (DEWNR) Coorong Lower Lakes and Murray Mouth (CLLMM) Recovery project has undertaken significant modelling work since 2008. In 2012-13 year this work focused on forecasting future conditions to inform salinity and water quality management of this critical site.

Inter-annual variations in local meteorological conditions impact on determining salinity in the Coorong

As part of the CLLMM recovery project, CSIRO utilised their hydrodynamic computer model to forecast salinities in the Coorong (Webster, 2012). A detailed description of the model has been prepared by Webster (2006). The aim of the study was to better understand the potential need for implementation of actions over the next one to three years, to support the 'recovery' of the South Lagoon's ecological character from the effects of over-allocation and the 'Millennium' drought.

It is recognised that water levels and salinities in the Coorong vary significantly from year to year in response to inter-annual variations of inflows from the Murray-Darling Basin. To assess the impact of future barrage flows on water level and salinity in the Coorong, consideration was given to the variability in response that would arise from uncertainty in predicting weather and sea conditions in the future. The study applied a range of historical meteorological conditions and sea level variations, to a series of prescribed barrage flows and flows from the Upper Southeast Drainage area.

The study performed multiple simulations using variations of water levels and salinities over time between 1982 and 2012. Data included in these simulations included wind stresses, sea levels, evaporation rates, precipitation rates and the measured flow and salinities for the Upper South East Drainage (USED).

The median outcome of the simulations was then used to examine the potential for a given flow scenario to result in salinities exceeding thresholds of concern. Exceeding such a threshold in reality would require the implementation of management actions to mitigate the effect. These mitigation actions could include the provision of environmental flow or pumping of hypersaline water from the South Lagoon to the Southern Ocean.

Figure 3 shows the range of lagoon-averaged salinity in the South Lagoon of the Coorong from the simulations. The simulations indicate that salinity in the South Lagoon varied by up to about 10 g/L greater than or less than the median. The standard deviation of salinity about the median was approximately half of these ranges providing an estimate of the level of variation in the simulated

salinities that could be expected due to meteorological and sea level inter-annual variability (Webster, 2012). This result can be compared to the baseline case which utilised a single sequence of local conditions, demonstrating the idiosyncrasy that a single time series of local conditions can have and the potential implications this can have when seeking to determine the outcomes from the provision of specified barrage outflow.

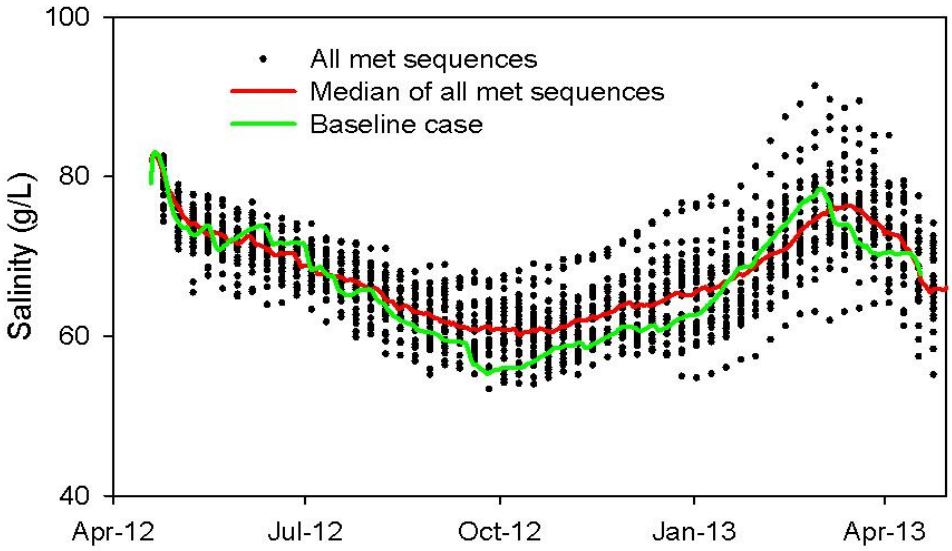

Figure 3 Impact of inter-annual meteorological and sea level variations on average salinities in the South Lagoon (Also shown is the median salinity and the salinity for the base case (Courtesy Ian Webster, CSIRO))

The outcomes of this study demonstrates that when forecasting the effect of flow provision on salinity and water level outcomes in the Coorong, consideration should be given to the full range of inter-annual variations in sea level and local meteorological conditions that maybe experienced. Modelling to assess the implications of actions such as options for the provision of environmental water or adjustments of the Sustainable Diversion Limit should seek to incorporate this approach to understand the risk of exceeding thresholds that would significantly damage the ecological character of the site.

2.3 Setting Salinity Targets

The Ministerial Council will adopt end-of-valley targets to protect values and assets while providing for targets to be revised, as new information becomes available. The partner Governments will empower catchment management organisations to advise on end-of valley targets and determine within-valley targets and monitoring arrangements, under salinity and catchment management plans.

(BSMS 2001–2015)

In 2012-13 DEWNR contributed to the Review of End of Valley Targets conducted by the MDBA as required under clause 9 of Schedule B of the Murray-Darling Basin Agreement. The scope of the project was to 'review the adequacy and appropriateness of each end-of-valley target'.

Review of End of Valley Targets

In 2012-13 the MDBA managed a project to review and amend the end of valley targets as part of the five year review required under clause 9 of Schedule B of the Murray-Darling Basin Agreement. DEWNR contributed to the project through workshops and the provision of advice.

The End of Valley and Basin targets are integral to the BSMS and have driven both accountability and on-ground action for more than 10 years. South Australia has continued to reinforce the value of the End of Valley targets throughout the review process and promote their continued inclusion in both Schedule B and any successor to the BSMS.

Given the reduced future salinity threat from dryland catchments it will be necessary to review and in some cases revise the End of Valley targets. When revising End of Valley targets it is important that the principles of no deterioration and effort commensurate with risk are considered in addition to the effect that any change may have on the Basin Salinity Target at Morgan.

The inclusion of the End of Valley targets in the Basin Plan has provided an additional mechanism to ensure that the targets are considered when undertaking long term salinity planning and management functions. To further assist in the implementation of the End of Valley targets South Australia recognises that there is a need to consider future integration of Schedule B of the Murray-Darling Basin Agreement and Water Quality and Salinity Management Plan requirements.

To support the future review of the BSMS, Schedule B and End of Valley targets South Australia recommends that a salinity audit similar to that completed in 1999 be completed to provide an agreed future salinity projection. The provision of a robust and defensible document will ensure that future salinity management is based on sound reasoning that can be easily explained to both decision makers and the public.

2.4 Managing Trade-offs with the Available Within-Valley Options

The States will analyse and review the best mix of land management, engineering, river flow, and living with salt options to achieve salinity targets while meeting other catchment health targets and social and economic needs. The States will assist communities to understand and agree the options with affected groups, industries and people through best practice planning processes.

(BSMS 2001-2015)

The Government of South Australia is working with local communities, scientists, technical experts and engineers to address tradeoffs and develop long-term sustainable solutions through the development of environmental watering plans and annual operating strategies.

Environmental watering 2012-13

Broad scale environmental watering measures are extremely beneficial to the health of floodplains and wetlands. They also have the potential to mobilise significant volumes of salt to the river, which may result in accountable actions under Schedule B to the Murray-Darling Basin Agreement.

Both the annual environmental watering priorities and long term environmental watering plans under the Basin Plan must identify salinity risks associated with delivery of environmental water and ensure that due regard is given to the requirement to not exceed salinity targets specified in the Water Quality and Salinity Management Plan (Chapter 9 of the Basin Plan).

The 2013-14 Annual Environmental Watering Plan for the River Murray was developed during 2012-13 to document the South Australian program for environmental water delivery for the 2013-14 water year. It identifies the annual environmental watering priorities as required by the Basin Plan and aims to ensure that the best environmental outcomes are achieved for the South Australian stretch of the river and its floodplains. DEWNR is also working on the development of long term watering plans, which will be required in November 2015 (within 12 months of the MDBA publishing the Basin-Wide Environmental Watering Strategy, expected in November 2014).

Environmental water bids for 2012-13 were developed and submitted to the MDBA, The Living Murray Program (TLM) and the Commonwealth Environmental Water Holder (CEWH). Securing water for barrage releases was the highest priority watering action. This resulted in good flows over the barrages, lowered salinity levels in the lakes, improved fish passage and contributed to keeping the Murray Mouth open.

The local real-time (short term) salinity impacts associated with environmental watering are likely to be particularly significant and will warrant decision-making before and during the course of managed events to ensure salinities do not exceed agreed salinity targets. Real time impacts need to be given serious consideration, particularly where multiple sites along the River Murray are being watered concurrently.

South Australia will be undertaking further work in 2013-14 and beyond to ensure integration between its environmental water planning, water quality and salinity management planning, and river operations planning processes. South Australia has been active in engaging the MDBA to consider how to manage

real time, downstream and cumulative salinity and water quality impacts from single and multiple environmental watering events.

While preliminary salinity scenario modelling of the use of environmental water has been undertaken by the MDBA, more work is required to determine the cumulative salinity impacts of multiple environmental waterings in the short and longer term. The recently adopted TLM framework for salinity spike management could form the basis of addressing real time salinity management more broadly under the Basin Plan.

SA River Murray Annual Operating Plan 2012-13

South Australia's River Murray Annual Operating Plan is the key document that guides transparent and coordinated River Murray operational decisions. The 2012-13 plan sought 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 practically possible;
- outline preferred environmental watering priorities and urban and irrigation water delivery requirements under a range of inflow and water availability scenarios. This takes into account environmental watering actions, consumptive water delivery, river health, salinity, water quality and river management targets;
- provide for operational arrangements to underpin the security of supply for all consumptive uses;
- ensure that the requirements are fulfilled under the Murray-Darling Basin Agreement 2008 (Cwlth), MDBA's River Murray System Annual Operating Plan 2012-13 and Objectives and Outcomes Document for River Operations for 2012-13; and
- provide a documented and transparent rationale for South Australian River Murray operational decisions made in 2012-13.

The objectives and targets in the plan, which relate to the BSMS and how they were delivered in 2012-13, are identified below.

Water quality and salinity to remain within defined targets (including proposed Basin Plan targets)

At the key locations identified in the SA River Murray Annual Operating Plan 2012-13, the salinity was maintained below the targets for 100% of the time in 2012-13 (Table 1). Water quality targets were also measured and reported on.

Table 1 Salinity operating targets

Location	Target (EC)	2012-13 Max (EC)	2012-13 Average (EC)
Lock 6	< 580	440	280
Morgan	< 800	500	360
Murray Bridge	< 830	500	370
Milang	< 1 000	650	460

Maintain Lake Alexandrina salinity levels below 1,000 EC from July 2012 to June 2013

In 2012-13, the salinity level in Lake Alexandrina was maintained below 1,000 EC except in mid August to mid September 2012, where there were two tidal salinity spikes (due to reverse head conditions through the barrages) which temporarily raised salinity levels.

Reduce salinity levels in Lake Albert to an average of 2,000 EC by the end of June 2013

The salinity level in Lake Albert was reduced by approximately 1,000 EC in 2012-13 but did not meet the target of 2,000 EC. The salinity level on 1 July 2012 was approximately 4,000 EC, which reduced to approximately 3,050 EC on 30 June 2013. The minimum salinity level in 2012-13 was 2,900 EC in December 2012. The target of 2,000 EC was not achieved due to the high salinity level at the start of the year and the volume of water available for mitigation actions. The site is still recovering from the extreme events of the Millennium Drought.

Maintain Coorong South Lagoon salinity levels below 100 ppt from July 2012 to June 2013

The salinity level in the Coorong South Lagoon was maintained below 100 ppt throughout 2012-13. The maximum salinity level was 94.15 ppt on 29 March 2013. Salinity levels below 100 ppt in the South Lagoon are required to support key biota, such as fish, invertebrates and the keystone plant species Ruppia tuberosa. In 2012-13, condition monitoring identified a gradual recovery for most species in the Coorong.

2.5 Implementing Salinity and Catchment Management Plans

This Strategy acknowledges gains made by existing plans, but requires that actions in existing and new plans, or the plans themselves, will need to be assessed and reported against the end of-valley and Basin targets and recorded on Salinity Registers.

The partner Governments will continue and enhance support for land and water management plans (LWMPs) in irrigation regions.

The partner Governments will enhance support for development and implementation of ICM Policy-compliant salinity and catchment management plans in dryland regions.

(BSMS, 2001-2015)

The significance of River Murray salinity as an issue for South Australia is reflected in it being recognised through key State level and regional strategies and plans. The aim is to facilitate management action within South Australia that contributes to improved salinity outcomes locally and thus assists in meeting BSMS objectives.

South Australian River Murray Salinity Strategy

The fifteen-year vision of the South Australian River Murray Salinity Strategy (2001-15) is to maintain salinity in the River Murray in South Australia at current levels (i.e. when the Strategy commenced). The strategy is now drawing to a close and a review will need to be undertaken once the future of the BSMS and salinity management across the MDB is clearer. South Australia will continue working with the MDBA in the interim to explore options for integration of the Basin Plan and Schedule B and extending the BSMS beyond the current 2015 expiry date.

South Australian State Natural Resources Management (NRM) Plan

The blueprint for managing South Australia's natural resources 'Our Place Our Future': State Natural Resources Management Plan, South Australia 2012 – 2017, was released by the then Minister for Sustainability, Environment and Conservation, Paul Caica on 5 June 2012.

Management of salinity and water quality is recognised under guiding target 6 - 'maintain the productive capacity of our natural resources'. A key measure for this target is trends in water quality including salinity in the River Murray.

Water for Good- A plan to ensure our water future to 2050

The relevant Water for Good action (Action 56) is to 'Maintain a positive balance on the MDBA's Salinity Register, and continue to implement strategies and actions to ensure the real time management of salinity in the lower reaches of the River Murray so that water quality remains at levels suitable for human consumption'.

The desired outcome is that the entire length of the River Murray is a healthy, working waterway that continues to provide critical human water needs for Adelaide and regional South Australia, irrigation

requirements and water for the environment. Key performance indicators include measurement of salinity and water quality levels in the Lower Murray.

South Australia's Strategic Plan

An updated South Australian Strategic Plan (SASP) was released in September 2011. The plan reflects the input of thousands of South Australians and responds to what the community viewed as most important for our future.

Management of salinity in the MDB continues to be recognised in SASP with a specific salinity target: River Murray Salinity – South Australia maintains a positive balance on the MDBA's Salinity Register (T.77, formerly T3.11).

DEWNR reports annually against the River Murray salinity target contained in SASP. The graph in Figure 4 provides a projection of South Australia's future salinity credit balance over time. The graph assists in informing future policy directions and guides further investment and management actions to maintain South Australia's credit balance.

Fact sheets relating to SASP targets can be downloaded at: http://saplan.org.au/targets/77-river-murray-salinity

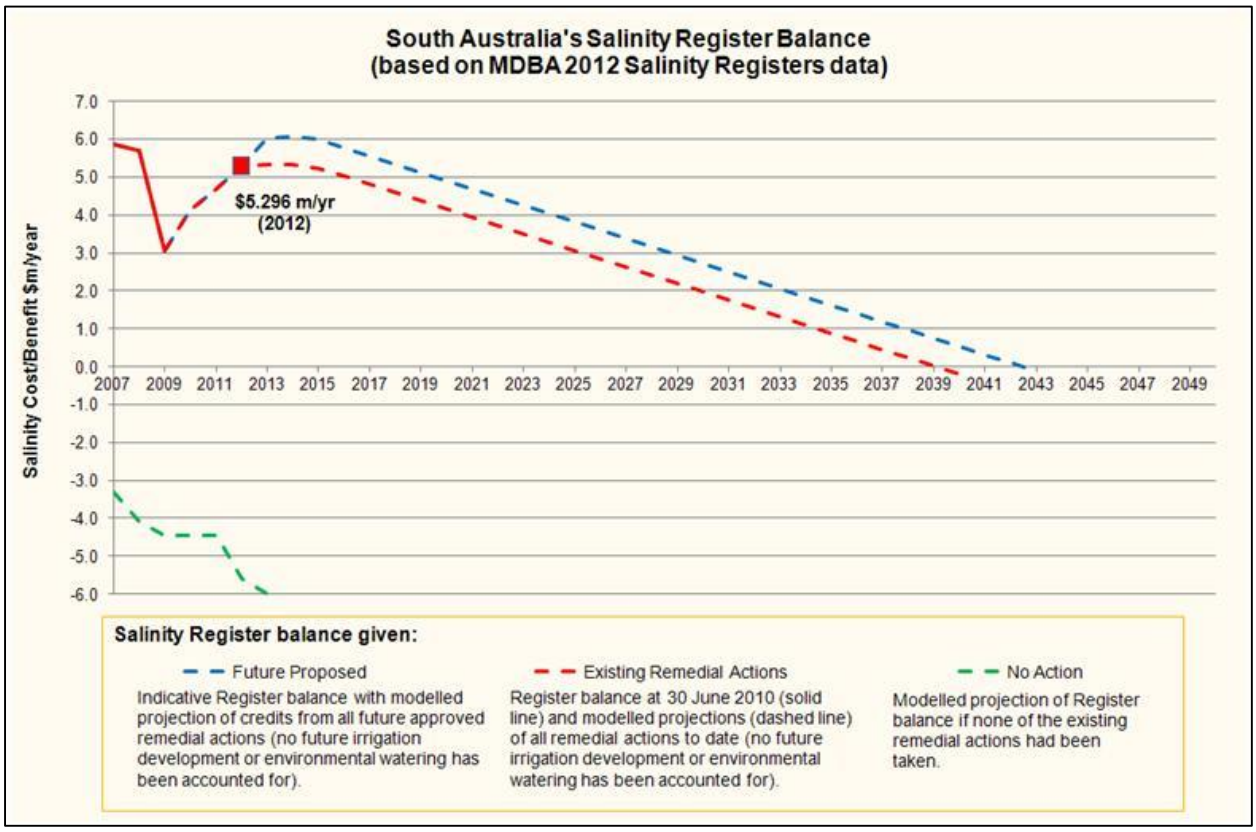

Figure 4 Graph of South Australia's salinity register balance based on the 2012 Salinity Register

River Murray Act

The *River Murray Act 2003* provides for the protection and enhancement of the River Murray and related areas and ecosystems. The *River Murray Act 2003* has two specific objectives which relate to the management of salinity in the river, these are:

- water quality within the River Murray system should be improved to a level that sustains the ecological processes, environmental values and productive capacity of the system; and
- the impact of salinity on the ecological processes and productive capacity of the River Murray system is to be minimised.

Water Allocation Plan for the River Murray Prescribed Watercourse

The SA MDB NRM Board, in accordance with the *Natural Resources Management Act 2004*, (NRM Act) is responsible for developing Water Allocation Plans for the South Australian MDB region in partnership with DEWNR.

The River Murray WAP is a legal document that sets out the rules for managing the take and use of prescribed water resources. The River Murray WAP contains principles that minimise the salinity impact associated with irrigation, promote efficient irrigation and require annual irrigation reporting.

A formal amendment process for the River Murray WAP is currently underway and due for completion in 2014. As part of the amendment it is proposed to include the Salinity Zoning Policy in the WAP to provide a complete, transparent policy framework for the take and use of water within the River Murray prescribed watercourse. The WAP amendment will build on the knowledge gained through implementation of the existing salinity and water use efficiency principles.

SA MDB NRM Plan

The SA MDB NRM Plan sets out how the environment in the SA MDB region should be managed to ensure balance is achieved between our collective need for resources and the needs of our environment. It is a plan for community, business and government.

The Regional NRM Plan outlines a number of regional actions to manage salinity and includes key outcomes associated with irrigation efficiency and salinity management including:

- W1: All water resources are managed sustainably by 2018, and
- W2: Improve water quality to achieve the regionally endorsed environmental values by 2030.

A number of related management action targets are also identified including:

- W1.4: Minimise impacts of irrigation induced saline groundwater flows to water or ecosystem assets,
- W1.5: Complete a Basin wide prioritisation process for the development of land and water management plans by 2012, and
- W1.6: 90 percent of the irrigated area achieving water use efficiency (WUE) as prescribed by the relevant WAP by 2014.
- W2.1: Maintain South Australia's position on MDBA Salinity Register in balance by 2014.

Between June and August 2012 the SA MDB NRM Board initiated an evaluation to address the question "what progress are we making against the MATs?" Individuals with relevant knowledge were brought together at a series of workshops to review a range of evidence and make an assessment of target progress. The expert panels included SA MDB NRM Board members, staff of Natural Resources SA MDB, NRM Groups, Local Government, State Agencies and a number of non-government bodies such as Local Action Planning Groups.

The evaluation shows that regional achievement against the MAT's is tracking well. In 2012, 60% of all MAT's were either on track, ahead of schedule or achieved compared to 52% in 2010. Three out of four salinity targets were on track with limited progress on achieving 90% of irrigated areas achieving WUE due in part to lack of data.

2.6 Redesigning Farming Systems

The partner Governments will coordinate and enhance research and development into new farming and forestry systems that deliver improved control of groundwater recharge in the high rainfall grazing, winter rainfall cropping, and summer rainfall cropping zones. Over and above current programs the Commission will enhance research and development into new industries based on salinised resources, such as broadacre saltland agronomy, saline aquaculture, and salt harvesting.

(BSMS, 2001-2015)

Minimising the salinity impact of irrigation actions remains of critical importance. By improving irrigation efficiency and applying the latest irrigation technology on farm the sustainability of irrigation developments is enhanced while minimising discharge of saline groundwater to the River Murray.

Water for the Future - Sustainable Rural Water Use and Infrastructure Programs

During 2012-13 the SA MDB NRM Board was successful in attracting in-principle funding approval through Round 3 of the Australian Government's On-Farm Irrigation Efficiency Program. The in-principle funding approval of $36.5m will support close to 200 individual irrigator projects and with potential to achieve total water savings in excess of 15GL. It is anticipated that implementation of the Round 3 projects will commence early in 2013-14.

The incorporation of the latest on farm technology through the program is not only providing water savings but also reducing off farm environmental impacts and improving productivity. The adoption of new irrigation systems is enabling irrigators to more closely match real time crop water requirements, which in turn is reducing deep drainage below the rootzone and minimising the discharge of saline groundwater to the River Murray.

The SA MDB NRM Board has now been successful in attracting over $57m of investment into the SA MDB region on behalf of irrigators in its capacity as a Delivery Partner. These investments will potentially deliver over 21GL of total water savings which will be shared between the environment and irrigators. The SA MDB NRM Board is also intending to submit an application for the fourth and final round of the On-Farm Irrigation Efficiency Program which opened in July 2013.

Irrigation Research and Development

In 2012-13 the SA MDB NRM Board continued its collaboration with the University of Naples (Italy) to conduct the IrriEYE trial in the Bookpurnong-Lock 4 irrigation district to assess the effectiveness of satellite based remote sensing input to inform agricultural water management.

IrriEYE provides farmers and water managers with real-time irrigation water data needs from field and irrigation unit to district and river basin scale. IrriEYE enables irrigation events to be planned using an evaluation of actual crop development from satellite observations. The use of this information has the potential to reduce water use, improve the quality of agricultural products and reduce off site salinity impacts.

An assessment of theoretical crop water use using the IrriEYE remote sensing application with actual irrigation records was undertaken during 2012-13. It is planned to produce a summary report of the IrriEYE trial based on the 2011-12 and 2012-13 data and seek specific feedback from the irrigators involved in the trial as to the suitability of the IrriEYE system to inform irrigation management practices.

On-Farm Salinity Monitoring and Management Trials

During 2012-13 the SA MDB NRM Board continued with its support of on-farm root zone salinity management trials in the Angas Bremer irrigation area in partnership with the Angas Bremer Water Management Committee, Langhorne Creek Grape and Wine and CSIRO. The project work has also investigated the possibility of utilising Smart Phone technology to transfer data directly from the field to a web platform. These opportunities will be explored during 2013-14.

The results of the trial **Error! Reference source not found.**have reinforced the importance of implementing an active monitoring program to support informed decision making and encourage adaptive management solutions. It highlights that operational conditions are dynamic in nature and therefore farm management practices need to reflect this in order to support the adoption of long term sustainable practices.

Full Stop is a wetting front detector. It is installed in the soil profile and when the wetting front passes into the FullStop it activates a flag to indicate the soil profile is 'full' so 'stop' irrigating. GDot measures soil moisture (tension) and essentially the more dots that are illuminated the wetter the soil profile.

Irrigation Case Studies

The SA MDB NRM Board continued working in partnership with community Land and Water Management Planning (LWMP) districts during 2012-13 in a number of irrigation areas across the SA MDB Region.

Following on from the 'Sustainability' Reports that were prepared for both the Bookpurnong-Lock 4 and Taylorville North LWMP regions in 2011-12, Sustainability reports were produced for the Pike River and Murtho LWMP districts.

Detailed assessments of irrigation efficiency levels were calculated as part of the reports and included updates to district irrigation footprint data. The water use efficiency outputs from the Pike River district are shown in Figure 5.

The results show that over 65% of properties surveyed were demonstrating efficiencies above the 85% water use efficiency target included in the River Murray WAP, with a whole of district average of 100%. The results suggest that as a region, drainage below the root zone which is a gauge for salinity impact to the river is limited. However, further detailed monitoring at a property scale is required to support the district results, as there is considerable variation between properties.

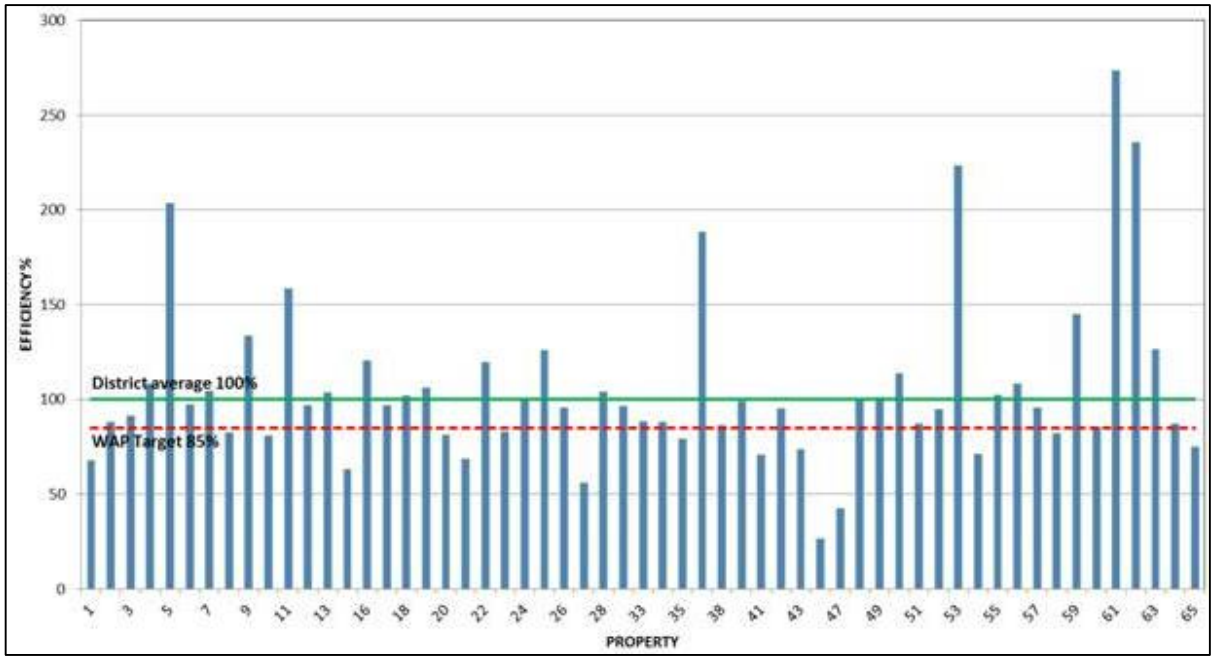

Figure 5 Water use efficiency by property – Pike River LWMP District 2011-12

2.7 Targeting Reforestation and Vegetation Management

The partner Governments recognise the necessity for landscape change specifically targeted at salinity control. In order to facilitate such targeted change, where changed farming systems are not adequate, the Commission will further develop the concept of a vegetation bank to have the capacity to finance extension of forestry outside of traditional forestry areas.

The partner Governments will further consider the financing of native vegetation management, rehabilitation and land stewardship, and the commercialisation of short rotation tree crops, particularly for the wheatbelt.

(BSMS, 2001-2015)

Reforestation and vegetation management activities are significant in promoting overall catchment health and land management. Reforestation can also provide long-term benefits in terms of stabilising groundwater movement and thus discharge of saline groundwater to the river.

River Bend Bush Bids

River Bend BushBids used a single-sealed bid reverse auction to allocate payments to managers of remnant vegetation on privately managed land. The program successfully established conservation agreements over 5,757 ha of native vegetation on private land in the northern Murray Plains, Northern Mallee and the southern Rangelands of the South Australian Murray-Darling Basin region. River Bend BushBids followed the conservation tender methodology of previous successful BushBids programs.

The project greatly exceeded initial targets, with:

- more than two and a half times the expected area contracted for conservation management,
- two and a half times the expected area of new sites assessed for ecological values, mapped and supplied with management plans, and
- more than three times the number of management plans produced than originally expected.

All River Bend BushBids funded sites will be protected and managed for a five year period under a River Bend BushBids Management Agreement. Sites representing five existing Heritage Agreements were funded for comprehensive management and a further two new Heritage Agreement applications (representing 307 ha across three sites) were initiated by River Bend BushBids. Comprehensive management plans were prepared for 7,704 ha of native vegetation on private land (target was 3,100 ha).

Native vegetation is being actively managed at 32 sites; including sites where three threatened plant communities, 29 rare/threatened fauna species and three rare/threatened flora species have been recorded. Four properties with successful bids are receiving funds to protect and actively manage 338 ha of threatened/significant plant communities.

The River Murray Forest

The River Murray Forest project is a State Government initiative, initiated in 2006, to establish local native trees and shrubs along the River Murray corridor, from the State Border to the Coorong, for biodiversity

and carbon sequestration outcomes. The project has also contributed to reduced rainfall recharge in dryland regions which is stabilising groundwater movement and reducing the discharge of saline groundwater to the river.

Nineteen sites have been contracted for direct seeding and planting, and the project is now in the final stages. Site monitoring, reporting and remedial infilling is continuing on the established sites, with better climatic conditions experienced over the past couple of years, compared with the drought conditions early in the project, resulting in improved plant survival and growth.

2.8 Constructing Salt Interception Works

The Commission will construct and operate new joint (partner Government funded) salt interception works to protect Basin-wide assets and values, including the shared water resources of the Murray and Darling Rivers. This will provide protection beyond the benefits from simply meeting end-of valley targets, based upon agreed cost sharing and benefit allocation principles. The benefits will continue to include salt disposal entitlements to offset the impacts of future actions that aggravate salinity.

(BSMS, 2001-2015)

Salt interception remains a key salinity mitigation strategy for the River Murray. Salt interception has proven invaluable in providing a reduction of saline groundwater flows to the River Murray, thereby reducing in-river salinity and protecting water quality for all water uses.

Within South Australia, all SIS, except the Qualco-Sunlands Groundwater Control Scheme, have been constructed through the Salinity and Drainage Strategy or the BSMS. In 2012-13, the program that oversees the development of new SIS in South Australia was largely completed, with the Murtho SIS expected to be commissioned in late 2013.

The established SIS continue to meet their operational targets and intercept large volumes of saline groundwater from entering the River Murray. Table 2 presents data relating to the existing SIS within South Australia.

Table 2 Operating SIS within South Australia

Scheme	Date Commissioned	Joint works vs. South Australia %		Construction Costs ($M)			Average Salinity 12-13	Volume Pumped 12-13	Salt Load intercepted 12-13
		SA	Joint Works	Total	SA	MDBA	EC	ML	(Tonnes)
Woolpunda	1990	-	100	25	-	25	31,845	4,325.5	87,979.5
Waikerie	Stage I - 1992 State IIA - 2003	-	100	15.6	-	15.6	30,230	3,100.5	55,599.2
	Waikerie Lock 2 - 2009	6	94	4.4	0.26	4.19	39,000		
Bookpurnong	2006	30	70	21.8	6.5	15.3	39,000	413.3	10,323.1
Loxton	Stage 1:2009 Stage 2: 2010	2	98	19.5	0.39	19.1	15,1743	693.5	6345.8
Pike	Stage 1: 2010	8	92	25.31	2.02	23.3	55,150	542.2	23,070.6

Woolpunda SIS

Woolpunda SIS is a highland scheme with rows of bores located 0.5-1km back from the cliffs on either side of the river between Lock 2 and Lock 3. The scheme is the largest and oldest in South Australia, consisting of 49 production bores distributed over 33km. The scheme has been continually operational for over 20 years.

The Woolpunda Salt Interception Scheme is currently recognised on the 2012 Salinity Registers as preventing approximately 200 tonnes of salt per day entering the River Murray (47.4 EC at Morgan) and is the largest individual entry on the Salinity Registers.

In 2012-13 the Woolpunda SIS continued to operate effectively with few operational problems.

Waikerie SIS

The Waikerie SIS operates between Lock 2 and the Holder settlement, east of Waikerie. The scheme was developed in stages; Waikerie Stage 1 consisting of 17 bores was commissioned in 1992, Waikerie Stage IIA consisting of 12 bores was commissioned in September 2003, and Waikerie Lock 2 consisting of seven bores was commissioned in 2009.

The Waikerie Salt Interception Schemes are currently recognised on the 2012 Salinity Registers as preventing approximately 130 tonnes of salt per day entering the River Murray (31.7 EC at Morgan).

In 2012-13, the Waikerie SIS continued to operate effectively with few operational problems.

Bookpurnong SIS

The Bookpurnong SIS is located on the eastern side of the River Murray, 8 km south of Berri and is comprised of 15 floodplain bores (typically pumping groundwater from a depth of 7m) and seven highland bores (typically pumping from a depth of 45m). The purpose of the scheme is to intercept saline groundwater from the Bookpurnong Irrigation District.

The Bookpurnong SIS was the first scheme designed to provide additional environmental benefit to the floodplain. The highland borefield has been specifically located to hold back the regional groundwater flow to allow natural flooding of the floodplain to occur.

The Bookpurnong SIS is currently recognised on the 2012 Salinity Registers as preventing approximately 70 tonnes of salt per day entering the River Murray (15.3 EC at Morgan).

Loxton SIS

The Loxton SIS is located adjacent to the Loxton township and was approved for construction by the MDBA as a joint works scheme under the BSMS in 2003. The purpose of the scheme is to intercept saline groundwater from the Loxton Irrigation District.

The scheme was constructed in two stages, a floodplain and a highland scheme. Due to the complex hydrogeology in this region a number of unique interception techniques were developed in addition to the standard type of production bores. The Loxton Floodplain SIS, which has been operational since 2009, comprises 28 production wells, and a 285m Cliff Toe Drain. The Loxton Highland SIS, comprises 21 convention production bores, five low yielding airwell production bores and a horizontal well with 250m of production zone. The scheme disposes the intercepted saline groundwater to the Noora Basin, located approximately 20km east of Loxton.

The Loxton SIS is currently recognised on the 2012 Salinity Registers as preventing approximately 50 tonnes of salt per day entering the River Murray (11.7 EC at Morgan).

Pike SIS

The Pike SIS is approximately 5 km south-west of Renmark, between Lock 5 and Berri in the Pike River Region. An approval submission for the Pike SIS was submitted to the MDBA in April 2009 for consideration. The scheme has been recognised by the MDBA as a technically sound proposal; however a decision regarding arrangements for cost sharing for construction and operation and maintenance has been deferred. In order to utilise available funding South Australia constructed a portion of the Pike SIS (four production bores), which was commissioned in 2011.

The South Australian constructed scheme prevents approximately 15 tonnes of salt per day from entering the River Murray and South Australia claims 2.9 EC credit at Morgan on the Salinity Registers.

Qualco-Sunlands Groundwater Control Scheme

The drought and severe restrictions on irrigation allocations resulted in a considerable reduction in drainage to the Qualco-Sunlands groundwater mound. Under these conditions groundwater levels have stabilised and the scheme is being operated on a care and maintenance basis with most pumps running for only two hours per day with the exception of three bores adjacent the river that provide salinity protection.

Murtho SIS

The Murtho SIS is currently under construction and is expected to be commissioned in late 2013. The scheme is conceptually designed to intercept 94.4 tonnes of salt per day with a 30 year average benefit of 20.2EC at Morgan. Following construction updated modelling will need to be undertaken which may amend the salinity benefit that is entered on the Salinity Registers.

The scheme is considered to provide considerable local environmental benefit to the wide Murtho floodplain located between the scheme and the River Murray.

2.9 Ensuring Basin-Wide Accountability: Monitoring, Evaluating and Reporting

The partner Governments will demonstrate accountability by reporting to the Commission and Council through State end-of-valley Report Cards and Commission Salinity Registers that record the salinity effects of actions, including salt interception schemes and salinity and catchment management plans. The Council will receive audits every five years for each valley and Commission Register entry, assessing impacts on river salinity and progress towards targets, with the provision to require further action as necessary.

(BSMS, 2001-2015)

South Australia undertakes a number of salinity monitoring, evaluating and reporting programs. These programs help support South Australia to meet long-term accountability requirements under Schedule B (BSMS Salinity Registers entries) as well as providing a basis for understanding the short-term variations in-river salinity to guide real-time management actions.

Monitoring

Telemetered salinity monitoring equipment has enabled observation of salinity changes along the river to be captured in near real time. The equipment has enabled a very high percentage of "good" data to be collected with little missing or poor quality data.

Salinities at the South Australian border remained below 500 EC for the report period, but all downstream stations showed gradually increasing salinities during the latter half of the report period following the return to entitlement flow. This gradual rise in salinity is shown at Figure 6.

The maximum recorded salinity at Morgan was 535 EC with both Murray Bridge and Berri maximum reaching 550EC. Of interest is the significant salinity peak following the high flow decline at both Morgan and Murray Bridge, which is not evident at other upstream sites. While the expected flow recession eventually occurred in October 2012 the predicted high salt accessions did not eventuate.

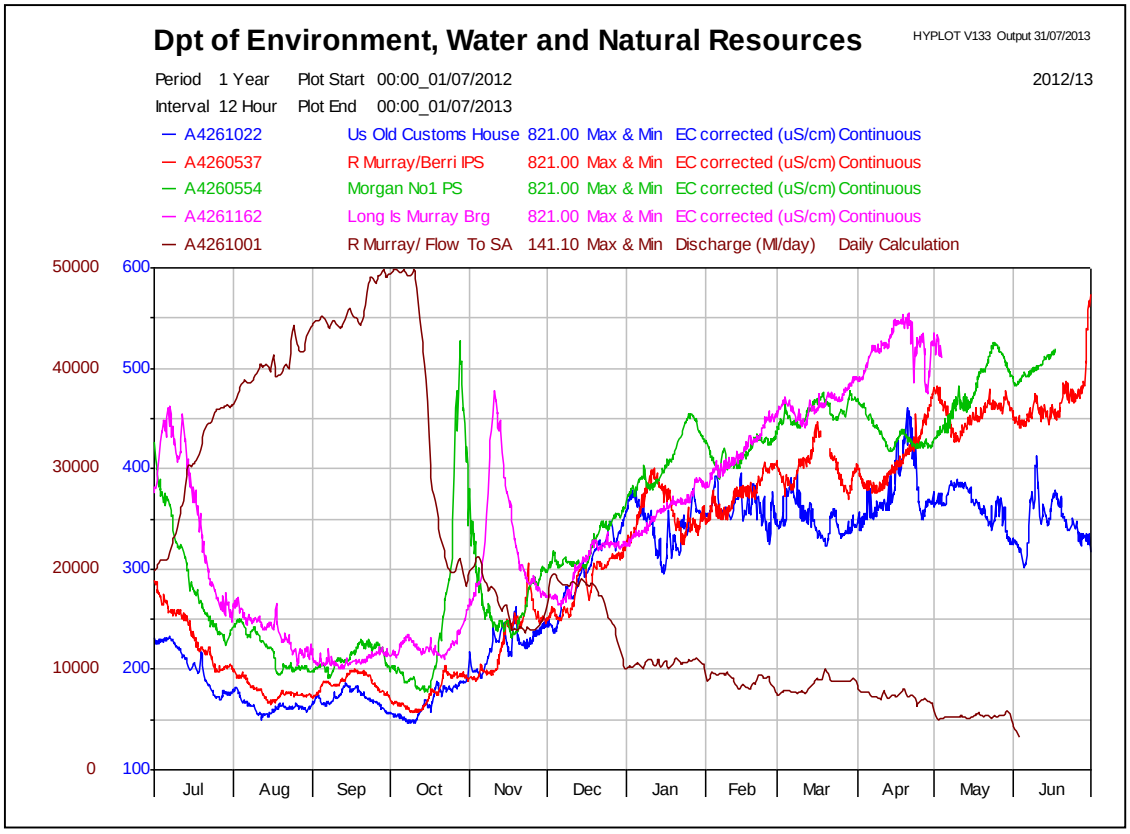

Figure 6 Recorded EC (us/cm) at the SA EofV sites, 2012 – 2013, with Flow to SA ML/day

Flow Monitoring

In 2012-13 flow measurements were reduced and limited gauging was completed through the high flow period. This was mainly due to extensive gauging undertaken throughout the 2011-12 period of high flows and unstable flow conditions.

The Chowilla Creek flow monitoring site has continued to operate well in 2012-13 through the various flow conditions and previous gauging has confirmed the validity of the developed Velocity Index rating. The construction of the Chowilla regulator further downstream may alter the velocity index and this will be closely monitored throughout the construction and operation phases to ensure the validity of data from this site. Only a small percentage of data is missing due to a sensor malfunction from late December to early January.

Close Interval EC Surveys

No close spaced 3-Dimensional EC surveys were carried out in 2012–13 due to the increased flows in the whole river system.

Run of River Salinity Surveys

Flows remained too high and variable during 2012-13 to conduct Run of River salinity surveys. Ideal conditions are expected in July 2013 when river flows will be below 4,000 ML/day and are predicted to be steady through this time. These conditions will provide the slow and stable river travel times needed for salt load calculations. Runs will be conducted from River Km (AMTD) 721 to 274 at Lock 1.

Evaluating

Groundwater Models in South Australia

South Australia now has a complete set of MDBA accredited groundwater models that span the full length of the River Murray in South Australia, as shown in Figure 7. The models underpin the estimation of salt loads entering the River Murray, and thus are the basis for accountable action entries on the BSMS Salinity Registers. Accountable actions simulated in the models include mallee clearance, irrigation development, improved irrigation practices and rehabilitation of irrigation infrastructure, groundwater control and salt interception schemes.

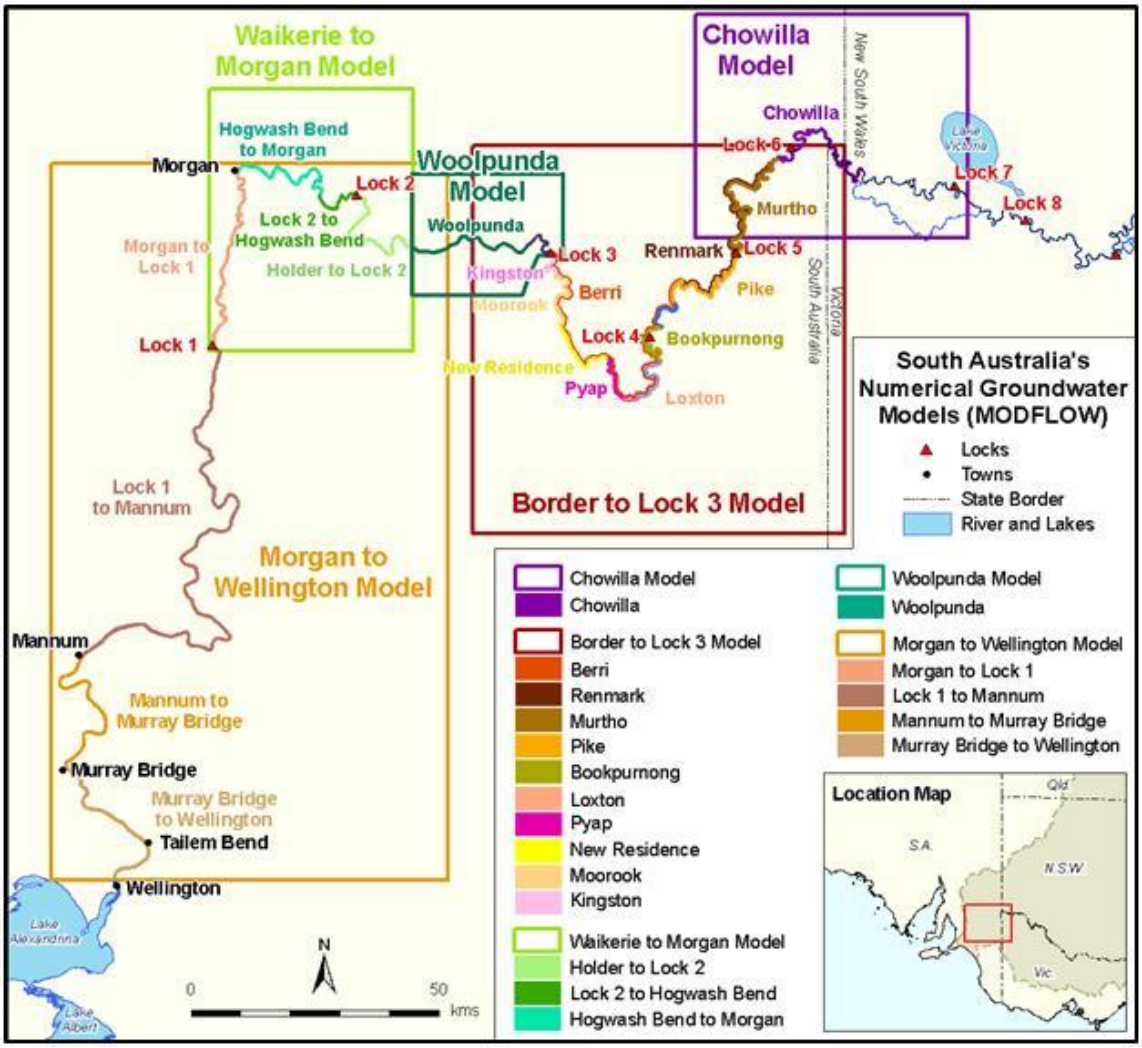

Figure 7 Coverage of South Australia's Numerical Groundwater Models

Review of South Australia's BSMS Salinity Register Entries

An important BSMS Salinity Registers process is the review of entries and models. Salinity Register entries require review every five years (Schedule B, clause 33 (1b)) while models are required to be reviewed before 31 December 2014 and thereafter at intervals of not more than seven years (Schedule B, clause 39 (1a)).

South Australia has progressively developed a suite of numerical groundwater models, based on the MODFLOW platform. The models utilise a series of scenarios that are applied consistently to each MODFLOW model to derive South Australia's entries on the BSMS Salinity Registers. The scenarios allow the impact of highland actions such as mallee clearance, irrigation development (pre and post 1988), improved irrigation practices and rehabilitation of irrigation infrastructure, groundwater control and salt interception schemes to be assessed.

South Australia has commenced the process of reviewing these models, commencing with the Loxton-Bookpurnong Numerical Groundwater Model in 2010-11, the Waikerie to Morgan Numerical Groundwater Model in 2011-12, the Woolpunda Numerical Groundwater Model in 2012-13 and continuing with the Pike-Murtho Numerical Groundwater Model in 2013-14.

As the MODFLOW models have been developed and accredited at different times, with their outputs contributing to multiple entries on the BSMS Salinity Registers, the timing for the 5 year review of each of South Australia's BSMS Salinity Register entries is not a single date. Rather, each entry will be updated as the individual MODFLOW models that contributed to the entry are updated.

Accountable Actions for 2013 BSMS Salinity Registers Update

With the accreditation of the Waikerie to Morgan Numerical Groundwater Model in 2012 and the Woolpunda Numerical Groundwater Model in 2013 the suite of highland accountable actions in these areas will be updated with the revised model output in the 2014 Salinity Registers. Noting that the entries for the Salt Interception Schemes (Waikerie 1, Waikerie IIA, Waikerie Lock 2, Woolpunda) will be updated once the five year review of these schemes is completed.

The updates to South Australia's BSMS Salinity Register entries in 2013 are derived from SIMRAT based assessments for Site Use Approvals for 2012-13. Output from the accredited SIMRAT model will continue to be used as an interim assessment until the five year review of the underlying MODFLOW model is completed.

SIMRAT based assessments of Site Use Approvals for 2012-13

The Site Use Approval (SUA) represents the permission to use water at a particular site in a particular manner in South Australia and is used as the basis for accounting for the salinity impacts of irrigation development using the SIMRAT model. In making the assessments, it was identified that changes to SUAs for 1 July 2013 to 30 June 2014 relate to variations due to prior commitment.

Prior Commitment clauses were included in the Salinity Zoning Policy as a transitional measure to ensure that entities with commitments to developments within the high salinity zone, prior to the implementation of the Salinity Zoning Policy in June 2003, were not unduly disadvantaged by the policy and so were exempt from the restrictions to develop in the high salinity impact zone.

An update to the 2013 Salinity Registers is not required where Prior Commitment was approved on the basis of crop requirements for existing plantings at commencement of the Salinity Zoning Policy in 2003 This is due to the salinity impact of irrigation development from 1988 to 2002-03 being sourced from the MODFLOW suite of models which is based on the 2003 irrigation footprint. There were 13 variations to SUA on this basis, totalling 12,018 ML.

An update to the 2013 Salinity Registers is required where Prior Commitment has been taken up and the salinity impacts have not been recorded on the Salinity Registers. On this basis, in 2012-13 there were three increases to SUA, totalling 22,558 ML, which require inclusion in the 2013 Salinity Registers.

The variations to SUAs that are to be entered on the Salinity Registers in 2013 are presented in Table 3.

Table 3 Updates for 2013 Salinity Register - Post 1988 irrigation based on site use approvals

Assessment Year	Reach	Total Volume (ML)	Number of Applications	Impact @ 2013 Salt tonnes/day	Impact @ 2014 Salt tonnes/day	Impact @ 2015 Salt tonnes/day	Impact @ 2050 Salt tonnes/day	Impact @ 2100 Salt tonnes/day
2012-13	Border to Lock 5	22,162.5	2	0.1	0.1	0.1	1.6	21.3
2012-13	Lock 5 to Lock 4	0.0	0	0.0	0.0	0.0	0.0	0.0
2012-13	Lock 4 to Lock 3	0.0	0	0.0	0.0	0.0	0.0	0.0
2012-13	Lock 3 to Lock 2	395.1	1	0.0	0.0	0.0	2.3	3.0
2012-13	Lock 2 to Morgan	0.0	0	0.0	0.0	0.0	0.0	0.0
2012-13	Lock 1 to Murray Bridge	0.0	0	0.0	0.0	0.0	0.0	0.0
2012-13	Murray Bridge to Mouth	0.0	0	0.0	0.0	0.0	0.0	0.0
		22,557.6	**3**	**0.1**	**0.1**	**0.1**	**3.9**	**24.3**

3. VALLEY REPORTS

3.1 End of Valley Report Card

The Independent Audit Group - Salinity has previously acknowledged that the End-of-valley Summary Report Card is not entirely suitable for South Australia, as it does not make provision for downstream targets, actions or reporting. However, South Australia has provided a description of the key monitoring sites at Section 3.2 (and listed below at Table 4) and completed the relevant fields of the End-of-valley Summary Report Card using 2012-13 monitoring data, refer Table 5.

Table 4 Monitoring sites

Monitoring site	Target EC *	Description
Border (downstream of Rufus River)	412	This site near the SA/NSW border effectively provides the salinity of water entering South Australia
Berri (Irrigation Pump Station)	543	This site has good long-term data and a continuous data recorder
Murray Bridge (Pump Station)	770	This site is a major off-take, and is downstream of the major urban off-take. The installation of a continuous recorder will ensure data quality will be maintained.

*Target EC for 80 percent of the time

Table 5 End-of-Valley summary report card

Valley	Target site	Interim 2015 Target (% of 2000 Benchmark Conditions)	Valley Reporting Site	Progress Given Actions To-Date 2012-13 Monitoring data (Daily Mean EC)
Basin salinity target	Lock 6 to Morgan	800 EC (95%ile)	Murray at Morgan	535 EC (Max) 513 EC (95 %ile) 457 EC (80 %ile) 41 610 ML/Day Max Flow
South Australia	SA Border	412 EC (80%ile)	Murray at SA Border	437 EC (Max) 381 EC (95 %ile) 358 EC (80 %ile) 49 831 ML/Day Max Flow
	Berri	543 EC (80%ile)	Murray at Berri	536 EC (Max) 464 EC (95 %ile) 420 EC (80 %ile)
	Below Morgan	770 EC (80%ile)	Murray at Murray Bridge	547 EC (Max) 521 EC (95 %ile) 470 EC (80 %ile)

3.2 Summary of Monitoring Sites

Border (A4261022)

The pontoon-mounted salinity monitoring equipment located at the SA – Vic Border provided reliable "good" coded data for 100% of the time. As part of the Living Murray Chowilla environmental pre regulator monitoring program, a bottom mounted salinity sensor and DO sensor has been added to this site.

Flow records for this site are derived from a rating at A4260200 (Victorian Gauging station, Murray River downstream of Rufus River) and A4140211 (Victorian Gauging station, Mullaroo Creek). During this period all flow data was derived from the rating tables developed for these sites. These rating tables are administered by THIESS Environmental. Maximum rated flow to South Australia was 49,831 ML/day on the 29th of September, 2012 and the minimum recorded flow was 2,981 ML/day on the 3rd of June 2013.

Berri (A4260537)

The salinity monitoring equipment located at the Berri Irrigation Pumping Station continued to operate reliably, with 100% of data being of "good" quality in 2012-13.

Generally EC data was reasonably smooth mainly due to a regular monthly visiting and cleaning regime which kept biofouling to a minimum.

Flows for the site at Berri are calculated at Lock 4 (A4260515, 8kms downstream of Berri), up to a stream-flow of 40,000 ML/day. Above 40,000 ML/day when water levels rise above the flow calculation formula range, the high-flow gauging site at Lyrup (A4260663, 12kms upstream of Berri) is used. Flows at Lock 4 were quality coded "good" for 100% of record below 40,000 ML/day for 2012-13.

The Lyrup high flow rating from 40,000 ML/day to 100,000 ML/day is rated "good". No gauging occurred through the 2012-13 period for this station.

Morgan (A4260554)

The salinity monitoring equipment located at the Morgan Pumping Station pontoon operated reliably, with all data coded "good" quality in 2012-13. A maximum salinity of 535 EC was recorded on 23 June 2013.

Flow monitoring at Morgan has been compromised due to an unknown sensor anomaly. The sensor has been removed and replaced but the problems still exist. The manufacturers of the unit are attempting to source the fault. This issue has meant that the theoretical flow calculations are being substituted for the developed velocity index rating. Confidence is still high for this rating as comparisons to the velocity index rating have indicated little variance, the data collected during the period when the unit was malfunctioning has been rated unverified to reflect the change in process detailed above. Gauging was also undertaken to validate this theoretical rating with good results.

Murray Bridge (A4261162)

The water level and EC monitoring installation (A4261162) at Long Island continued to operate well and 98% of salinity data is coded "Good".

No continuous flow measurements are possible at Murray Bridge.

4. RESPONSE TO 2011-2012 INDEPENDENT AUDIT GROUP RECOMMENDATIONS

Recommendation 1: Redefinition of the Salinity Risk Expected in 2050 Guide Future Program Development

The BSM AP update the projected salinity risk for the Basin in 2050 as a basis for prioritising future actions and funding based on past trends, works and measures, impacts environmental watering and emerging salinity risks.

South Australia supports this recommendation. The implementation of the Basin Plan, recovery of large volumes of water for the environment and changes to river operating regimes will have a significant impact on the projected salinity risk for the Basin in 2050.

Coinciding with this is the review of MDBA joint programs and budgetary pressures on state and federal governments. It is important that the Basin jurisdictions are equipped with the necessary information to make informed decisions regarding future salinity mitigation activities. This includes the need to continue to operate existing salinity mitigation structures to ensure that BSMS and Basin Plan salinity targets can be achieved.

South Australia agrees that this is a high priority for the BSMS as it will provide guidance to the review and prioritisation of actions, allocation of resources and direct the need for the development of a revised strategy following the finalisation of the BSMS in 2015.

Recommendation 2: Accountability for salinity impacts of environmental watering

a) Then policy principles for environmental watering be evaluated through modelled scenarios of salinity and dilution impacts, including lag times, of various watering options for selected icon sites outside the TLM program and be undertaken by the Commonwealth Environmental Water Holder, the Basin Salinity Management Strategy Advisory Panel and the Murray-Darling Basin Authority.

b) The Basin-wide plan and policy framework for managing the potential impacts and responsibility for reporting the accountable actions from environmental watering as required under Schedule B be settled between the Commonwealth Water Holder and the operating jurisdictions.

South Australia supports both elements of this recommendation and its priority for being addressed.

The Basin Plan brings forward a focus on environmental water management. Resolving the accounting and management framework for the potential salinity impacts of environmental watering is therefore a priority to ensure that both short term and long term salinity risks are duly considered in decision making processes.

South Australia advocates a shared Basin wide approach to the allocation of credits and debits associated with the delivery and use of environmental water. This acknowledges that watering actions are premised on improving the health of the system for water users across all jurisdictions.

The complex nature of environmental watering actions and the spatial extent of the actions will require the assessment of salinity impacts at a whole of Basin scale. Environmental watering actions cannot be assessed in isolation, as environmental water is likely to be used at multiple sites, in various manners, and across state borders.

South Australia supports Schedule B and the BSMS accounting framework but reiterates that the development of policy to account for environmental watering salinity impacts should not be limited by the existing Schedule B framework as the different temporal nature of irrigation and land based induced salinity (with changes occurring slowly over years or decades) and environmental watering induced salinity (with changes occurring rapidly and episodically with a duration of days to months) warrants consideration of different estimating and accounting approaches.

Recommendation 3: Outstanding Submission of Register Reviews

a) ***New South Wales should develop and submit to the MDBA a schedule for the up-coming Salinity Register reviews;***
b) ***Queensland should formally submit the three outstanding Salinity Register reports.***

South Australia supports the recommendation in the interest of maintaining accountability within the salinity registers.

Recommendation 4: The Basin Salinity Management Strategy (BSMS) Model Success Story

The success of the BSMS is promoted to demonstrate how good multi-government programs can work when roles, responsibilities and accountabilities are well developed, an adaptive management framework used and where excellent jurisdictional collaboration and commitment to progressing the strategy occurs.

South Australia supports this recommendation.

The promotion of BSMS achievements is important to demonstrate the effectiveness of the inter-governmental collaboration. As part of any communications it would be useful to include future salinity predictions to demonstrate that the strategy has been successful to date, but also that there is a need for further work to ensure that water quality is protected into the future.

South Australia recommends that in the first instance the MDBA develop a webpage for the MDBA website, similar to the web pages provided for all other MDBA programs. Additionally consideration should be given to developing a document similar to that recently released for the TLM program "The Living Murray Story".

Recommendation 5: Review of the Monitoring Framework for the Basin Salinity Management Program

Review the monitoring framework to ensure spatial distribution, priority salinity risk areas and environmental watering sites are all adequately assessed. The review to include confirmation of the monitoring protocol, maintenance of instrumentation and the handling of missing data to address the requirements for real-time data and predictive modelling of salinity impacts.

South Australia supports this recommendation.

The in river monitoring undertaken by South Australian Government agencies is based on best practice standards.

It is suggested that any review undertaken of the monitoring framework for the Basin Salinity Management Program, should also consider the broader context of the Basin Plan water quality and salinity monitoring requirements.

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6. GLOSSARY

AHD - Australian Height Datum

BSMS - Basin Salinity Management Strategy

CEWH - Commonwealth Environmental Water Holder

CLLMM - Coorong, Lower Lakes and Murray Mouth

COAG - Council of Australian Governments

CSIRO - Commonwealth Scientific and Industrial Research Organisation

DEWNR - Department of Environment, Water and Natural Resources

DFW - Department for Water

EC - Electrical Conductivity - µS cm^{-1} EC

GL - Gigalitre (1 000 000 000 litres)

IAG - Independent Audit Group

LWMP - Land and Water Management Plan

MDB - Murray-Darling Basin

MDBA - Murray-Darling Basin Authority

ML - Megalitre (1 000 000 litres)

NRM - Natural Resources Management

OFIEP - On-Farm Irrigation Efficiency Program

RRP – Riverine Recovery Program

SA MDB - South Australian Murray-Darling Basin

SA MDB NRM Board- South Australian Murray-Darling Basin Natural Resources Management Board

SARFIIP - South Australian Riverland Floodplains Integrated Infrastructure Program

SASP - South Australia's Strategic Plan

SIS - Salt Interception Scheme

SKM - Sinclair Knight Mertz

t - Tonne

TDS - Total Dissolved Solids

TLM - The Living Murray

WAP - Water Allocation Plan

Government of South Australia

Department of Environment,
Water and Natural Resources