Australian Government

MURRAY–DARLING BASIN AUTHORITY

Report of the Independent Audit Group for Salinity 2012–13

January 2014

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Cover image: Lake Littra, Chowilla Floodplain, South Australia, Arthur Mostead, 2008

Acknowledgement of the Traditional Owners of the Murray–Darling Basin

The Murray–Darling Basin Authority (MDBA) acknowledges and pays its respect to the Traditional Owners and their Nations of the Murray–Darling Basin. The contributions of earlier generations, including the Elders, who have fought for their rights in natural resource management are also valued and respected.

MDBA recognises and acknowledges that the Traditional Owners and their Nations in the Murray–Darling Basin have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters. MDBA understands the need for recognition of Traditional Owner knowledge and cultural values in natural resource management associated with the Basin. Further research is required to assist in understanding and providing for cultural flows. MDBA supports the belief of the Northern Murray–Darling Basin Aboriginal Nations and the Murray Lower Darling Rivers Indigenous Nations that cultural flows will provide beneficial outcomes for Traditional Owners.

The approach of Traditional Owners to caring for the natural landscape, including water, can be expressed in the words of Ngarrindjeri elder Tom Trevorrow: ‘our traditional management plan was don’t be greedy, don’t take any more than you need and respect everything around you. That’s the management plan—it’s such a simple management plan, but so hard for people to carry out.[1] This traditional philosophy is widely held by Traditional Owners and respected and supported by MDBA.

[1] Tom Trevorrow (2010). Murrundi Ruwe Pangari Ringbalin ‘River Country Spirit Ceremony: Aboriginal Perspectives on River Country’.

Auditors' foreword

February 2014

Chairperson
Murray–Darling Basin Authority
GPO Box 1801
CANBERRA ACT 2601

Dear Chairperson,

We have pleasure in submitting to you the Report of the Independent Audit Group for Salinity, 2012–13.

This, the eleventh such audit of the Basin Salinity Management Strategy (2001–2015), covering the sixth year of Phase 2, has been carried out in accordance with the provisions of Schedule B to the Murray–Darling Basin Agreement (Schedule 1 to the *Water Act 2007*).

This year, the modelled Morgan target of 800 EC for 95% of the time was reached for the fourth time in a row since it was set. This is a significant achievement for the Basin Salinity Management Strategy. The continuous river flows over the past three years have allowed a significant amount of salt to flow to the sea without any peaks in salinity that could have been expected if the flow following the flood had quickly reduced back to entitlement.

The Basin Salinity Management Strategy is due to be completed by 2015 and we are very pleased that a review of the salinity threats in the Basin is now under way. While the threat from a continuing rise in salinity predicted in 2001 was overly conservative, it is still a Basin–wide threat, and the General Review of Salinity Management should provide some future insights upon which a forward program can be considered.

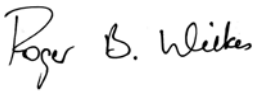
The Basin Salinity Management Strategy continues to be supported by an excellent framework of responsibilities and a common commitment by the agencies and officers to make it work. This model of action is to be commended, and the science and knowledge of the system have continued to improve. The management issues in the Basin are changing because of the increasing commitment to environmental watering and because of coal seam gas developments occurring in the Basin. The threats and opportunities they provide need to be captured in the future policy and accountability framework for salinity in the Basin.

We are impressed by the collective commitment of staff from all jurisdictions, including the Murray–Darling Basin Authority and the states and the Australian Capital Territory, to the Basin Salinity Management Strategy and extend our thanks for their cooperation and assistance.

Yours sincerely,

ROGER WICKES

Lead Auditor



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Abbreviations

2CSalt	Upland Water and Salt Generation Model
ACT	Australian Capital Territory
BSM AP	Basin Salinity Management Advisory Panel
BSMS	Basin Salinity Management Strategy
CAP	catchment action plan
CAT1D	Catchment Analysis Tool One Dimension
CEWO	Commonwealth Environmental Water Office
CMA	catchment management authority
CSG	coal seam gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cwlth	Commonwealth
EC	electrical conductivity (expressed in units of µS/cm)
EM	Eastern Mallee (modelling package)
EoVT	End–of–valley target
ET	evapo-transpiration
GL	gigalitre (1,000 ML)
GSM	Goulburn–Broken–Campaspe–Loddon REALM model
HGL	hydrogeological landscapes
IAG–Salinity	Independent Audit Group for Salinity
ICM	integrated catchment management
IQQM	integrated quantity and quality model (surface water model software)
Kc	crop coefficient used to convert reference crop evapotranspiration to crop evapotranspiration
LWMP	land and water management plan
MDB	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority
MDBMC	Murray–Darling Basin Ministerial Council
ML	megalitre (1,000 m3)
MODFLOW	modular flow model (groundwater model software)
MSM–BigMod	monthly simulation model—big model (River Murray model software)
NRM	natural resource management
NSW	New South Wales

RCS	regional catchment strategy
REALM	resource allocation model (surface water model software)
SA MDB NRM	South Australian Murray–Darling Basin Natural Resource Management
SAR	sodium adsorption ratio
SARDI	South Australian Research and Development Institute
SIMRAT	Salinity Impact Rapid Assessment Tool
SIS	salt interception scheme
Source	Water Quantity and Quality Model Software (eWater Ltd)
TLM	The Living Murray Program

Contents

Tables

Figures

Executive summary

Introduction

In August 2001, the Murray–Darling Basin Ministerial Council (MDBMC) launched the Basin Salinity Management Strategy (BSMS) (MDB 2001). In December 2008, the Murray–Darling Basin Commission was succeeded by the Murray–Darling Basin Authority (MDBA). Schedule C to the Murray–Darling Basin Agreement, which set down the legislative framework for the implementation of the BSMS, became Schedule B to the Murray–Darling Basin Agreement, which is Schedule 1 to the *Water Act 2007* (Cwlth).

Schedule B provides for the appointment of 'independent auditors for the purpose of carrying out an annual audit', whose task is to review progress in implementing the BSMS.
The four members of the present Independent Audit Group for Salinity (IAG–Salinity) were appointed in November 2013.

The terms of reference for the IAG–Salinity (Appendix 1) and Schedule B (Appendix 2) require the IAG–Salinity to review progress on the BSMS both broadly and in terms of the steps laid down in the schedule. The terms of reference also require the audit to focus on the specific measurement and recording of progress with the BSMS and the outcomes at 30 June each year.

This report presents the consensus view that the IAG–Salinity has reached in undertaking the audit covering the 2012–13 financial year. The state contracting governments, the Australian Capital Territory (ACT) and MDBA submitted reports on their activities, valley reports, the status of five-year rolling reviews, and BSMS salinity register entries or adjustments.
The Australian Government (Department of the Environment) also submitted a brief report related to environmental watering activities.

The audit process adopted by the IAG–Salinity included a review of the annual jurisdictional reports and the salinity registers, followed by meetings with representatives of the jurisdictions and with members of MDBA. The recommendations were developed and jurisdictions were given an opportunity to provide factual comments on the audit report.

The 2012–13 context for BSMS implementation

In 2012–13, continuing flows in the River Murray meant that about 1.4 million tonnes of salt flowed to the sea during the year—below the average of 2.9 million tonnes per year (averaged over the preceding three years). The continuous good flow meant that the expected high salinities on a post–flood recession did not occur in the lower Murray.

The acceptance of the Basin Plan and the near completion of the BSMS has focused attention on how salinity should be managed in the Murray–Darling Basin (MDB) in the future.
A work plan has been developed for the General Review of Salinity Management to explore the current salinity threats, ongoing management and the potential need for a new Basin–wide management strategy. The uncertain future for the funding for joint MDBA programs, upon which the cooperative approach to salinity management between the jurisdictions has been based, is an area of concern. It has been the high level of cooperation supported by the joint

funding which has led to the success of the implementation of the BSMS. This is the fourth year that the Basin salinity target at Morgan (800 EC for 95% of the time, as defined in Schedule B during the 1975–2000 benchmark period) has been reached.

Observations of groundwater changes have indicated that the salinity issues in the dryland tend to be cyclical and related to climate. For instance, the watertable levels in the Goulburn and Loddon areas fell during the drought, but have risen in recent years because of the return of rain. The results of the five–year reviews in these dryland areas indicate that there are still likely to be future small increases in salinity impacts. However, greater understanding of the cyclical nature of the groundwater levels in both the irrigated and dryland areas will provide a better estimate of the salinity threat in the future. This is being examined in the General Review of Salinity Management that is currently under way.

It is evident from the substantial increase in knowledge of salinity processes and trends in the Basin over the past 13 years that the projected 2050 levels of salinity, predicted in 1999, were overestimated. The General Review of Salinity Management will consider future risks and cost–effective management options. It is very important that the projected salinity risks, and their likely impacts, are re–evaluated so that future initiatives can be best targeted to ensure that the significant gains in salinity management over the previous years are maintained into the future. The southern jurisdictions were concerned that any adjustment to program funding be based on future requirements for the management of the ongoing salinity threat in the Basin, and that the experiences people and businesses had with salinity in the 1990s, which led to the BSMS, are not forgotten.

The purchase of entitlement water by the Commonwealth for the environment is strongly supported, but the accountability framework for the salinity impacts of environmental water use is still to be settled. The Commonwealth is the largest holder of entitlement water in the Basin and it is essential that the impacts of its use of that water be included in the framework for managing salinity in the Basin. There is not yet an agreement on the accountability for any salinity impacts or dilution benefits; nor have responsibilities been assigned to jurisdictions for notifying MDBA of any reportable actions that may have an effect on salinity outcomes within the Basin.

The integration of the BSMS into the new salinity management arrangements adopted to implement Schedule B of the *Water Act (2007)* in the next year is an important step, and there are a number of important attributes developed during the implementation of the BSMS that should not be lost. The focus on implementing the strategy and the reporting framework set out in Schedule B has ensured a continuous improvement in both the understanding of the salinity process and in the ability to modify actions to meet the targets set out in the BSMS.
It is important that the Basin–wide focus is maintained and future actions sustain the gains made in arresting the threats from salinity.

The salt interception schemes (SISs) have been the primary source of salinity credits that appear in the registers. While the costs of running and maintaining the infrastructure are high, the efficiency gains that can be made mean that the review of the SISs should consider the needs of the system in the first instance, rather than being budget driven. Otherwise, the gains in salinity management may be compromised in the long term. While the net level of credits in terms of salinity effect is 165 EC across the Basin, a substantial positive credit
(in the order of 100 EC) is most likely required in the long term to maintain compliance.

Progress in implementing Schedule B—items for special mention

Implementation of the BSMS

It is evident that the implementation of the BSMS has been very successful and that significant outcomes for the Basin have been achieved. The strategy has nine elements based on the understanding of the system in 2001 and the management actions that may improve the salinity at the Basin salinity target at Morgan. Much more data, experience and knowledge have been gained since the commencement of the strategy and it is appropriate that it be reviewed. Integration within the new salinity management arrangements is also expected to occur in the next period. The IAG–Salinity considers that there are a number of elements of the BSMS that have made it particularly successful and that should be considered for inclusion in the new arrangements. These are:

- A Basin–wide approach to salinity management and accountability has focused the program on achieving the target set at Morgan.
- Data and knowledge updated every five years provided a basis for good decision–making and an improvement in understanding of how the system behaves.
- The register system has allowed jurisdictions to trade off positive and negative impacts of actions they may take.
- Governance arrangements (that is, a strategy supported by a jurisdictional committee focused on achieving the targets in the strategy) have worked well.

Current salinity management in the Basin

The modelled salinity target at Morgan over the 1975–2000 benchmark period (that is, below 800 EC for 95% of the time) has been met for the fourth year in a row. The SIS program has contributed to this success in low-flow years by reducing highly saline groundwater accessions to the river. Dilution from high flows over recent years after a return to average rainfall has also had a significant effect. Table 1 shows that the model prediction for river salinity at Morgan over the benchmark period is less than 800 EC for 96% of the time.

Table 1 Modelled salinity levels (EC) at Morgan, South Australia for baseline year 1988 and 2013, incorporating implemented salinity management based on the 1975–2000 benchmark period

Period	Time interval	Average	Median (EC)	95 percentile (EC)	% time greater than 800 EC	% time less than 800 EC
25 years	Modelled baseline conditions 1975–2000	665	666	1058	28%	72%
25 years	Modelled 2013 conditions 1975–2000	491	486	781	4%	96%

The effect of salinity management in the MDB on salinity at Morgan based on both salinity measurements and modelled salinity, with and without intervention, is shown for the duration of the BSMS in Figure 1 and for the past two years in Figure 2. Without salinity management intervention, salinity at Morgan would have exceeded the 800 EC target for most of the June 2007 to January 2010 period, with occasional breaches in other years. The continuous high flows in the River Murray over the two and a half years from August 2010 until October 2012 were considerably larger than salt inflows into the river, but salinity then increased in the subsequent nine months due to reduced flows. It is difficult to quantify the impact of salinity management intervention during the three years because of the small differences in low salinity concentrations relative to the uncertainty in the modelling results.

The significant reduction in salinity at Morgan in the dry years, particularly 2006 to 2010, shows the impact of actions under the BSMS in reducing salinity in the lower Murray. It is important to continue to monitor the Morgan target as irrigation footprints, environmental watering and river flows change under the implementation of the Basin Plan.

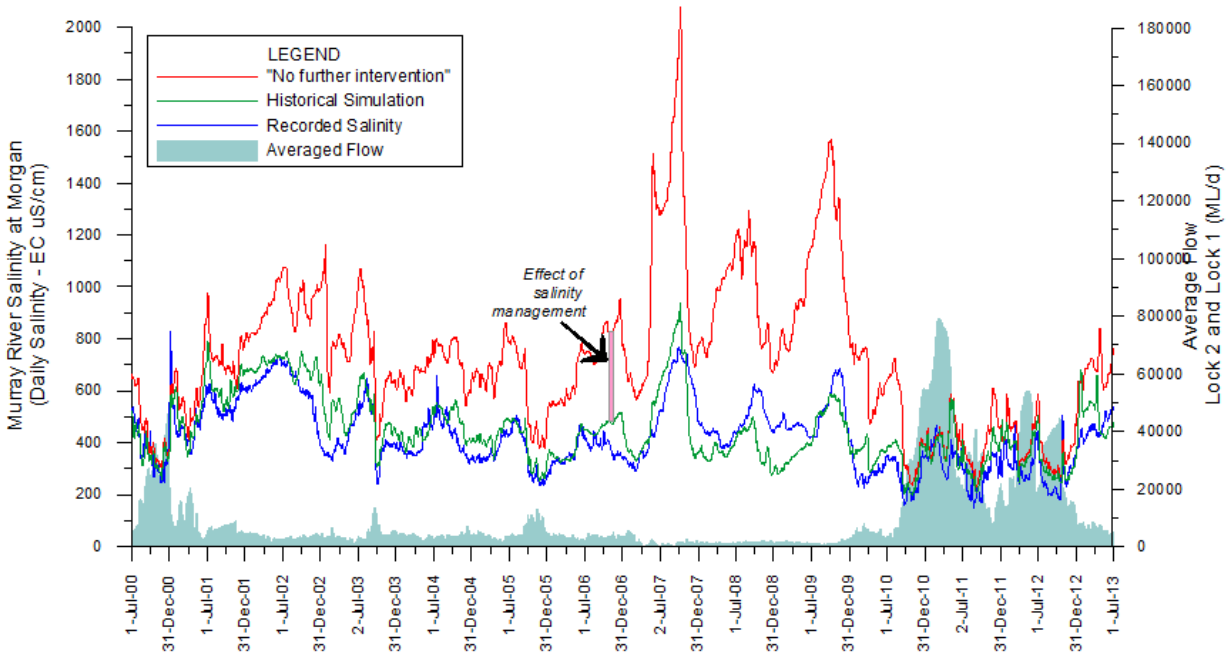

Figure 1 Mean daily observed salinity levels at Morgan from July 2000 to June 2013 (blue line) compared to modelled salinity levels for historical actions (green line) and modelled salinity levels without salt interception schemes, improved land and water management actions and additional dilution flows ('no further intervention' scenario) (red line), and average daily River Murray flow (teal) between Lock 1 and Lock 2. The difference is primarily attributed to salinity management actions and is significant during dry conditions.

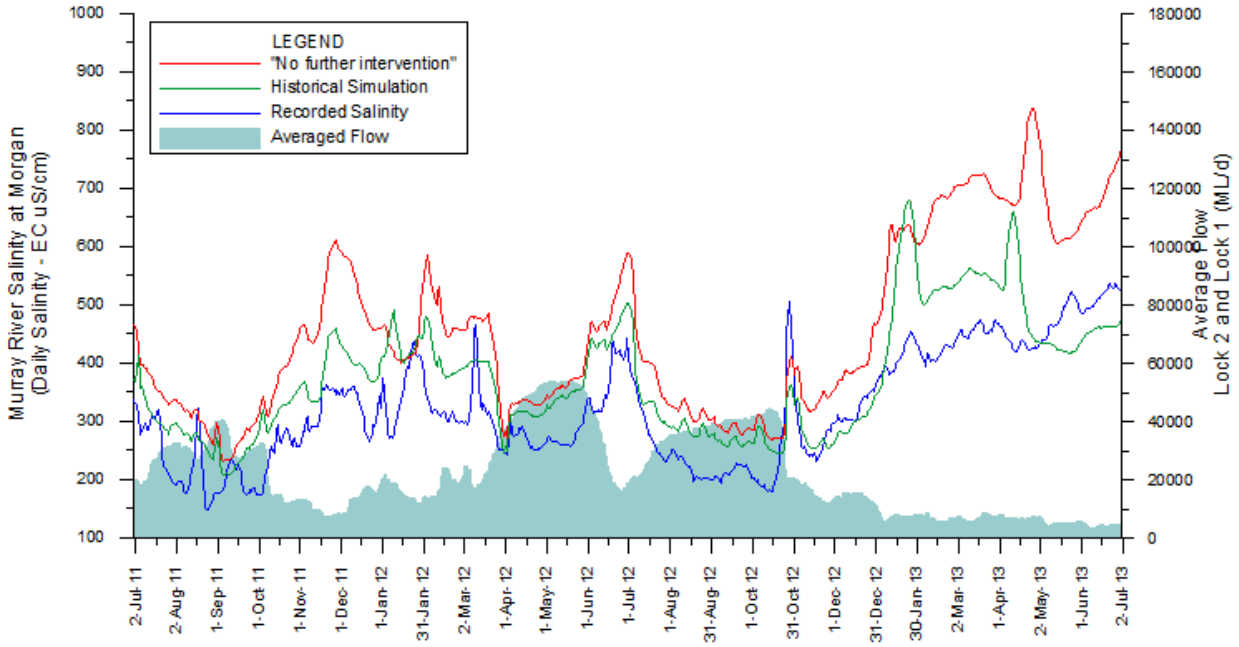

Figure 2 Mean daily observed salinity levels at Morgan from July 2011 to June 2013 (blue line) compared to modelled salinity levels for historical actions (green line) and modelled salinity levels without salt interception schemes, improved land and water management actions and additional dilution flows ('no further intervention' scenario) (red line), and average daily River Murray flow (teal) between Lock 1 and Lock 2. The difference is small, indicating that during these flow conditions the impact of salinity management actions is relatively small compared to the model uncertainty.

BSMS review

Knowledge and modelling of the Basin salinity threats have improved over time, and it is now evident that projections for the salinity problem have been overestimated, although still significant. The investment in data collection, the modelling of the system and the successful works and measures program have delivered major salinity credits on the registers, and have ensured the target at Morgan has been met, particularly through the drought years.

The salt interception program is on schedule to deliver an average salinity reduction of greater than 61 EC at Morgan. The BSMS predicted that further credits were needed, and the 2008 mid–term review of the strategy recommended the development of a subsequent works and measures program to deliver a 40 EC credit for the second half of the strategy.
However, increased knowledge of the Basin suggests that further credits are not necessary at this time. This should be investigated in the current General Review of Salinity Management.

The SISs are essential for the continuous management of salinity in the Basin.
However, as reported in the 2011–12 IAG–Salinity report, efficiencies and savings may be made by adjusting how the system is run.

Environmental watering

The purchase of water entitlements for environmental activities is changing the use and distribution of water in the Basin. Environmental watering using Commonwealth and state held water has not been included on the registers, and consequently the registers do not accurately reflect the salinity debits and credits operating in the Basin. The IAG–Salinity has been seeking a resolution of this matter over the past four years (MDBA 2010, 2011, 2012, 2013).
Some case studies currently under way, particularly as part of The Living Murray (TLM) program, should give a better basis for assessing environmental watering, but early evidence suggests that it may provide a positive outcome for salinity management in the Basin in the long term. The salinity threats from environmental watering of specific sites may be able to be managed through real–time stream operations. However, unless this activity is planned and accounted for there is no certainty about its impact on the Morgan target and the implications for the broader management of salinity.

Flood recession and salt mobilisation from the floodplains

An important investigation by MDBA (2014) has identified the Lock5 to Lock 6 reach as significant uncertainty about the amount of salt mobilised during flood recession.
The unaccounted salt load in the MDBA river model (BigMod) is high (185 tonnes per day). South Australia is also investigating how it may include the floodplain in the groundwater models that cover this section of the river. This will provide greater predictability for meeting the target at Morgan and a clearer picture of the salinity threat from the floodplain.

Coal seam gas and coal mines

The development of the coal seam gas (CSG) industry and the increase in the number of coal mines (which can contribute significant amounts of water and salt) have been expected to add a new dimension to salinity management in the Basin. However, the policy settings in New South Wales (NSW) and the low water content of the planned extractions indicate a low threat to the Basin from the NSW activity. In Queensland, there are plans for significant volumes of water and salt to be extracted. Queensland was not able to provide the IAG–Salinity with adequate surety of the level of salinity threat, as there is no centralised database or analysis of the data that can provide the knowledge required. On this basis, the risk is considered to be high.

End–of–valley targets

The framework for managing salinity across the Basin includes end–of–valley targets (EoVTs) for each region. The Morgan target, as the Basin EoVT, has been very useful as it has been related to at–risk assets, and management actions have been applied to protect those assets. The jurisdictions have reported against the targets for the sub catchments, providing a check on the level of salinity (load and concentration) coming from each catchment. However, the catchment communities did not really adopt these targets as there was a perception that the 1999 salinity audit had overstated the extent of the problem and, over time, salinity did not reach the predicted levels across these landscapes. Therefore, the funding went into SISs and improved irrigation practices, where greater gains could be made. A review of EoVTs by MDBA has indicated that the targets were over–engineered, considering the level of risk.

A reconsideration is warranted of how the EoVT can be used to inform the community of the actions required, if it is still expected that the community needs to include salinity management in its plans; otherwise, local issues will dominate these choices.

Land management strategies

A number of elements of the strategy are targeted to dryland areas of the Basin. Landholders in upstream catchments that have a high salinity threat need a range of land management options to better manage the threat. Those options provide a local benefit and have increased on-farm production while protecting native habitat in the Basin. Unfortunately, it has not been possible to attribute a credit on the registers to this work. NSW attempted to do so for the Murrumbidgee River, but the credit was too small to consider as a register item. Given the continued investment since that time in the Murrumbidgee catchment, it could now show a credit if the changes were recalculated. Better understanding of salinity processes in the dryland areas has meant that longer term salinity threats may not be as high as originally predicted.

The monitoring framework

The monitoring of sites in the Basin to meet EoVTs and the compilation of data to support models and evaluate trends are essential if the Basin is to be managed in a sustainable way. MDBA has completed a review of the EoVT and the associated monitoring sites. This has been accepted by the jurisdictions. All of the jurisdictions have undertaken reviews of monitoring networks, which has resulted in the rationalisation (loss) of both surface water and groundwater sites. None of the EoVT sites has been affected. The audit panel was not provided with information on these reviews and consequently cannot comment on the methodology used in the rationalisation. The concern is that key gauges may be removed in this process, affecting future understanding of catchment processes, particularly in high salinity threat areas and at environmental watering sites. Monitoring is also occurring in irrigation areas, and the future collection of data to support modelling in those areas may also be an issue. A transparent review process based on an agreed risk assessment would potentially overcome this.

Benchmark period

The benchmark period was set based on available data at the time and the need to select a sufficiently long and variable period to represent the longer climatic records.
This was appropriate for the BSMS, but following the General Review of Salinity Management it may be possible to further reduce the uncertainty in the models if a longer run of information is included as part of the benchmark period. Further climate, flow, level and salinity data collected in the Basin has improved our understanding of the salinity processes that operate in the Basin. In addition, the catchment has been through the worst drought on record (the millennium drought), broken by significant floods. The sequence of extremes has provided knowledge of how catchments respond to extremes in climate that were not experienced in the benchmark period. Recent salinity data in catchments has suggested that the behaviour of some catchments is different from the behaviour calibrated and conceptualised in the benchmark models. On this basis, to improve the certainty in salinity registers, the benchmark period and models should be extended, reconceptualised and calibrated to include the more recent years. As a first check, models should be validated in the extended period to determine whether they are performing adequately in this climatically unique period.

The IAG–Salinity's opinion on the balance of salinity credits and debits for each state
Schedule B, Clause 16 (1) provides as follows:

16.(1) A State Contracting Government must take whatever action may be necessary:

(a) to keep the total of any salinity credits in excess of, or equal to, the total of any salinity debits, attributed to it in Register A; and

(b) to keep the cumulative total of all salinity credits in excess of, or equal to, the cumulative total of all salinity debits, attributed to it in both Register A and Register B.

Register A currently shows NSW, Victoria and South Australia to be in net credit, while Register B shows NSW and South Australia to be in net credit and Victoria slightly in debit.
For the combined registers, all three states are in credit. Queensland and the ACT do not have register entries.

Opinion on register balances

The IAG–Salinity has examined the registers as provided for this audit and has come to the opinion that NSW, Victoria and South Australia are in a net credit position.

Opinion on MDBA's accuracy in maintaining the registers

The IAG–Salinity found no inaccuracies in MDBA's maintenance of the registers as provided for incorporation into this report.

The audit did not identify any requirement to update individual entries in the registers incorporated in this report.

Recommendations

The following are the recommendations of the IAG–Salinity in descending order of priority. The recommendations were arrived at through a review of the reports of the jurisdictions, the annual BSMS implementation reports and past IAG–Salinity reports, followed by discussion with representatives of the jurisdictions and the catchment management authorities (CMAs).

1. BSMS review

In regard to the General Review of Salinity Management, the IAG–Salinity considers that the following features should be continued in the future salinity management arrangements:

- *The Basin salinity target at Morgan is a target connected to assets at risk and agreed actions are implemented to ensure that the target is met.*
- *There is a Basin–wide focus for salinity management as a major water quality issue for the Basin.*
- *Data and knowledge of the system continually improve and support good decision–making.*
- *Knowledge of the system and the models are upgraded every seven years through 'fit–for–purpose' model development, providing increasing surety about the outcome.*

- *The intent of Schedule B in providing the register system is maintained, given that it focuses the management of salinity and provides for trade–offs that cater for changing circumstances in each jurisdiction.*
- *The SISs provide surety in meeting the salinity target at Morgan.*
- *The governance arrangements for the BSMS (annual reviews, the joint jurisdictional programs and advisory group, the mid–term review and the independent audit of the registers and activities) have worked well.*

There are areas of the BSMS that could not deliver as originally expected and need further consideration:

- *The upstream EoVTs were unrelated to upstream assets and were set as targets relevant to the Morgan target. However, there was little upstream community ownership or agreed management actions in the catchments to achieve those targets.*
- *The broadacre agriculture and revegetation elements, while delivering local benefits, have not provided joint outcomes at the Basin scale that could be accounted for at Morgan.*

2. Environmental water

(a) Three new register items should be added to the registers with notional values to cover:

i. environmental water recovery

ii. use of water for environmental purposes

iii. environmental works and measures (initially covering the TLM works).

(b) The policy principles for environmental watering and use of environmental works should be evaluated through modelled scenarios of salinity and dilution impacts undertaken by the Commonwealth Environmental Water Office (CEWO), the Basin states/territory and MDBA.

(c) The Basin–wide plan and policy framework for managing impacts and responsibility for reporting the accountable actions from environmental watering and use of environmental works as required under Schedule B should be settled between the Commonwealth, MDBA and the operating jurisdictions.

3. Monitoring reviews

(a) In reviews of monitoring sites conducted by jurisdictions, the reviews:

- *need to be made available to the IAG–Salinity*
- *should show they meet the jurisdictional BSMS reporting obligations*
- *should be based on a risk approach to match the management regime for data collection and improvements in models*

- *should adopt a scientific approach to minimise the loss of information in the monitoring network.*

(b) *The agreed protocols for collecting salinity data need to be updated and adopted.*

(c) *Queensland has salinity hazards arising from CSG and irrigation and requires a better combined monitoring network if it is to analyse them.*

4. CSG water in Queensland

(a) *Queensland adequately monitors salinity hazards arising through CSG operations and associated irrigation, which will require a better combined monitoring database.*

(b) *The potential cumulative impacts of CSG and any associated irrigation in Queensland need to be assessed to determine whether they are a threat to the Basin salinity program.*

5. End–of–valley targets

(a) *In the future salinity arrangements, catchment EoVTs should be based on requirements of upstream and downstream assets (as detailed in the End–of–Valley Target Review). On this basis, targets should be representative of the salinity regime that will affect the agreed assets, and should not be constrained to the threshold and exceedance percentiles. This will assist in making the link between targets and community-driven management of potential asset impacts.*

(b) *Salt load requirements should only be required as part of EoVTs where they are relevant to assets.*

6. Outstanding register items

(a) *Queensland should provide written evidence to MDBA of the low salinity risk catchments that will not affect the Morgan target and do not require any further work to assess them for a register entry.*

(b) *Queensland, with assistance from MDBA, should undertake an analysis to determine the level of salinity threat in the Border Rivers catchment and needs to consider whether it is a significant item for salinity register purposes.*

(c) *NSW should formally advise MDBA of its schedule for its upcoming salinity register reviews.*

7. Modelling

(a) *By the end of the BSMS, MDBA should assess how closely the benchmark period matched the 2000–2015 climate (on average) and assess the magnitude of the difference between recorded and dynamically modelled Morgan salinity.*

(b) *A risk-based approach should be applied to model improvement as part of the seven–year review process, in line with the principle that further investment in model development should be driven by the salinity risk and the level of data available.*

(c) *Priority should be given to understanding and modelling physical linkages between rivers, floodplains and groundwater.*

Recommendations of previous IAG–Salinity reports not considered elsewhere

Many of the important recommendations from the 2010–11 and 2011–12 reviews have been progressed but not completed. Rather than being brought forward as new recommendations, those recommendations have been classified here as progressing or completed.

Recommendations being progressed

1. **Redefinition of the salinity risk expected in 2050 to guide future program development (Rec 1, 2012):** The Basin Salinity Management Advisory Panel (BSMAP) 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, possible reduced irrigation footprint, possible increased agricultural production and emerging salinity risks. **Progressing:** The General Review of Salinity Management has commenced and is planned to be completed in June 2014.

2. **The Basin Salinity Management Strategy model success story (Rec 4, 2012):** The success of the BSMS is promoted to demonstrate how good multigovernment programs can work when roles, responsibilities and accountabilities are well developed; an adaptive management framework is used and excellent jurisdictional collaboration and commitment to progressing the strategy occurs. **Progressing**: It is expected that the recommendation will be progressed following the General Review of Salinity Management.

3. **Salt interception program review (Rec 8, 2011):** The salt interception program is reviewed to consider optimising the system, taking into account the increasing maintenance requirement and the operational costs and capital investment made.
   Progressing: MDBA commenced a review, which will be completed during 2013–14.

4. **Updated economic valuations in the registers and forward projections based on salinity risk (Rec 9, 2011):** The registers be interpreted annually for policymakers, providing a current and forward economic valuation based on the values in the registers (which are in current dollars) and the level of credits needed into the future, taking into account any increase in credits to meet the target at Morgan.
   Progressing: To be considered in the future arrangements for salinity management.

5. **Flood recession salinity risks (Rec 1, 2010):** That MDBA with support from the BSMAP continue this program as a matter of urgency and prepare the operational plan required to manage the salinity risks. **Progressing:** MDBA has completed its review, which indicates that the section of the floodplain that provides the most threat is a section of the Murray between Lock 5 and Lock 6 (Chowilla). South Australia is undertaking analyses of the floodplains to bring them into its modelling.

Recommendations completed or not progressed

1. **Salinity impact zoning for Sunraysia New South Wales (Rec 10, 2011):** NSW reports a low risk with little new development and therefore does not intend to progress salinity impact zoning. However, it will bring any approved new developments to the registers. **Completed.**

2. **Irrigation Salinity Accountability Framework (Rec 10, 2010): Completed.** The only outstanding issue was the Riverine Plains analysis, which was reviewed and completed in 2012–13.

3. **Salinity expertise for the Commonwealth Environmental Water Holder (Rec 11, 2010): Not progressed.**

4. **Alignment of BSMS with catchment action plans (CAPs) (Rec 11, 2009): Completed.**

5. **Priority for upland catchment actions (Rec 6, 2011): Not progressed.** Considered in a new recommendation on EoVTs in this report.

6. **Targets and monitoring sites review (Rec 7, 2011): Completed.**

BSMS mid–term review

The recommendations in the mid–term review (2008) have all been progressed and are either completed or part of the current recommendations.

1. Introduction

Objectives and structure of the Basin Salinity Management Strategy

The Basin Salinity Management Strategy (BSMS) provides a framework for communities and governments to work together to control salinity and protect key assets and natural resource values in the Murray–Darling Basin (MDB). Its objectives are to:

1. maintain the water quality of the shared water resources of the Murray and Darling rivers for all beneficial uses—agricultural, environmental, urban, industrial and recreational
2. control the rise in salt loads in all tributary rivers of the MDB, and through that protect their water resources and aquatic ecosystems at agreed levels
3. control land degradation and protect important terrestrial ecosystems, productive farmland, cultural heritage and built infrastructure at agreed levels Basin–wide
4. maximise net benefits from salinity control across the Basin.

The obligations that provide for the implementation of the BSMS are set down in Schedule B to the Murray–Darling Basin Agreement, which is Schedule 1 to the *Water Act 2007* (Cwlth).

Schedule B supports effective salinity management by:

- promoting joint works, measures and other actions to reduce or limit the rate at which salinity increases within the MDB
- providing for the adoption of salinity targets
- establishing salinity registers to record salinity impacts and to allocate salinity credits and salinity debits to contracting governments
- providing for monitoring, assessing, auditing and reporting on progress in implementing the strategy.

Achievement of the BSMS objectives is measured not only through the salinity registers but also through the degree of achievement of the end–of–valley target (EoVT) and the Basin salinity target at Morgan. Progress towards meeting the agreed EoVT and the land management objectives is assessed through annual reports from the contracting governments and MDBA. The reports include valley reports for the catchments where an EoVT has been adopted. The Independent Audit Group for Salinity (IAG–Salinity) conducts an independent annual audit of the reports and register entries, and of the performance of the contracting governments and MDBA.

A key driver of the BSMS is the principle of 'capping' increases in salinity in the MDB by a system of salt credits and debits managed by the participating governments through two major mechanisms. One is joint investment in salt interception schemes (SISs) and associated infrastructure; the other is investment in target setting and monitoring systems at the end–of–valley sites in concert with plans and actions to improve land management practices across the Basin. Victoria has set sub–targets for irrigation areas and upland systems so that it can monitor their effect on the EoVT.

The nine elements of the BSMS are:

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

The BSMS commenced in 2001–02 and is scheduled for completion by 2015.

Terms of reference

The terms of reference of the IAG–Salinity of the BSMS are in Appendix 1 of this report. A summary of Schedule B, including its provisions concerning the audit of the BSMS, is in Appendix 2.

The development of the annual audit and reporting process has been a significant achievement for the BSMS. As set down in the Audit Plan, priority areas for review in this audit included the following:

1. **Registers:** those Schedule B accountabilities required to be reported to MDBA and to the Ministerial Council, particularly the auditors' assessment of whether the BSMS salinity registers are a fair and accurate record of the salinity impacts of actions.
2. **Reviews:** those rolling five–year reviews of register entries that are due to be completed and assessed; however, where the reviews have not been completed within the timeframes set down in Schedule B, some comment should be provided on:
    - the potential for improved estimates, given the available data and the development of analytical tools since the last assessment

- the relative risks in terms of likelihood and consequence, compared with other salinity assessments that have been, or should be, undertaken by the contracting governments.

3. **2012–13 IAG–Salinity recommendations:** The recommendations made by the IAG–Salinity are based on the draft 2012–13 annual implementation reports provided by each contracting government and MDBA and the auditors' assessment of progress made against the 2010–11 and 2011–12 recommendations. This may include a statement about progress made to date by the BSMS program as a whole on the mid–term review recommendations and directions. Note that some of those recommendations have been included in the Basin Plan.

The steps taken by the IAG–Salinity in carrying out the 2012–13 audit included:

- assessing the annual reports of the jurisdictions
- reviewing Registers A and B with MDBA staff
- travelling to each jurisdiction and meeting with the representatives of the contracting governments and MDBA; these were essentially all–day meetings with the contact officers, their teams of managers and specialists and, in some cases, managers of regional catchment management authorities (CMAs)
- discussing technical, scientific and policy issues with specialist staff from the jurisdictions and MDBA, seeking clarification or correction of misunderstandings
- providing the main draft text to jurisdictional contact officers for factual comments.

2. Implementation of the BSMS

Background

The reporting of progress is organised under the nine BSMS elements. The IAG–Salinity's assessment of the need for action under different elements sometimes leads to the same recommendation.
To improve readability, a recommendation is repeated if it arises a second time.

The relative priorities of the recommendations are shown in the executive summary and in this chapter. Each recommendation includes a priority number.

Overview

The BSMS, which is now in its 13th year, has been highly successful, as has been demonstrated by the Morgan target being met for the past four years. This may be attributed to both the run of recent climatic events and the implementation of the BSMS. The BSMS is reaching a conclusion, and this is the last IAG–Salinity audit before the strategy is to be reviewed. In the view of the IAG–Salinity, the BSMS has delivered the following benefits:

- a clear focus on providing good water quality at Morgan to provide for downstream assets, which has been successful
- clear accountability of all jurisdictions for meeting the Morgan target
- a joint program of investment, which:
    - improved the quality of water in the River Murray to meet the target established at Morgan and protected downstream assets from expected damage from salinity
    - enabled irrigation development to continue to occur with no further deterioration in salinity
    - enabled the water market to operate, allowing water to move to its highest value use with no further deterioration in salinity
- an agreed process for the allocation of benefits and costs between the joint venture and individual jurisdictions.

The strategy has provided a focus for the continuation of a collaborative joint effort between jurisdictions, which was maintained even through the highly charged period of Basin Plan development.

The strategy has the confidence of the jurisdictions and their communities because of the transparency of the registers and the annual audit process.

The challenge is now to review the BSMS and subsequent integration to manage salinity under the Basin Plan. The IAG–Salinity is pleased that the first step in this process, the General Review of Salinity Management, is now under way, as recommended in previous audits.

However, the IAG–Salinity suggests that the following key points be considered in integrating the new Basin salinity arrangements:

- The benefits provided by the BSMS should be built upon and not lost.
- Improved knowledge of Basin salinity generated during the past 13 years shows that salinity tends to be cyclical and driven in part by rainfall.
- The collaborative work on the utility and status of the EoVT targets should continue.
- Concern has been expressed, particularly from the two southern states, that the experiences of living with salinity in the wetter 1990s, which led to the strategy, should not be forgotten and that the more general approach to water quality and water resource plans as set out in the Basin Plan should not reduce the focus on salinity, which made it such a success.
- The introduction of water resource plans needs to be framed so that salinity can still be accounted for and monitored at the Basin–wide level.

The IAG–Salinity has captured some of the elements that have made the BSMS a success and makes the following recommendations.

Recommendation 1: BSMS review

In regard to the General Review of Salinity Management, the IAG–Salinity considers that the following features should be continued in the future salinity management arrangements:

- *The Basin salinity target at Morgan is a target connected to assets at risk and agreed actions are implemented to ensure that the target is met.*
- *There is a Basin–wide focus for salinity management as a major water quality issue for the Basin.*
- *The data and knowledge of the system continually improve and support good decision–making.*
- *Knowledge of the system and the models are upgraded every seven years through 'fit–for–purpose' model development, providing increasing surety about the outcome.*
- *The intent of Schedule B in providing the register system is maintained, given that it focuses the management of salinity and provides for trade–offs that cater for changing circumstances in each jurisdiction.*
- *The SISs provide surety in meeting the salinity target at Morgan.*
- *The governance arrangements for the BSMS (annual reviews, the joint jurisdictional programs and advisory group, the mid–term review and the independent audit of the registers and activities) have worked well.*

The BSMS could not deliver as originally expected in some areas, which need further consideration:

- *The upstream EoVTs were unrelated to upstream assets and were set as targets relevant to the Morgan target. However, there was little upstream community ownership or agreed management actions in the catchments to achieve those targets.*
- *The broadacre agriculture and revegetation elements, while delivering local benefits, have not provided joint outcomes at the Basin scale that could be accounted for at Morgan.*

Over the past 13 years, significant investments have been made in the following elements of the BSMS, with a great deal of success and change. The impact of some elements has been difficult to quantify because they involve diffuse sources of salinity. On the other hand, improved irrigation practices and the works and measures programs have been able to be modelled and measured. The following sections provide an overview of actions in the past 12 months and some comment on the overall success of each of the elements.

Element 1: Developing capacity to implement the BSMS

MDBA and the 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.

Catchments

Increasing knowledge of salinity processes in the catchments of the Basin has remained a priority across all the partner governments and MDBA.

A key focus for jurisdictions and MDBA in 2012–13 was a major review of the EoVTs addressing significant questions about their role and value, particularly in relation to:

- their linkages to land management, principally in dryland areas for which they were intended to be an indicator
- their value in achieving Basin outcomes rather than local ones
- their importance, given changes in future projections in salinity trends
- their relationship to the 'legacy of history' entries on Register B.

A review of Murray–Darling Basin EoVTs was undertaken by MDBA as a collaborative venture with the active participation of all jurisdictions. It used the best available science and modelling and the most recent data from all jurisdictions to understand the extent of valley-scale salinity threats and the historical salinity record and to more accurately make future salinity projections. It detailed the improvement of the knowledge base since the inception of the BSMS, provided a rationale for current targets, provided a methodology to revise targets and reviewed the status and direction of modelling and monitoring.

The review report is a substantial piece of work and illustrates a key point made by all jurisdictions and recognised by MDBA — that salinity (particularly in the dryland areas) is cyclical, is driven primarily by climate and responds to wet and dry cycles. As a consequence, it is now recognised that the salinity projections made at the commencement of the BSMS were 'worst case' projections, reflecting a wet period in the climate cycle and unlikely to occur at the levels predicted unless there is a return to prolonged very wet conditions. This has significant implications for the future management of salinity in the Basin and, as a result, the review made recommendations for the revision of the EoVTs as well as their potential role in the review of Schedule B and in the implementation of the Basin Plan.

The outcomes have been strongly supported by all jurisdictions.

A second piece of work undertaken collaboratively by MDBA and jurisdictions was the development of the Irrigation Salinity Assessment Framework to assess the salinity impacts of changes to irrigation water use, with application to several regional case studies. A key finding of the project was that the potential impacts on salt mobilisation from changes in irrigation water use were consistently low across most of the Riverine Plains, except for the Torrumbarry Irrigation District (Barr Creek), where there was potential for significant impacts.

In addition, jurisdictions continued to invest in research and investigations aimed at improving knowledge, investment priorities and salinity management practice.

In South Australia:

- the South Australia MDB Natural Resource Management (NRM) Board continued its collaboration with the University of Naples (Italy) to conduct a trial in the Bookpurnong–Lock 4 irrigation districts to assess the effectiveness of satellite–based remote sensing input to inform agricultural water management
- a study was undertaken to understand the best evapo-transpiration (ET) method and respective Kc (crop water use coefficient) values to use for major crop types to support greater water–use efficiency.

In Victoria (DEPI 2013), projects included:

- the release of the Victorian Dryland Salinity Update and the Victorian Soil Health Strategy
- the Shepparton Irrigation Region Salt and Water Balance Project, which maps out soil salinity and shallow watertables and is aimed at improving understanding of watertable accessions relating to climate, water use, antecedent conditions and improving irrigation management
- a study to improve the calculation of maximum water application rates for various crops and management practices in the Mallee
- understanding the salinity impacts of flushing Psyche Bend Lagoon
- the publication of a single report outlining the current understanding of salinity management in the Mallee
- completion of Stage 2 of the Kerang Lakes REALM upgrade to update the model to simulate the operation of the mid–Murray storages and estimate salinity within the Torrumbarry system in the Murray River.

Work in NSW included the following:

- The Salinity Hazard for Catchment Action Plan update was undertaken. This project utilised statewide datasets and provided a salinity hazard map and report for each CMA to include in its catchment action plan (CAP) update.
- The Hydrogeological Landscapes (HGL) process was applied in a number of priority catchments, including in western areas of the Central West CMA region and in high–salinity sub catchments of the Murrumbidgee. This aims to develop specific land use and management actions to reduce salinity impacts on farming land and river inflows in dryland areas. It is highly effective at the local scale but unlikely to have significant impacts at the Basin scale. It has recently been extended to assist in the mapping of wetland areas.

In Queensland:

- a number of projects relating to the distribution and mobilisation of salt and catchment salt balances in the Queensland catchments of the MDB were completed
- investigations were completed on the potential salinity impacts of using coal seam gas water for agriculture and forestry in the Queensland MDB
- a report on the potential impacts of land clearing and irrigation development since 2000 on salinity (Biggs et al. 2013) was used in the development of the EoVT report.

Flood management

Flooding can mobilise a significant salt load from the floodplain, both during the flood and in the subsequent succession period through groundwater recession. However, floodplain processes governing salt export are not well understood and are currently represented in models in only a rudimentary way. This has been of significant concern to jurisdictions and MDBA and is increasingly important, given that the Basin Plan will return large volumes of water to the environment and that those volumes will be used where possible to enhance floodplain watering.

During 2012–13, MDBA completed the second stage of the Flood Recession Salt Mobilisation from the Murray Floodplains Study, which aims to improve the accuracy of modelling of salinity impacts associated with flooding. The project recommended some small improvements to existing models in the representation of unaccounted salt in the BigMod models and suggested areas for further work.
The project showed that there is still a long way to go in our understanding of floodplain processes and the source and movement of salt during flooding, and that this will require significant work in the future to ensure that those factors can be represented accurately in model and accountability frameworks.

South Australia has recognised the importance of this in its River Murray systems and is doing significant work to improve understanding. This includes Modelling Salt Dynamics on the River Murray Floodplain in South Australia—a project with the South Australian Goyder Institute. Specific work is also being undertaken at key icon sites where environmental works are being built or are proposed to enhance flood regimes (for example, detailed work has been undertaken at Chowilla to enable the development of an operating strategy for the Chowilla regulator that will minimise salinity impacts on the river as the regulator commences operation in 2014). Further work is also being undertaken to support the South Australian Riverland Floodplains Integrated Infrastructure Program. A $155 million project on the Pike River will integrate the operation of environmental regulating structures built on the floodplain with an

expanded SIS and applications of environmental water to enhance the environmental values of this section of the South Australian Murray floodplain.

Environmental water

The recovery of water for the environment by the Commonwealth and the delivery of environmental water are both areas of immediate interest to jurisdictions in managing salinity into the future. In previous years, the IAG–Salinity has made recommendations on the imperative to develop the policy and governance framework for the management of environmental water and its salinity threats. Those recommendations have not yet been addressed.

This is now becoming urgent, as environmental water holders are now delivering large volumes of water through their delivery partners. During 2012–13, the Commonwealth Environmental Water Office (CEWO) used 1,272 GL of water (CEWH 2013). Of that volume, five watering proposals totalling around 400 GL included specific water-quality objectives and were expected to have positive salinity outcomes. The Goulburn–Broken CMA delivered about 250 GL to support fish, macroinvertebrates and vegetation in the lower Goulburn River and lower Broken Creek and to Barmah–Millewa Forest to support waterbird breeding events. South Australia secured Commonwealth water and TLM water for barrage releases.

Following discussions with jurisdictions, the CEWO and MDBA, the IAG–Salinity considers that there are four policy areas related to the BSMS to be dealt with in the recovery and use of water for the environment under the Basin Plan:

1. Quantifying and accounting for the long–term salinity impacts of water recovery through irrigation modernisation and changes to farm management, such as through Commonwealth on–farm programs. This should be dealt with by jurisdictions as accountable actions and where necessary be entered on Register A.

2. Quantifying and accounting for the long–term salinity impacts of taking 2,750 GL and the TLM and Snowy water out of production and redirecting it to the environment, where a large proportion of it will result in improved river flows and is therefore likely to provide dilution benefits. This should also be dealt with as an accountable action and entered on Register A.

3. Quantifying and accounting for the long–term salinity impacts of any environmental works built to provide enhanced or more efficient floodplain watering. These will include the TLM works and any environmental works built as environmental offsets under the Basin Plan. Each of these will have an operating strategy, similar to an SIS proposal, which can be assessed. This should also be dealt with as accountable actions and, where necessary, entered on Register A.

4. Understanding and mitigating the real–time salinity threats associated with a specific environmental watering action. Environmental watering must have regard to the water quality targets outlined in the Basin Plan. How this will be interpreted needs clarification, as targets are to be assessed over five years under the Basin Plan. If that is the case, there should be no long–term salinity impacts under Schedule B that could be treated as an operational issue.

Point 1 can be undertaken within the current BSMS governance framework, and both Victoria and South Australia have foreshadowed that they will be quantifying this in future years. Victoria outlined that the next iteration of the Shepparton Irrigation Area Salinity Management Plan will include the impacts of the Goulburn–Murray Water Connections Project and the Commonwealth on–farm programs. South Australia will also examine the impact of its equivalent programs.

On Point 2, MDBA indicated that it had done some preliminary work to understand the potential long–term dilution benefits of environmental water sourced under the Basin Plan and from the TLM and Snowy initiatives. However, further work needs to be undertaken using the broad directions of the Basin Plan's Environmental Watering Plan to quantify this and enter it on Register A. In addition, the policy and governance framework for the ownership, use and accountability of salinity credits or debits needs to be developed as a matter of urgency between the Commonwealth, which owns most of the environmental water, and the jurisdictions, which own some of the water and through which it is all deployed.

On Point 3, considerable work has been done in relation to the TLM works as part of their business cases and detailed design. As each work nears completion, jurisdictions provide MDBA with operating strategies for the structures. Preliminary salinity impact assessment reports of watering actions have been submitted to MDBA for the following TLM sites with environmental works:

- Koondrook–Perricoota Forest on the Wakool and Murray rivers
- Lindsay Island Stage I works and measures
- Mulcra Island, Hattah Lakes and Gunbower Forest.

While MDBA has used these reports to inform some preliminary estimates of the salinity impacts of the TLM environmental works, further policy work on assessment, accountability and management needs to be undertaken and agreed to ensure that the salinity impacts of the TLM works are properly and consistently accounted for under the BSMS. This is necessary, given that the TLM works are the first suite of environmental works to be built. Victoria, South Australia and NSW are currently preparing feasibility studies and concept designs for works to be considered as environmental offsets under the Basin Plan. Long–term salinity impacts are being identified as part of this process.

Recommendation 2: Environmental water

(a) Three new register items should be added to the registers with notional values to cover:

i. environmental water recovery

ii. use of water for environmental purposes

iii. environmental works and measures (initially covering the TLM works).

(b) The policy principles for environmental watering and use of environmental works should be evaluated through modelled scenarios of salinity and dilution impacts and be undertaken by the CEWO, the Basin states/territory and MDBA.

(c) The Basin–wide plan and policy framework for managing impacts and responsibility for reporting the accountable actions from environmental watering and use of environmental works as required under Schedule B should be settled between the Commonwealth, MDBA and the operating jurisdictions.

In relation to Point 4 (understanding and mitigating the salinity risks associated with environmental watering events), considerable work has been undertaken by the jurisdictions and the CEWO to minimise the real–time salinity impacts. The CEWO advised that its process included an agreed requirement that annual watering priorities and seasonal watering proposals must identify salinity risks. Where potentially high risks are identified, the CEWO has worked with delivery partners in the past to commission work to better understand the nature of the threat. For example, in 2013 the CEWO, in collaboration with the Mallee CMA, worked with MDBA to model the potential salinity impacts of providing water to a number of Mallee wetlands so as to be able to plan the mitigation of any impacts.

Where necessary, watering proposals will include mitigation strategies and the design of the watering option must be consistent with existing Commonwealth and state legislative requirements, including the CEWO's obligation to have regard to the Basin Plan's water quality and salinity targets.

Operational monitoring is undertaken for all watering actions to ensure that water is delivered as planned and to help manage risks, including salinity, where it is determined that the risk requires active management. In addition, the CEWO has contracted the South Australian Research and Development Institute (SARDI) to undertake short–term intervention monitoring of Commonwealth environmental water in the lower Murray. This work includes the application of two separate models to:

- analyse the influence of environmental water flows on the transport and export of salt and nutrients from Lock 1 in South Australia through the Murray Mouth
- model the effects of environmental water on water and salinity levels in the Coorong.

These operating processes have been developed involving MDBA and jurisdictional environmental water holders. Given this process to manage the real–time salinity impacts of environmental watering and the recommendation that the effect of environmental works and measures be dealt with separately (see Point 3), it is likely that the long-term risk will be minimal. However, a watching brief should be maintained to ensure that this is the case.

Communication

All states have processes for communication with their CMAs and regional bodies and with communities through their regional bodies and CMAs. In addition, all states have programs for working with landholders to improve land management practices (such as HGL, outlined above).
Activities during 2012–13 included irrigation training days, workshops, salinity education in schools and through Waterwatch, working with Landcare groups, and conducting Reading the Landscape and Salt of the Earth courses and training courses for local government in urban salinity. Programs include NSW's Key Sites program, Victoria's Beyond Soilcare program, and South Australia's Automatic Weather Monitoring Network.

Modelling

The development and management of salinity registers is dependent upon models, which include catchment models, river models and groundwater models. Different models are used by the various jurisdictions. For catchment modelling, the baseline is defined by analysis of historical data and projections modelled with 2CSalt (Stenson et al. 2005) and MODFLOW. River modelling is with IQQM (Simons et al. 1996), REALM (Diment 1991; Perera et al. 2005) and MSM–BigMod (Close 1996), although salinity routing is not implemented in all cases. Where groundwater is modelled, it is modelled using MODFLOW. Surface water and groundwater interactions are not explicitly modelled.

MDBA

MDBA is currently using MSM–BigMod for salinity assessment on the River Murray, although significant progress has been made towards the implementation of eWater's Source (Water Quantity and Quality Model Software—Welsh et al. 2012) under the National Hydrological Modelling Platform project.
Under this project, MDBA is building a Murray stem–Lower Darling Source model and is integrating it with a Murrumbidgee Source model being built by NSW and a Goulburn Source model being developed by Victoria to develop a fully integrated Source model of the southern connected Murray system.
The water quantity and some of the water management components have been calibrated.
Work on salinity modelling will commence in the near future. The salinity routing algorithms used in BigMod have been integrated within Source, which should make the task of transferring parameters relatively easy; most of the work will be in ensuring that Source is working correctly. The other advantage is that, as the other states implement Source, they can adopt the marker tracking method used in BigMod.

REALM and IQQM use a fully mixed salinity routing approach. This approach is much simpler but moves salinity at kinematic wave or lag speeds rather than at the velocity of flow. For natural river systems, flow velocity is about 70% of the kinematic wave speed. In the future, as Source is implemented, it may have implications for salinity concentration peaks where peaks may be amplified by being shifted to lower flow periods.

Surface water and groundwater interactions are described by regression relationships. In some reaches, unaccounted salinity is as high as 30%. It is hoped that these interactions will be more physically based as knowledge improves and the capability in Source is used. This will be particularly important for considering the impact of environmental watering.

Australian Capital Territory

The ACT has a 2CSalt model. There are no river or groundwater salinity models. There are source quantity models of the ACT within the ACT Environment and Sustainable Development Directorate, and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has developed a source model that covers the ACT and upper Murrumbidgee (CSIRO 2008c). These models have not been used for salinity purposes.

New South Wales

NSW IQQMs (integrated quantity and quality models) have been upgraded for water sharing plan assessment, but the upgrade has been limited to water quantity. The models used for salinity assessment have not been upgraded. NSW is now upgrading some of its regional models to Source.
Significant progress has been made on the Namoi, and work is commencing on the Murrumbidgee.
These Source models only consider water quantity. Significant work will be required to include salinity in the models. When configuring models for salinity, the conceptualisation of water quantity may need to change to reflect salinity behaviour in systems and a subsequent recalibration may be required.

NSW has developed a broad suite of groundwater models, all based on MODFLOW, for water sharing plan purposes. None of the models is used directly for MDB salinity purposes, apart from a model of the Buronga SIS developed around 2005 at the time of SIS expansion. Accreditation has not been sought for any NSW groundwater models. However, NSW and Victoria jointly sponsored the development of the Eastern Mallee Modelling Package (formerly EM 2.3), and that model has been accredited.
Some work was done on linking surface water and groundwater quantity as part of the Sustainable Yields projects (CSIRO 2008c). It is hoped that surface water and groundwater models can be linked for both water quantity and salinity in the future. This will be important for understanding the potential salinity impacts of environmental watering and will be particularly important for high salinity threat areas, such as the Gwydir region.

Queensland

Queensland uses IQQM for water quantity and salinity modelling. A 2CSalt model has been built for one small catchment—Hodgson Creek. Queensland has plans for upgrading all of the river system models to Source. Salinity and other water quality parameters will be incorporated into these models.

The Office of Groundwater Impact Assessment (formerly the Queensland Water Commission) has taken responsibility of developing a regional groundwater model (in MODFLOW) for the Surat Cumulative Management Area, for the cumulative assessment of water impacts from coal seam gas operations.
The Phase 1 Underground Water Impact Report became effective in December 2012. Several research projects, including on connectivity between the Condamine Alluvium and sub-cropping Walloon Coal Measures, are under way. The model will be updated by 2015.

There is currently no linkage between groundwater and surface water models from either a quantity or a salinity perspective. Some work on linking surface and groundwater quantity was done as part of the Sustainable Yields projects (CSIRO 2007a) in the Condamine and Border Rivers catchments.
The existing groundwater models are poor (CSIRO 2008a) and do not cover high-threat regions, so there is no immediate need to connect the models, which could happen as knowledge evolves.
At present, no groundwater models are accredited for MDB salinity purposes.

Victoria

Victorian REALM models have been continuously upgraded for water management purposes, but this has been limited to water quantity. Minimal changes have been made to the REALM salinity models for baseline conditions. However, projection work has been improved using CAT1D and 2CSalt, and those projections have been included in REALM. Significant progress has been made on the Source Goulburn–Broken–Campaspe–Loddon model (GSM). This model only considers water quantity, and significant work will be needed to include salinity.

Although the entire state of Victoria is covered by groundwater models of various scales, there is little reliance on them for MDB salinity purposes. One exception is the Sunraysia Eastern Mallee Modelling Package (SEMMP EM 2.3.1), jointly developed with NSW, which has been accredited.

Some work on linking the GSM and Kutunga groundwater quantity models was undertaken as part of the Sustainable Yields projects (CSIRO 2008b). It is hoped that surface water and groundwater models can be linked for both water quantity and salinity in the future. This is particularly important in Victoria, where the interaction between surface water and groundwater has a significant impact on river salinities.

South Australia

South Australia has made some significant advances in MODFLOW modelling with five regional models and is heavily reliant on them for quantifying accountable actions on the salinity registers.
The models provide estimates of headwater catchment contributions to salinity and are linked with MSM–BigMod. They have been specifically developed and accredited explicitly for the salinity registers. There is a significant gap in modelling the interactions of floodplains and the river; while this is true for all modelling along the river, the greatest need identified in the MDBA analysis of floodplains is in the South Australian section of the river. South Australia's Goyder Institute is currently undertaking research into conceptualising floodplain–groundwater–river interactions in South Australia. That research could be implemented in MSM–BigMod or Source.

SIMRAT is still in use for rapid assessments of water–use applications.

Future directions

Although the existing models have been accredited and are considered 'fit–for–purpose', significantly more data has now been collected. This has improved the understanding of how salinity operates in various catchments and over longer time cycles, and is showing that:

- salinity is cyclical, reflecting longer term climate conditions (raising questions about the ongoing appropriateness of the modelling benchmark period of 1975–2000)
- dryland salinity is not as big a problem as it was first thought, and land–use improvements in these areas are providing local rather than Basin–wide salinity benefits (this suggests that, while upper catchment modelling can be significantly improved, dryland salinity is not a great risk for the Basin and is not a high priority).

The major issue with the current river models is that they do not consider the physical linkages between rivers, floodplains and groundwater from either a quantity or a salinity perspective. Modelling this linkage is going to be particularly important to evaluate the impacts of environmental watering. There are also a range of models and calibration philosophies. Comparisons between register entries would benefit from a common modelling approach driven by best practice modelling. Comparisons would also benefit from understanding the uncertainty in these models. This can be achieved through well-established uncertainty analysis techniques.

Modelling of groundwater is particularly important in areas where there is a strong connection between groundwater and the river, such as in the lower Murray River. There is a range of options, from very simple models to the more complex MODFLOW models. The selection of the appropriate model should be driven by the significance of salinity impacts as well as the availability of data. A need for consistency of approach and an understanding of uncertainty is also important for groundwater models as they are used to assess changes in salinity due to environmental watering and SISs.

The IAG–Salinity notes that model development is an expensive exercise and that, consequently, model improvement should be driven by a risk–based approach. Models that assess the highest salinity risk should be considered first. Model complexity should be driven by the salinity risk and by the level of data available. More complex models should be used for high–risk areas with reasonable data and less complex models for low–risk areas and poor data.

Recommendation 7: Modelling

(a) By the end of the BSMS, MDBA should assess how closely the benchmark period matched the 2000–2015 climate (on average) and the magnitude of the difference between recorded and dynamically modelled Morgan salinity.

(b) A risk–based approach should be applied to model improvement as part of the seven–year review process, based on the principle that further investment in model development should be driven by the salinity risk and the level of data available.

(c) Priority should be given to understanding and modelling physical linkages between rivers, floodplains and groundwater.

Element 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 recognises that living with salinity is the only choice in some situations.

Planning

All jurisdictions outlined that the identification of values and assets at risk from salinity is undertaken through their catchment planning processes. While the process differs among jurisdictions, they all have the same general model. High–value economic, social and environmental assets are identified within catchments, together with key threats. On the basis of that identification, priorities are set for NRM activities and investment. Salinity is therefore treated as one threat among many and balanced against other catchment health targets and economic and social needs. In areas where salinity poses a significant risk to assets, it will be identified and addressed specifically. In areas where it is less of a threat, it will be dealt with as a general water quality issue. This holistic NRM planning process has evolved to meet the requirements of both the Australian Government's and state and territory governments' varying funding programs.

In terms of catchment planning, 2012–13 was a significant year in the Basin. During the year, regional bodies in NSW and Victoria revised their catchment plans. In NSW, CMAs across the state were required to update their 10–year statutory CAPs. In Victoria, all CMAs reviewed their statutory regional catchment strategies (RCSs). The strategies provide an overarching strategic framework for action, under which a range of sub–strategies and action plans are undertaken, including land and water management plans (LWMPs) in irrigation areas. The reviews of the strategies involve significant consultation with the catchment communities.

In NSW and Victoria, recent statewide assessments of salinity risk were provided to CMAs to ensure that the review of their strategies was based on the best available information. In NSW, this was through the provision of a salinity hazard report for each CMA region. Where the more detailed HGL process had been undertaken, this was also considered in the CAP updates. In Victoria, the Victorian Dryland Salinity Update provided contemporary information on Victorian salinity provinces and identified where the concentration and severity of salinity coincide with high–value natural assets.

In Queensland, regional NRM bodies in partnership with government agencies are continuing to identify local environmental values and draft water quality objectives for streams in their regions within the Queensland part of the MDB. This will contribute to the development of environmental values and water quality objectives under the Environmental Protection Policy Water (2009) and associated Healthy Waters management plans, which guide catchment water quality improvement action. Once finalised, the water quality objectives and values will be formally approved under the *Environment Protection Act 1994.*

In South Australia, the Morgan target helps to protect relevant assets. Short–term salinity spikes may occur, and during the drought significant increases in salinity were observed in the Lower Lakes even though the Morgan target was achieved. Many of the assets are identified in the South Australian MDB NRM Plan (SA MDB NRM Board 2008), the South Australian Strategic Plan and the Water for Good Strategy of the South Australian Government.

In the view of the IAG–Salinity, recent catchment planning processes in NSW and Victoria were a significant improvement on past planning arrangements, in that communities were provided with the best available information on salinity hazards in their regions and were able to overlay it on their catchment assets to get a real picture of the risk salinity poses in the region and to balance the need for salinity management with other catchment health objectives. It is important that this information remains current, enabling communities to understand the cyclical nature of salinity and to continue to build it into their catchment plans and management programs.

2012–13 salinity risk

The modelled salinity target at Morgan has been achieved for the fourth year in a row, assisted by actions taken under the BSMS. Although 2012–13 was not as wet as the previous two years, states have continued to monitor watertables to identify any re-emerging salinity risks and to better understand the responsiveness of groundwater systems to climate variations.

In Victoria, the Goulburn–Broken CMA is monitoring 414 representative bores in the Shepparton Irrigation District. The bores showed a rapid rise in watertables of approximately 2 m in the two years after the end of the drought. However, they have appeared to stabilise in the past year. This work is allowing the CMA to refine the areas most at risk within the irrigation district and to start to develop triggers for action; based on groundwater levels—a significant improvement over the last LWMP that will result in better targeted investment and action.

The North Central CMA reported that its region’s groundwater levels appear to have returned to drought levels, two years after the biggest floods on record in the region.

Queensland reported that groundwater levels have risen in productive aquifers such as the Condamine Alluvium and are reflected in increased base flows and elevated salinities being observed in all catchments except for the Paroo. Shallow groundwater tables have also risen in the Border Rivers following the flooding in recent years. In the Moonie catchment, shallow groundwater levels have risen in areas where previously cropped land has been converted to pasture. In the Condamine catchment, there has been some increase in dryland salinity outbreaks.

These results are consistent with the view that salinity rises and falls in the dryland are cyclical and related to climate.

While the jurisdictions did not report any immediate significant salinity threats to their irrigation, biodiversity or urban assets in 2012–13, they are all monitoring the situation closely, given the return of wetter seasons. This information will improve their salinity planning and provide better information to landowners on their salinity risk and management options.

Coal seam gas water

Coal seam gas (CSG) is an emerging issue within the Basin, but its implications for salinity management remain unclear. CSG water contains significant but variable concentrations of salt, and dissolved solid values typically range from 2,000 mg/L to more than 10,000 mg/L. It also has a high sodium adsorption ratio (SAR) and may contain hydrocarbons that have the potential to cause environmental harm.

Both Queensland and NSW have developed policy frameworks aimed at ensuring that the salt produced does not cause environmental harm and encouraging the beneficial use of CSG water.

In December 2012, Queensland released its new Coal Seam Gas Water Management Policy.
The objective of the policy is to manage CSG water as a first priority, for a purpose that is beneficial to one or more of the environment, existing or new users and existing or new water-dependent industries. If that is not possible, then the second priority is to treat and dispose of the water in a way that minimises and mitigates impacts on environmental values. A number of CSG companies are proposing to use treated CSG water in either existing or new irrigation schemes. To guarantee that this does not result in either local or regional salinity problems, the IAG–Salinity considers that it will be important to ensure that any approval process examines the likelihood and severity of increased groundwater recharge leading to saline discharges to streams in the region. As the number of CSG projects increases, it will also be important to ensure that the cumulative impacts of increased irrigation activity are accounted for.

NSW undertook a significant review of its CSG policy framework during 2012–13 and released two major policy initiatives in September 2012—the Strategic Land Use Policy and the Aquifer Interference Policy. Water taken for CSG will require a water licence and will be accounted for in the water budget and water sharing arrangements. Disposal of CSG water will not use evaporation ponds and will require treatment to an appropriate quality, such that the water will have minimal impact on receiving waters and will not affect their beneficial use category. Because of differences in geology, lateral distances to recharge sources and vertical separation from prospective aquifers, the volume of CSG water per well in NSW is several orders of magnitude lower than for Queensland wells. Given the lower level of planned CSG development, CSG water in NSW is not likely to pose a significant risk of salinity.

The IAG–Salinity considers that these new policy frameworks should address most of the potential salinity issues associated with CSG development. Nonetheless, a watching brief should be maintained, particularly for the development or extension of irrigation, to ensure that the proposed controls are effective and, either individually or cumulatively, do not increase salinity impacts in the Basin.

However, the IAG–Salinity was concerned that Queensland would not be able to provide evidence that CSG would not affect salinity in the MDB because it does not have a central point of oversight or a central database of approvals, which are managed by a number of different departments.

Recommendation 3. CSG water in Queensland

(a) Queensland adequately monitors salinity hazards arising through CSG and associated irrigation, which will require a better combined monitoring database.

(b) The potential cumulative impacts of CSG and any associated irrigation in Queensland need to be assessed to determine whether those activities are a threat to the Basin salinity program.

Element 3: Setting salinity targets

This element requires the adoption of EoVTs 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 EoVTs and determine within–valley targets and monitoring arrangements under salinity and catchment management plans.

As noted in Element 1, the review of EoVTs as required under Schedule B has been completed. The review is described in two reports (*Review of end–of–valley targets: Phase 1* and *Review of end–of–valley targets Phase 2*).

The review found that the northern Basin poses a low salinity threat due to reasonably low groundwater levels on the floodplains. An improved understanding in the southern uplands indicates that the salinity threat was largely climate driven. The wetter conditions in the latter half of the 20th century led to rises in groundwater levels and, with the best information available at the time, led to a more concerning outlook than we have today. The recent dry period has included a drop in groundwater levels, reports suggest that groundwater is now in a dynamic equilibrium and we have greatly improved the management and knowledge of the system. On this basis, previous salinity projections were overestimates and should be revised.

Salinity in the riverine plains is largely due to increases in groundwater levels from irrigation recharge. Recent climate sequences highlighted the dependence of groundwater in this region on climate. Recent changes in water distribution, use and efficiency are expected to reduce groundwater mounding and hence the salinity threat, although local impacts may occur in areas of high irrigation intensity. The Mallee region poses a significant salinity threat, driven by rises in highly saline groundwater caused by additional recharge from changes in land use. The salinity threat varies with the flow regime and is greatest in the tail of flood recessions. The threat is being managed by limiting irrigation development to lower impact zones and SISs. It is expected that future environmental watering could cause salinity levels to rise sporadically. The report also concludes that dryland salinity is not as great a risk to valley assets as once thought.

Issues raised in the 2006–07 audit (MDBC 2008), the EoVT review and recent discussions with jurisdictional agency personnel during this audit highlighted the disconnection between the EoVTs and impacts on regional assets, particularly those significantly upstream of target sites.
Jurisdictions are supportive of some aspects of the EoVT concept in salinity management in the Basin. The review suggests that:

> the rationale for targets can be likened to dashboard indicators designed as a signal to governments and communities as to their contributions to impacts of land and water management actions within their valley. This obligation to consider the downstream impacts of development influences the decisions of regulatory bodies, and encourages the investigation of mitigation measures or the investment in offsets. The effectiveness of the accountability framework has been demonstrated within the lower Murray (due to the operation of the registers and the location of the Basin Target). Such examples are less obvious within the upper catchments where cost effective investment is more difficult to locate and outcomes harder to quantify, however the principles provided by the end–of–valley accountabilities are an effective policy signal; a signal that would possibly not be deemed relevant if the only in–stream target site was at Morgan.

The Basin Plan requires a risk–based approach to water quality management, and the likelihood and consequence of the salinity threat will need to be assessed on that basis. To support 'likelihood', a better understanding of uncertainty in both observed data and model output will be required.
To support 'consequence', a greater understanding of the impacts of salinity on assets will be required.
The EoVT review used a method for deriving EoVTs that takes into consideration the linkage between both upstream and downstream assets and the EoVT, as described in Figure 3.

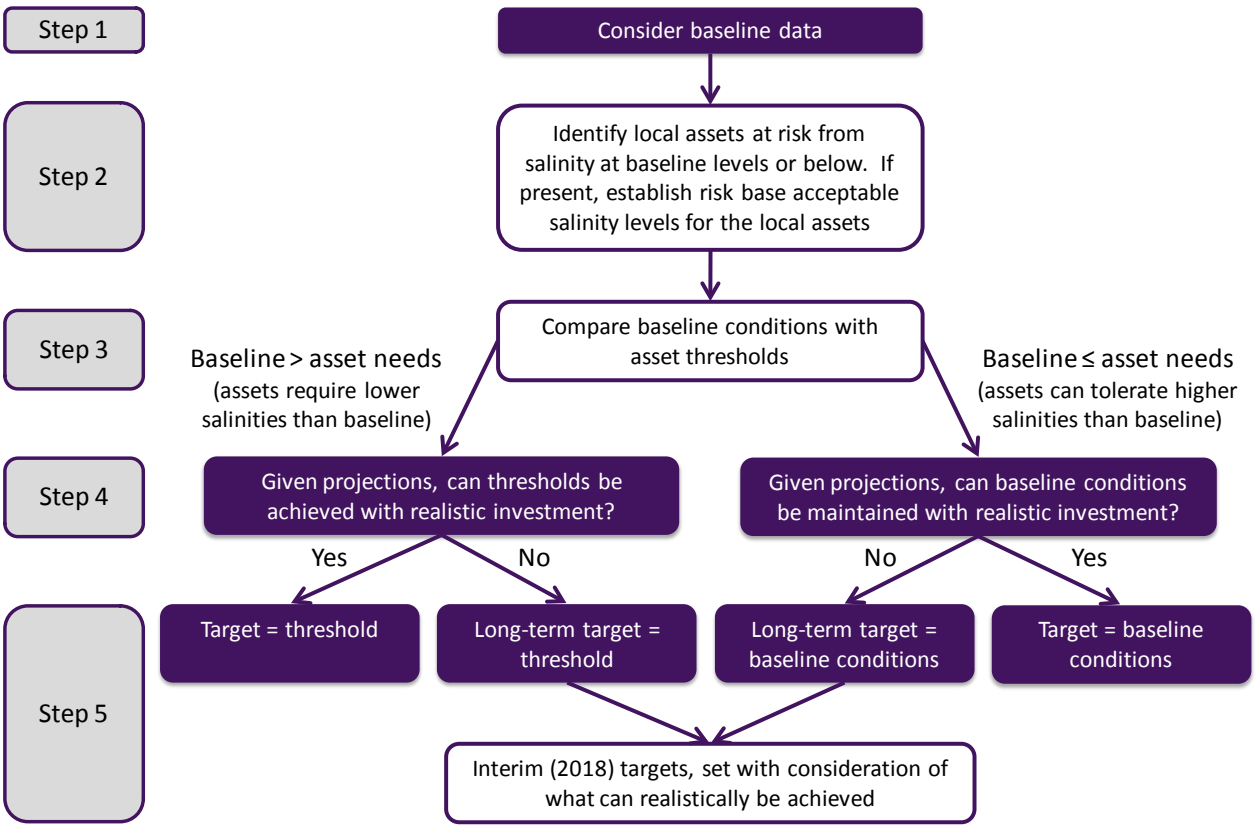

Figure 3 Method for assessing the adequacy and appropriateness of targets (MDBA, unpublished)

The EoVT review suggests that in most cases baseline salinities are appropriate, which indicates that for most of the regions the salinity risk is low. However, many EoVTs would need to be reduced to satisfy this recommendation. Salinity projections do not suggest a significant rise in water salinity that would create investment challenges to maintain baseline conditions over the longer term. Exceptions to these findings are as follows:

- In the Gwydir, Avoca and Loddon regions, projections from baseline conditions may be difficult to maintain without significant investment.
- In the Queensland Border Rivers catchment, there is evidence that a groundwater mound may be developing beneath intensively irrigated areas between Tallwood and Mungindi (Figure 4). There is insufficient data to support an understanding of the linkage between these local aquifers and the stream network (Recommendation 3).
- The below-baseline target at Morgan should be maintained in line with the Basin salinity target (800 EC at Morgan, 95% of the time).

Finally, the EoVT review (Section 12.2) and the previous audit (MDBA 2013) discuss the relevance of using salt load as part of the target definition. Reasons for not using salt loads include the following:

- Salt loads cannot be controlled in unregulated systems (other than by specific works and measures).
- Salt loads are not a meaningful metric in highly ephemeral systems.
- Impacts on assets are related to concentration rather than to load.

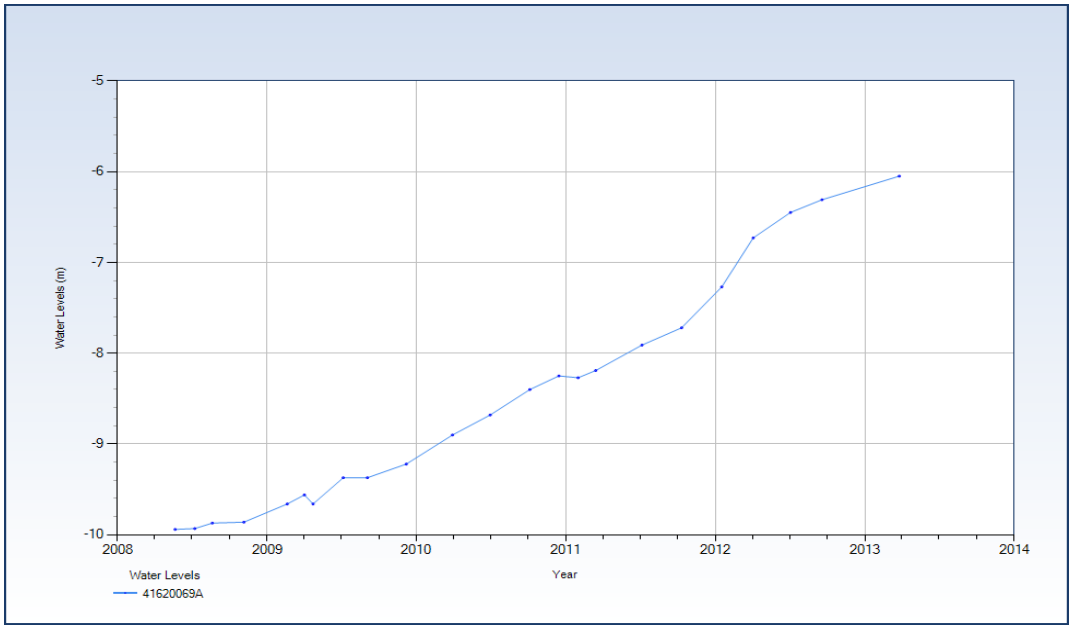

Figure 4 Representative trends in water levels in the Queensland Border Rivers lower floodplain

The IAG–Salinity believes that the EoVT review is a significant piece of work that should be given serious consideration in the General Review of Salinity, the Review of the BSMS and integration with the Basin Plan.

Recommendation 5: End–of–valley targets

(a) In the future salinity arrangements, catchment EoVTs should be based on the requirements of upstream and downstream assets (as detailed in the EoVT review). On this basis, targets should be representative of the salinity regime that will affect the agreed assets, but should not be constrained to the threshold and exceedance percentiles. This will assist in making the link between targets and community–driven management of potential asset impacts.

(b) Salt load requirements should only be required as part of EoVTs where they are relevant to assets.

Monitoring and data collection

Data is the primary source of knowledge and provides the foundation for understanding processes, leading to the development of conceptual models that describe those processes. Data collected since the benchmark period has highlighted this issue (current evidence suggests that salinity trends are not as severe as the data first suggested). Data collection since that period has helped to refine model conceptualisations and subsequently improve certainty in salinity estimates and projections.

Mandatory monitoring requirements under Schedule B (clauses 25–28) (MDBC 2005) are largely being met by the jurisdictions. However, clause 28 may need to be expanded to consider works and measures for environmental purposes, as the impact of those assets should be considered within the registers described in Schedule B. The issues of adherence to recording protocols (MDBC 2005) mentioned in the previous BSMS audit have not been addressed. The audit panel was advised that Queensland hydrographers were not aware of the protocols and, having been made aware of them, are reluctant to change from the National Standard for Water Quality Data Collection (AS/NZ 1:199). The cost, distance to sites, frequency of visits and problems with ephemeral streams were cited as some of the reasons for accuracy issues and gaps in records.

All of the jurisdictions have undertaken reviews of monitoring networks that have resulted in the rationalisation (loss) of both surface water and groundwater sites. None of the EoVT sites has been affected. The audit panel was not provided with information on these reviews and consequently cannot comment on the methodology used in the rationalisation. The concern is that key gauges may be removed in this process and that this may affect future understanding of catchment processes, particularly in high salinity threat areas and environmental watering sites.

Recommendation 3: Monitoring reviews

(a) In reviews of monitoring sites conducted by jurisdictions, the reviews need to:

- *be made available to the IAG–Salinity*
- *show they meet the jurisdictional BSMS reporting obligations*
- *be based on a risk approach to match the management regime for data collection and improvement in models*
- *adopt a scientific approach to minimise the loss of information content in the monitoring network.*

(b) The agreed protocols for collecting salinity data need to be updated and adopted.

(c) *Queensland has salinity hazards arising from CSG and irrigation and requires a better combined monitoring network if it is to analyse them.*

Element 4: Managing trade–offs with 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 on the options with affected groups, industries and people through best practice planning processes.

The IAG–Salinity noted the recent work being undertaken by jurisdictions to include salinity outcomes within their catchment and planning frameworks (Element 2 — Identifying values and assets at risk). Each jurisdiction is implementing some form of risk–based approach that looks to invest or take action where there are high salinity risk and valuable community assets. The IAG–Salinity considers that these are sensible decision–making approaches to trade off salinity impacts against other catchment health targets and social and economic needs in the setting of catchment goals and targets.

However, implementation often raises further issues where optimisation among outcomes is required, and principles and processes need to be developed to govern this potential trade–off.

In Victoria, LWMPs provide the framework for enabling irrigation development and water trading while maintaining broader salinity obligations. The Victorian Mallee Irrigation LWMP is designed to encourage development to occur within the low-impact salinity zones. The proposed caps in annual use limits for Mallee salinity impact zones are being reviewed in consideration of the available salinity credits and irrigation development demand and have been shown to be highly effective in achieving this.
The LWMPs are providing a guide to the annual use limit cap in low impact zones.

NSW has not implemented a similar scheme in its Sunraysia area, as it advised that there had been minimal development activity and that this was not expected to change. However, NSW informed the IAG–Salinity that it does evaluate salinity impacts of proposed developments using SIMRAT and will impose development conditions to restrict the net impact of individual developments to those of a low impact zone should adverse salinity assessments be made.

The NSW Office of Water entered into a ‘Green Offset’ scheme with the Norske Skog paper mill in Billabong Creek. The scheme allows the mill to discharge up to 2,500 EC water into the River Murray and is offset by an SIS scheme in Billabong Creek. This provides a 0.1 EC benefit at Morgan.

South Australia is addressing a new challenge facing the southern connected system—the need to integrate environmental water delivery with traditional consumptive water delivery and ensure no third–party impacts. South Australia developed the South Australian River Murray Operating Plan in 2012–13. The plan integrates and optimises the management and delivery of all water to and within South Australia (including environmental water provided by the CEWO). The 2012–13 plan helped to maintain salinity considerably below target for 100% of the time at Lock 6, Morgan, Murray Bridge and Milang. Salinity levels in Lake Alexandria were maintained below 1,000 EC except for mid–August to mid–September, when tidal salinity spikes caused that level to be exceeded. The salinity in Lake Albert was reduced from approximately 4,000 EC to 3,000 EC but did meet the 2,000 EC target. The salinity level in the Coorong South Lagoon was maintained below 100 g/L throughout 2012–13.

Element 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 LWMPs in irrigation regions. The partner governments will enhance support for development and implementation of Integrated Catchment Management (ICM) Policy–compliant salinity and catchment management plans in dryland regions.

All partner governments emphasised that salinity and catchment management is now undertaken as part of their broader regional NRM planning framework aimed at identifying the most effective suite of actions required to achieve agreed environmental, social and economic outcomes for their catchments. Therefore, specific salinity actions are only identified in areas where there is a high salinity risk potentially affecting high–value community assets.

It was also noted that on–ground action reflected changing government funding priorities.
Since the commencement of the BSMS, the drought had mitigated much of the projected salinity problem. Consequently, governments (particularly the Australian Government) redirected their funding away from specific salinity programs, particularly in the dryland areas, towards more contemporary priorities and in recent years have reduced their total NRM budgets as part of general budget tightening.

Nevertheless, all jurisdictions reported on the implementation of their salinity and catchment management plans.

Catchment plans

In Queensland during 2012–13, action was funded through the Australian Government's Caring for our Country program and the Queensland Government program. This focused on:

- property mapping
- demonstration projects
- improving land management practices to increase carbon retention and reduce soil erosion
- undertaking gully and waterway stabilisation
- fencing native vegetation and riparian areas
- weed control
- installation of watering points.

This included on–ground works in more than 563 ha in the Goondoola sub catchment where there is a high risk of salinity and 1,938 ha in the Teelba sub catchment where the potential for a salinity threat exists. In addition, work continued on the Great Artesian Basin Sustainability Initiative to improve groundwater usage, providing the secondary benefits of a reduction in salinity along bore drains and around bore heads and reducing saline discharge to streams.

In NSW, action was funded through Caring for our Country and Catchment Action NSW. NSW outlined significant institutional changes that will take effect in 1 January 2014 and will be the focus for NRM delivery, including salinity management, in NSW. The changes comprise the establishment of local land services boards that will integrate CMAs, livestock health and pest authorities and the advisory service of the Department of Primary Industry. The IAG–Salinity notes that the new boards are not catchment–based and that several include both MDB and non-MDB areas. This is likely to present challenges for the management of salinity and the integration of activities across catchments. It will be important that the new boards have a good understanding of their salinity obligations under the BSMS and the Basin Plan.

In Victoria, all CMAs continued to carry out salinity actions funded through Caring for our Country and Victorian Government programs as part of their planned implementation of their RCSs and LWMPs in irrigation areas. In the dryland areas, actions concentrated on whole–farm planning, reforestation and revegetation works. Using state funding alone, around 4,200 ha of revegetation was established in the Victorian MDB catchments during 2012–13.

In South Australia, work is focused more in the irrigation areas that are the priority under the South Australian MDB NRM Plan.

Irrigation

Work in the irrigation areas progressed significantly in Victoria and South Australia.

In Victoria, the Mallee CMA renewed and merged three salinity management plans into the Victorian Mallee Irrigation Region LWMP, which was endorsed during 2012. In the Goulburn–Broken catchment, the Shepparton Irrigation LWMP was replaced by the Shepparton Irrigation Region Catchment Implementation Strategy. In the accountable action category, some surface drains were constructed. There was a reduction in drain outfalls because of the implementation of drain management plans and an improvement in on-farm water management and a reduction in winter disposal from groundwater pumps.

The IAG–Salinity notes that during 2012–13, a seasonal adjustment was made to the annual use limits for irrigation across northern Victoria, reflecting increased water demand. The process to implement a seasonal adjustment is outlined in the Mallee Irrigation Region LWMP. It is based on a review of climatic conditions and water usage at key times during the irrigation season, together with consultations with water customers. It is not clear at this stage whether there is a genuine resurgence in water use to meet quality targets for high–valued crops, such as table grapes. The Victorian CMAs and rural water authorities are monitoring this closely.

In South Australia, the South Australian MDB NRM Board worked with communities in a number of irrigation districts, particularly on water–use efficiency. Detailed assessments showed that over 65% of properties surveyed were demonstrating efficiencies above the 85% water–use efficiency target in the water plan.

Both Victoria and South Australia stressed that current and future activity in irrigation areas will be dominated to a large extent by the infrastructure programs associated with water recovery for the Basin Plan. In Victoria, those programs include the GMW Connections Project, which will modernise the system and reduce the irrigation footprint in the Goulburn–Murray Irrigation District, the Sunraysia Project, which will modernise components of the Mallee Irrigation Area, and the Australian Government's Water for the Future On–Farm Program.

Element 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, MDBA will enhance research and development into new industries based on salinised resources, such as broadacre saltland agronomy, saline aquaculture, and salt harvesting.

The Australian Government's Water for the Future On–Farm Program, which provides funds for irrigation improvements in exchange for water entitlement savings to be transferred to the Commonwealth, has continued to be strongly supported in Victoria, NSW, South Australia and Queensland.
Each landholder entering the program must first develop a property management plan and show how the savings will be made.

The adoption of new irrigation systems is enabling irrigators to more closely match real–time crop water requirements. In turn, this is reducing drainage below the root zone and minimising the discharge of saline water to the rivers. Together with the water buyback scheme, this is changing the footprint of irrigation along the river. In Victoria, 28,000 ha of irrigation area had new or modernised irrigation property plans developed for it, leading to water savings. In South Australia, approximately 200 individual irrigators are involved, with the potential to achieve water savings of more than 15 GL. A similar program is operating in NSW, although no statistics were provided. In Queensland, it is expected that 18.3 GL will be transferred to the Commonwealth as a result of this program.

There have been studies in Queensland on deep drainage that occurs particularly in furrow irrigation used extensively in the cotton industry. Where the drainage water is of good quality, for example in the Condamine Alluvium, the drainage water can be reused for irrigation. However, in the Border Rivers Alluvium the groundwater is saline and is rising quite rapidly and its connection with the river system needs to be determined, as a salinity problem may be developing.

In the dryland areas, the CMAs are investing in new farming techniques. In NSW, they have been provided with a map of HGL that identifies the critical salinity areas. These landscape descriptions are accompanied with a set of sustainable farming solutions to address the salinity impact with different actions for different landscapes. The NSW CMAs have recently reviewed their plans and included this activity in their Conservation Farming–Soil Health programs. A survey of CMAs has shown that the information is highly valued by the staff. In Queensland, 84% of the catchment is grazed and work is going on to improve the retention of the groundcover. In Victoria and South Australia, sustainable farming programs are generally aimed at better soil health.

There have been significant changes in farming practice over the life of the BSMS, but there has not been a way of measuring an impact at Morgan. NSW indicates that the Murrumbidgee catchment is the only catchment that may potentially provide a credit from dryland and irrigation farming system changes over the strategy. NSW did an analysis some years ago, and the outcome was too small to make a register entry. However, there has been continued investment within the catchment since then and it would be interesting to know whether it may now deliver a credit. While insignificant compared with SIS salinity achievements, it would provide a positive message about land management if a register entry for sustainable farming practice could be achieved. NSW has indicated that it is pursuing this outcome.

Element 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 consideration may be given to financing native vegetation management, rehabilitation and land stewardship, and the commercialisation of short–rotation tree crops, particularly for the wheat belt.

The proposition that reforestation and revegetation of the catchment would achieve significant salinity benefits has not been borne out. The concept of a vegetation bank in the BSMS, which invested in vegetating areas with only measurable salinity benefits, and the idea of short–rotation tree crops in the cleared areas of the Mallee region were not taken up in any significant way. A great deal of research was undertaken on the species and methods of revegetating cleared areas, but the farmers have not seen the benefits of these broadscale plantings. The forest industry has opted for more productive higher rainfall areas for its investments.

There have been significant rehabilitation of native vegetation and strategic plantings of trees to manage local salinity issues, which has improved the landscape in terms of local benefits. Also during the strategy, control of land clearing and incentives to protect stands of native vegetation through voluntary agreements across the Basin has been a significant policy shift with local benefits.

Under the Queensland *Vegetation Management Act 1999*, clearing in the state has been limited and most is now for urban and mining developments. Overall, 49% of the MDB in Queensland has woody vegetation cover. The protection of remnant vegetation is continuing, and 20,138 ha has been signed up under voluntary conservation agreements.

In NSW, where property vegetation plans are voluntary agreements for the management and clearing of native vegetation, the HGL framework has vastly improved salinity assessment in the property management planning process run by the CMAs.

In Victoria, there has been a continued uptake of reforestation and revegetation activities. Over 14,000 ha has been revegetated and protected in the past year. Revegetation has occurred at similar levels annually for much of the life of the BSMS and is a significant achievement.

South Australia has continued its revegetation efforts through the River Bend BushBids and The River Murray Forest programs.

Element 8: Constructing salt interception works

MDBA 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 EoVTs, 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.

SISs are recognised as major contributors to the success of the BSMS. They have been constructed and operate along the length of the Murray River in three states, and include one new scheme on the Darling River.

The SIS program of works is drawing to a close, as the targeted 61 EC reduction at Morgan will be reached by the end of 2013 when construction of the Murtho SIS is completed. At present, Register A includes a benefit of about 40 EC salinity effect at Morgan for the schemes established under the BSMS. A final benefit of about 70 EC is expected if the Murtho, Upper Darling and Mildura–Merbein rehabilitation schemes become fully operational. These benefits are in addition to a benefit of about 85 EC from SIS joint works and measures commenced under the Salinity and Drainage Strategy, which pre-dates the BSMS.

During 2012–13, construction activities continued on the Murtho scheme and the Mildura–Merbein Phase 1 refurbishment. The completion of five–year reviews for the Mallee Cliffs, Loxton and Bookpurnong schemes resulted in reduced benefits at Morgan from 0.9 EC to 2.0 EC salinity effect. Reviews yet to be reflected in Register A have been completed or are under way for the Buronga, Waikerie and Woolpunda schemes.

There was a decrease in salt production from the SIS schemes of about 11% to about 323,000 tonnes in 2012–13. Five of the schemes achieved target salt load diversions at least 95% of the time during the year. The Waikerie and Woolpunda schemes operated at 93% and 86%, respectively.
The Pyramid Creek scheme had a reduced duty cycle of 60% because of an extensive rebuild following flood damage to production bores and switchboards in the previous year. The Rufus River scheme operated only half-time because of a reduced budget.

Now that the construction phase is near completion, attention is shifting to the optimal operation of the SISs as a whole, especially in the light of expected benefits from environmental watering of a magnitude possibly commensurate to the benefit provided by the SISs. In addition, budgetary constraints on SIS operations are increasing and the Basin Plan is encouraging the flushing of salt out to the sea. To that end, MDBA has ranked the schemes according to cost–benefit ratios and has classified the schemes according to social benefit and response time. This will enable judicious assessment of the ongoing SIS configuration. The IAG–Salinity notes that reinstatement of any schemes that are mothballed would be costly, with severe lag times for sluggish schemes, and cautions that the ‘Legacy of History’ will continually erode salinity credits into the future. Accordingly, the long–term reliance on SISs must be kept in mind. Consideration could be given to the application of operations research optimisation techniques that take into account cost–benefit and salinity benefit in determining the best mix of SISs into the future.

Element 9: Basin–wide accountability

The partner governments will demonstrate accountability by reporting to MDBA and the Ministerial Council through state end–of–valley report cards and MDBA salinity registers that record the salinity effects of actions, including salt interception schemes and salinity and catchment management plans.

The Ministerial Council will receive audits every five years for each valley and Authority register entry, assessing impacts on river salinity and progress towards targets, with the provision to require further action as necessary.

Annual reports of the contracting governments

The contracting governments provide draft annual reports that contain necessary information for the IAG–Salinity to make an assessment. The Australian Government provides a summary of the work it has undertaken in progressing the recommendations from the previous audit, particularly the assessment of the effects of the environmental watering of wetlands on the salinity of the River Murray through contracts by the Department of the Environment.

Valley reports

Contracting governments must prepare an annual report for each valley for which an EoVT has been adopted, as outlined in Schedule B (clauses 29 and 30). A protocol has been established for information to be presented in the form of summary report cards. The reports are to set out how the contracting governments are implementing actions to meet the targets and impacts on the targets. As the EoVTs pertain to the benchmark period, direct performance measures cannot be reported annually. Instead, statistics for real-time salinity and flow measurements are reported.

The valley reports for 2012–13 again indicated varying levels of action and achievement.
Higher flows were experienced in the first four months of the reporting period, with generally an inverse relationship between flow and salinity. Over the year, salt load and salinity were generally less than targets in Victoria and South Australia, but in Queensland only half of the end–of–valley sites were below target. Each jurisdiction is still attempting to maintain the program from its own resources, but budget pressures are being felt by most jurisdictions. Some of the impacts of the budget changes, such as reducing generalist staff who had maintained monitoring sites in more remote areas, require alternative ways of servicing monitoring installations.

Report cards, in a standard format, were prepared by Victoria, South Australia and Queensland. NSW again foreshadowed the need to revise its EoVT set in 1999 based on improved understanding of upland salinity behaviour. NSW prefers to report end-of-valley performance in the context of statewide CAP targets.

Accountability for salinity under the BSMS and the Basin Plan

The BSMS system of accountability is undergoing continuous improvement each year, and the jurisdictions and MDBA have high confidence in it and are strongly committed to it. It provides a framework of continuing incentives for each state to manage salinity in a manner that is beneficial to the whole Basin. The level of confidence in the registers is due to the clear and transparent method of debating entries by the BSMAP, the quality of the scientific work that has gone into the development and use of the models, meticulous documentation and record keeping on the part of MDBA, and the scrutiny given annually to each entry by the IAG–Salinity. The contracting governments can see that each of them is contributing to salinity management in a balanced way without an inequitable burden falling on any one of them.

The *Water Act 2007* proposes that the water allocation and quality issues are set for each area in the Basin by water resource plans. Since the Act does not have power over the land management areas, the implementation of the Basin Plan will require a similar commitment and collaborative process as exists for the BSMS between MDBA and the contracting governments.

The Basin Plan will provide guidance for the future and, while there is a great deal of detail to be decided, the General Review of Salinity and of Schedule B of the *Water Act 2007* is currently under way.
The IAG–Salinity is of the opinion that the accountability framework continues to maintain a Basin–wide focus on salinity.

The BSMS mid–term review

This section sets out the recommendations of the mid–term review (MDBA 2008) relevant to this discussion, followed by IAG–Salinity comments on each (in italics).

Policy recommendations

Develop methods to account for and achieve environmental outcomes from salinity mitigation actions through integration across MDBA programs.

The TLM program has been able to put this recommendation into action, and salinity register items are currently under consideration. The environmental water held by the Commonwealth is furthering the intent of this recommendation.

Support integration and alignment of national funding initiatives and reporting with regional catchment strategies that reflect BSMS objectives and integrated catchment management outcomes.

While this recommendation is still relevant, the system has matured to the point where CMAs consider a range of outcomes in a catchment management outcome when making investment decisions.

Increased emphasis on catchment actions to address the causes of salt mobilisation and more innovative and sustainable measures to deal with the effects, such as real-time operations.

The IAG–Salinity is of the opinion that in the past few years significant work has been done in this area so that there is now better knowledge of the natural processes and the required management actions to deal with the effects. The real–time targets have been considered in the Basin Plan.

Operational recommendations

MDBA should complete the existing 61 EC joint works program.

MDBA has achieved this.

By June 2008, MDBA should develop a new Works and Measures program (provisionally estimated to be in the order of 40 EC) to offset anticipated increases in river salinity.

The extra works and measures are not required at this time, as the salinity risk has not increased at the rate that was originally predicted.

By December 2008, MDBA should investigate options for:

- real–time river operations that manage large salt loads mobilised to the river
- real–time in–stream targets that are integrated with the accountability framework.

The Basin Plan has included real–time targets. The unaccounted salt load that contributes to the large salt load peaks in the river have been narrowed down to a section of the river between Lock 5 and Lock 6, and South Australia is examining how it may include it in the models to ensure that it is managed. South Australia is also optimising the delivery of consumptive and environmental water and salinity outcomes in the South Australia River Murray Operating Plan.

Science and technical understanding recommendations

Hydrological datasets that reflect the latest research on climate change and climate variability should be developed and applied to modelling scenarios so as to ensure the best possible tools for predicting long–term salinity impacts.

MDBA has completed this work and a report has been published.

The Basin salinity target should be reviewed, with consideration given to a recommendation on replacement or complementary salinity targets that link more closely to the salinity registers and allow for adaptive real–time salinity outcomes.

This work is completed and part of the Basin Plan.

MDBA should develop a robust and transparent investment framework that enables environmental and social impacts to be assessed in the evaluation of benefits and disbenefits of salinity management measures, particularly joint works and measures proposals.

This was used by MDBA in preparing the Joint Works and Measures program, which is now almost complete.

MDBA should review the salinity registers with the objectives of making them easier to understand, including consideration of environmental and social impacts (in addition to the economic impacts), and making them relevant to real-time salinity management.

Registers A and B were adjusted in 2010 by using harmonised methods of calculating entries. The economic impacts are based on the value of the dollar in March 2006, and the usefulness of this measure should be considered in the upcoming review of the registers. IAG–Salinity has made recommendations in this report on the need to include the impacts of environmental water recovery, long–term environmental water use and environmental works and measures in the registers.

Progress in improving salinity registers

The purchase of significant volumes of entitlement water for environmental activities is changing the use of water in the Basin. This activity has not been included on the registers and consequently they do not accurately reflect the actual salinity debits and credits operating in the Basin. As the IAG–Salinity has been seeking a resolution of this matter over the past four years, it is of the view that a provisional entry of the likely magnitude of the salinity effect should be placed on Register A without attribution to the contracting governments in the first instance, but with the requirement that governments resolve this issue. The IAG–Salinity also recommends that environmental water recovery programs and the TLM environmental works be included on the register. There are a few case studies, particularly from the TLM program, that should give a better basis from which the framework for environmental watering can be improved.

Recommendation 2: Environmental water

(a) Three new register items should be added to the registers with notional values to cover:

i. environmental water recovery

ii. use of water for environmental purposes

iii. environmental works and measures (initially covering the TLM works).

(b) The policy principles for environmental watering and environmental works should be evaluated through modelled scenarios of salinity and dilution impacts by the CEWO, the Basin states/territory and MDBA.

(c) The Basin–wide plan and policy framework for managing impacts and responsibility for reporting the accountable actions from environmental watering and environmental works as required under Schedule B should be settled between the Australian Government, MDBA and the operating jurisdictions.

Status of Registers A and B

MDBA, in conjunction with the jurisdictions, prepared a revised version of Registers A and B dated 9 September 2013 (see Appendix 3).

Schedule B (within Schedule 1 of the *Water Act 2007*) provides that salinity registers A and B must be established as the primary record of the accountability for river salinity of each of the jurisdictions, and of the Basin overall. Register A records the salinity credits/debits of the jurisdictions since the baseline date (1 January 1988 for NSW, Victoria and South Australia and 1 January 2000 for Queensland). Register B records any salinity impacts arising from actions prior to the baseline date and the predicted future effects of actions aimed at delayed salinity impacts.

In 2012–13, no changes had been made to the number of accountable actions on Register A or Register B.

Other than changes due to annual increments, there are 11 other changes resulting from model updates, data extensions and reviews. Of those, seven are 0.5 EC or more in magnitude. Five are expected to increase the salinity at Morgan, while two entries are expected to reduce the salinity at Morgan by 0.8 EC each. All changes are documented thoroughly and transparently.

The largest non–interpolation changes are:

- Item 6: Mallee Cliffs Salt Interception Scheme (an increase of 2.0 EC at Morgan), because of a model update
- Item 12: Bookpurnong Joint Salt Interception Scheme (an increase of 1.1 EC at Morgan), because of a model update.

The Mallee Drainage Bore Decommissioning accountable action (Item 40) has had its salinity credit reclassified as ‘provisional’ until drain flow data becomes available to either inform the proposed adjustment to the salinity effect in Register A from –0.2 EC to 0.0 EC or to support the current salinity credit entry.

A number of five–year rolling reviews were completed in 2012–13, resulting in material adjustments to salinity register entries.

Some reviews are overdue. NSW has six reviews awaiting completion, but no schedule has yet been offered. However, the establishment of a salinity coordination role within the NSW Office of Water with additional modelling support for salinity register reviews should enable a schedule to be developed soon. South Australia is overdue for a review of the Qualco Sunlands GWCS (Item 50), but accountable action reviews are being aligned with numerical model reviews. Queensland has submitted its two Register A reviews, but the two Register B reviews are yet to be done. The IAG–Salinity considers that an indicative assessment of the possible magnitude of the Queensland ‘Legacy of History’ salinity effects should be conducted to determine whether a full–scale investigation is warranted.

Recommendation 6: Outstanding register items

(a) Queensland should provide written evidence to MDBA of the low salinity risk catchments that will not affect the Morgan target and do not require any further work to assess them for a register entry.

(b) Queensland, with assistance from MDBA, should undertake an analysis to determine the level of salinity threat in the Border Rivers catchment and whether it is a significant item for salinity register purposes.

(b) *NSW should formally advise MDBA of its schedule for its upcoming salinity register reviews.*

Net debit/credit status of the jurisdictions

As stated in Schedule B, a state contracting government must take whatever action may be necessary:

(a) to keep the total of any salinity credits in excess of, or equal to, the total of any salinity debits, attributed to it in Register A; and

(b) to keep the cumulative total of all salinity credits in excess of, or equal to, the cumulative total of all salinity debits, attributed to it in both Register A and Register B.

The credits are defined in Schedule B as salinity benefits in $m/year values. The salinity registers dated 9 September 2013, as provided to the IAG–Salinity, show that NSW, Victoria and South Australia are in net credit on Register A. There has been an increase in the South Australian credit balance of about 3%, while NSW has had a reduction of about 2%. Victoria has had a reduction of about 5%.

On Register B, two of the three jurisdictions are in credit and one (Victoria) is slightly in debit (0.339, –0.306 and 1.096 $m/year for NSW, Victoria and South Australia, respectively). NSW and South Australian salinity credits have reduced by about 13% and about 8%, respectively, but the Victorian debit has increased by more than 100% (from –0.117 to –0.306 $m/year). For the combined registers, all three states are in credit (5.772, 4.564 and 5.338 $m/year for NSW, Victoria and South Australia, respectively). The combined net credit in terms of salinity effect is 165 EC — a decrease of 2.4% over the previous year.

This is the fourth year in a row that the modelled EC at Morgan has been under the Basin salinity target of 800 EC for 95% of the time (Table 3). However, the two previous IAG–Salinity reports (2010–11, 2011–12) cautioned that the target would be breached now and into the future if contracting governments realised their salinity credits in full. Maintaining the registers in credit balance, as required under Schedule B, is not necessarily consistent with future compliance with the Morgan target. A substantial positive credit (in the order of 100 EC) would be required for long–term compliance. The advent of environmental watering as an accountable action on Register A will ease the situation.

Table 2 Modelled projections of Morgan EC for past and current registers

Year	Status	Register A [$m/year]	Registers A & B [$m/year]	Mean Morgan EC [µS/cm]	95-percentile Morgan EC [µS/cm]
1988	Benchmark			665	1058
2011	2011 Registers	23.168	24.732	508	786
2012	2012 Registers	23.848	24.322	501	781
2013	2013 Registers	23.194	25.305	491	781

Uncertainty in register entries

The salinity registers include confidence ratings of ‘very low’, ‘low’, ‘medium’ and ‘high’. The rating remains a qualitative indicator with no precise definition.

The distribution of the ratings has been fairly stable for the past two years. There was no change in the Register B ratings in 2012–13 and only one change in Register A. The Mallee Drainage Bore Decommissioning accountable action has reverted from ‘high’ to ‘low’, as it is not yet possible to quantify the amount of reused drain water in the Bumbang, Tol Tol and Boundary Bend coordinated group drainage schemes. The current salinity credit has become ‘provisional’ until the drain flow data becomes available to either inform a proposed adjustment to the salinity effect in Register A from –0.2 EC to 0.0 EC, or to support the current salinity credit entry.

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Appendix 1: Independent Audit Group for Salinity terms of reference

Preamble

The Basin Salinity Management Strategy (BSMS) agreed by the Murray–Darling Basin Ministerial Council in 2001 provides a framework for communities and governments to work together to control salinity and protect key natural resource values in the Murray–Darling Basin. The mandatory elements of BSMS are incorporated into Schedule B to the Murray–Darling Basin Agreement (Schedule 1 to the *Water Act* 2007).

Auditing is an integral part of the BSMS in that it ensures a fair and accurate annual assessment of the contracting governments' and Authority's performances against Schedule B. The Schedule B (clause 34) specifies that the Authority must appoint independent auditors to carry out an annual audit. These auditors together will henceforth be called the Independent Audit Group for Salinity or IAG–Salinity.

Principles for the audit

For the purpose of the annual audits, the following principles are to apply:

1. *Independence* — the IAG–Salinity will reach a view by consensus. The findings and recommendations of the IAG–Salinity will be entirely those of the IAG–Salinity.
2. *Provision of information* — the IAG–Salinity shall base the audit on the information provided by the Contracting Governments and the Authority.
3. *Quality assurance* — the quality assurance in relation of the information provided is the responsibility of the information provider.
4. *Timeliness* — the timely provision of information by the contracting governments and the Authority is required if the audit is to progress satisfactorily.
5. *Justification* — the findings shall include a supporting rationale.
6. *Prioritisation* — the recommendations shall include a priority classification.
7. *Continuous improvement* — the IAG–-Salinity shall encourage improvement through independent assessment of compliance against Schedule B obligations whilst acknowledging that priority activities should be targeted towards areas of highest salinity risk.
8. *Accountability* — the IAG–Salinity will work as a team with a Lead Auditor responsible for the conduct of the audit and completion of the auditors' report. The Lead Auditor will provide the primary contact between the IAG–Salinity, the contracting governments and the Authority.

Roles and responsibilities of the IAG–Salinity

1. The IAG–Salinity will annually audit the performance of each state contracting government and the Authority as described in subclauses 34(3)–(4) **Schedule B, *Water Act 2007.***

2. IAG–Salinity will report to the Authority on the audit undertaken under paragraph 1 above in accordance with subclauses 34(5)–(6) of **Schedule B, *Water Act 2007.***

3. If required or when requested, the IAG–Salinity will provide separate reports to advise the Authority on any key issue arising from the audit beyond the explicit audit requirements of the Schedule B.

Appointment of the IAG–Salinity

1. The Authority may establish the IAG–Salinity as a committee under clause 203 of the Water Act 2007 (Cwth) for the purpose of subclause 34 (1) of Schedule B to the Murray–Darling Basin Agreement.

2. The IAG–Salinity will be an expertise-based body consisting of one Lead Auditor and as many other members, as determined by the Authority from time to time based upon the workload, expertise required for the audit and any other factor the Authority considers appropriate.

3. The appointment to the IAG–Salinity will:

- Primarily be based on qualifications, knowledge and experience in natural resource management and auditing processes as outlined in selection criteria in **Annexure B**
- Be governed by the terms specified in subclause 34(2) of **Annexure A**
- Be based upon individual contract(s) for one year (2013–14) with the possibility for extension up to 2015–16 on the terms and conditions agreed between the Authority and the appointee(s).

Operating arrangements

The IAG–Salinity will follow a consultative process for conducting the audit and may amend this process for reasons of transparency, adequacy and efficiency. The Authority office will provide technical and administrative support to the IAG–Salinity.

Appendix 2: Basin salinity management — Schedule B

A summary and a key section from Schedule B of the Murray–Darling Basin Agreement which is Schedule 1 to the *Water Act 2007*(Cwlth) have been included. The purpose of Schedule B is to implement certain aspects of the BSMS; and the following relates to the annual audit.

34. Audit

(1) The Authority must appoint independent auditors for the purpose of carrying out an annual audit under this clause.

(2) A person who is appointed as one of the independent auditors referred to in subclause 34(1):

(a) Is appointed for such period and on such terms as are set out in that person's instrument of appointment.

(b) May resign by written notice addressed to the President.

(c) May only be removed from office during the period of that person's appointment by the Ministerial Council, on the recommendation of the Authority.

(3) The Independent Auditors must together carry out an annual audit of:

(a) The report of each review conducted in the preceding financial year by each State Contracting Government and by the Authority under subclause 33(1) and 33(3), respectively.

(b) Register A and Register B.

(4) The independent auditors must, in each audit, reach a view by consensus about:

(a) The performance of each State Contracting Government and of the Authority in implementing the provisions of this Schedule in the relevant year.

(b) Whether the Authority has fairly and accurately recorded the salinity impacts of each action entered in Register A or Register B during the relevant year.

(5) The Independent Auditors must prepare a report setting out:

(a) The findings of each audit.

(b) Any recommendations made by the independent auditors arising from that audit.

(6) Without limiting subclause 34(5), a report:

(a) Must set out the view reached on each of the matters referred to in subclause 34(4).

(b) May recommend to the Authority that the salinity impacts entered in Register A or Register B for an Accountable Action be varied.

(c) May set out a finding that the total salinity credits are not equal to, or do not exceed, the total salinity debits attributed to a State Contracting Government in Register A, contrary to paragraph 16(1)(a).

Appendix 3: Salinity registers (as at September 2013)

AUTHORITY REGISTER A (Accountable Actions)	Type	Date Effective	Provisional Salinity Credit ($m/yr)	Current Impact on Morgan 95%ile Salinity (EC)	Impact on Flow at Mouth (GL/y)	Salinity Effect (EC at Morgan)				
						2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)
JOINT WORKS AND MEASURES										
Former Salinity & Drainage Works										
Woolpunda SIS	SDS	Jan-91		-87	0	-47.4	-47.4	-47.4	-47.4	-47.4
Improved Buronga and Mildura/Merbein SIS	SDS	Jan-91		-6	0	-3	-3	-3	-3	-3
New Operating Rules for Barr Creek Pumps	SDS	Jul-91		-8	0	-4.9	-4.9	-4.9	-4.9	-4.9
Waikerie SIS	SDS	Dec-92		-19	0	-12.8	-12.8	-12.8	-12.8	-12.8
Changed MDBC River Operations 1988 to 2000	SDS	Apr-93		-1	4	-1.6	-1.6	-1.6	-1.6	-1.6
Mallee Cliffs SIS	SDS	Jul-94		-17	0	-11.4	-11.3	-11.3	-11	-11.3
Changed Operations of Menindee and Lower Darling	SDS	Nov-97		3	8	0.9	0.9	0.9	0.9	0.9
Waikerie Phase 2A SIS	SDS	Feb-02		-14	0	-8	-8.2	-10.7	-8.9	-8.2
Changed MDBC River Operations 2000 to 2002	SDS	Feb-02		-2	-1	-1.4	-1.4	-1.7	-1.9	-1.4
Sub Total - Former Salinity & Drainage Works				-151	11	-89.6	-89.8	-92.6	-90.7	-89.8
Basin Salinity Management Strategy										
Changed MDBC River Operations after 2002	BSMS	Dec-03		1	7	-0.2	-0.2	-0.4	-0.4	-0.2
Pyramid CK SIS	BSMS	Mar-06		-6	0	-5.1	-5.1	-5.2	-5.2	-5.1
Bookpurnong SIS	BSMS	Mar-06		-19	0	-8.2	-11.2	-16	-17	-10.9
Improved Buronga SIS	BSMS	Mar-06		-1	0	-0.6	-0.5	-0.5	-0.5	-0.5
Loxton SIS	BSMS	Jun-08		-17	0	-10.5	-10.8	-11.1	-12	-10.7
Waikerie Lock 2 SIS	BSMS	Jun-10		-17	0	-12.7	-10.3	-11.3	-11.8	-10.5
Sub Total Joint Works under BSMS				-59	6	-37.3	-38.1	-44.5	-47	-38
Joint Works Sub Total				-210	17	-127	-128	-137	-137.7	-127.8
STATE WORKS & MEASURES										
Shared New South Wales and Victorian Measures										
Permanent Trade Accounting Adjustment - NSW to Victoria	50N50V	Jun-06		0	0	0	-0.1	-0.1	-0.1	-0.1
Barmah-Millewa Forest Operating Rules	50N50V	Mar-02		-2	33	-2	-2	-1.9	-2.3	-2
Shared Measures Sub Total				-2	33	-2	-2.1	-2	-2.3	-2.1

Salinity Credits (Interpolation to Current Year Benefits $m/year)						Commonwealth Contribution (EC)	5 Year Rolling Review			Confidence Rating	Comment
NSW	Vic	SA	Qld	ACT	Total		Latest Review	Next Review	Status		
0.729	0.729				3.89	11.8	2007	2012		High	Based on salt loads in river
0.14	0.14				0.748	0.8	2005	2010		Medium	Based on salt loads in river
0.225	0.225				1.198	1.2	2011	2016		High	Rules need to be revisited 2007
0.198	0.198				1.057	3.2	2007	2012		High	Based on salt loads in river
0.15	0.15				0.797	0.4	2005	2010		High	
0.512	0.512				2.732	2.8	2013	2018		High	Based on 2012 Groundwater Model
-0.146	-0.146				-0.776	-0.2	2005	2010		High	
0.113	0.113				0.601	2	2007	2012		High	
-0.139	-0.139				-0.742	0.3	2008	2011		High	
1.782	1.782	0	0	0	9.505	22.4					
0.021	0.021	0.021			0.129	0.1	2005	2010		High	
0.229	0.229	0.229			1.396	1.3	2010	2015		High	Remodelled 2010
0.204	0.204	0.204			1.243	2.7	2013	2018		Low	Reviewed 2013
0.021	0.021	0.021			0.127	0.1	2006	2011		High	Remodelled 2006
0.206	0.206	0.206			1.254	2.7	2013	2018		High	Reviewed 2013
0.117	0.117	0.117			0.712	2.6	2010	2015		High	
0.797	0.797	0.797	0	0	4.861	9.5					
2.579	2.579	0.797	0	0	14.366	32					
0	0				0.001	0	2006	2011		High	No permanent trade since 2006
0.188	0.188				0.377	0	2006	2011		High	
0.189	0.189	0	0	0	0.376	0					

AUTHORITY REGISTER A (Accountable Actions)	Type	Date Effective	Provisional Salinity Credit ($m/yr)	Current Impact on Morgan 95%ile Salinity (EC)	Impact on Flow at Mouth (GL/y)	Salinity Effect (EC at Morgan)				
						2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)
New South Wales										
Boggabilla Weir	NSW	Dec-91		0	0	-0.1	-0.1	-0.1	-0.1	-0.1
Pindari Dam Enlargement	NSW	Jul-94		0	-17	0.7	0.7	0.7	0.7	0.7
Tandou Pumps from Lower Darling	NSW	Sep-94		2	-3	-0.1	-0.1	-0.1	-0.1	-0.1
NSW MIL LWMP's	NSW	Feb-96		-4	57	-4	-4	-4	-4	-4
NSW Changes to Edward-Wakool and Escapes	NSW	Jan-90		-2	4	-2	-2.1	-2	-2	-2.1
Permanent Trade Accounting Adjustment - NSW to SA	NSW	Jun-06		-2	1	-0.5	-0.4	-0.4	-0.5	-0.4
NSW Sunraysia Irrigation Development 1997 to 2008	NSW	Jul-03		1	0	0	0.9	4.5	6.1	0.8
RISI NSW	NSW	Jun-10		-5	0	-2.7	-3.9	-4.1	-4.1	-3.7
NSW S&DS Commitment Adjustment	NSW	Nov-02		0	0	0	0	0	0	0
New South Wales and Measures				-11	43	-8.8	-9.1	-5.5	-4	-9
Victoria										
Barr Creek Catchment Strategy	Vic	Mar-91		-12	0	-7.7	-7.7	-7.7	-7.7	-7.7
Tragowel Plains Drains at 2002 level	Vic	Mar-91		1	1	0.2	0.2	0.2	0.2	0.2
Shepparton Salinity Management Plan	Vic	Mar-91		0	24	1.4	1.4	1.5	1.5	1.4
Nangiloc-Colignan SMP	Vic	Nov-91		-1	1	0.4	0.4	0.4	0.4	0.4
Nyah to SA Border SMP - Irrigation Development	Vic	Jul-03		21	0	13.8	13.8	13.7	13.7	13.8
Kerang Lakes/Swan Hill SMP	Vic	Jan-00		2	4	1.1	1.6	1.1	0.9	1.6
Campaspe West SMP	Vic	Aug-93		1	0	0.4	0.3	0.4	0.3	0.3
Psyche Bend	50V50C	Feb-96		-4	0	-2.1	-2.1	-2.1	-2.1	-2.1
Permanent Trade Accounting Adjustment - Victoria to SA	Vic	Jun-06		0	2	-0.7	-0.8	-0.8	-1	-0.7
Woorinen Irrigation District Excision	Vic	Sep-03		0	-2	1.3	0.8	1	1.2	0.8
Sunraysia Drains Drying Up	Vic	Jun-04		-2	-4	-2.1	-2.2	-2.1	-2.1	-2.2
Lamberts Swamp	Vic	Jun-04		-5	0	-3	-3	-3	-3	-3
Chursh's Cut Decommissioning	Vic	Mar-06		1	0	-0.4	-0.3	-0.3	0	-0.3
Mallee Drainage Bore Decommissioning	Vic	Jun-08		0	0	-0.1	-0.3	-0.3	-0.3	-0.2
RISI Vic	Vic	Jun-10		-8	0	-2	-5.5	-6.8	-7.1	-5.2
Victorian S&DS Commitment Adjustment	Vic	Nov-02		0	0	0	0	0	0	0
Victoria Works and Measures Sub Total				-7	25	0.6	-3.2	-5	-5.1	-2.9

Salinity Credits (Interpolation to Current Year Benefits $m/year)						Commonwealth Contribution (EC)	5 Year Rolling Review			ConfidenceRating	Comment
NSW	Vic	SA	Qld	ACT	Total		Latest Review	Next Review	Status		
0.041					0.041	0	2007	2012		Medium	Remodelled 2007
-0.121					-0.121	0	2007	2012		Medium	
0.034					0.034	0	2005	2010		Medium	
0.684					0.684	0	2010	2015		High	
0.368					0.368	0	2005	2010		High	
0.108					0.108	0	2005	2010		High	No permanent trade since 2006
-0.174					-0.174	0	2007	2012		High	
0.814					0.814	0	2010	2015		Medium	
0.91					0.91	0					
2.665					2.665	0					
	1.963				1.963	0	2013	2018		High	Reviewed 2013
	-0.022				-0.022	0	2013	2018		High	Reviewed 2013
	-0.383				-0.383	0	2008	2013		Low	Exclude private pumps
	-0.102				-0.102	0	2013	2018		High	Reviewed 2013
	-3.25				-3.25	0	2008	2013		High	Data updated to 2013
	-0.361				-0.361	0	2010	2015		High	Remodelled 2006
	-0.077				-0.077	0	2010	2015		High	
	0.237				0.478	1	2011	2016		Medium	
	0.183				0.183	0	2005	2010		High	No permanent trade since 2006
	-0.236				-0.236	0	2010	2015		High	
	0.635				0.635	0	2011	2016		Medium	
	0.624				0.624	0	2011	2016		High	
	0.097				0.097	0	2010	2015		High	Remodelled 2010
						0	2013	2018		Low	Reviewed 2013
	1.193				1.193	0	2010	2015		Medium	
	1.6				1.6	0					
	2.103				2.34	1					

AUTHORITY REGISTER A (Accountable Actions)	Type	Date Effective	Provisional Salinity Credit ($m/yr)	Current Impact on Morgan 95%ile Salinity (EC)	Impact on Flow at Mouth (GL/y)	Salinity Effect (EC at Morgan)				
						2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)
South Australia										
SA Irrigation Development Based on Footprint Data*	SA	Jul-03		6	0	-3.6	5.8	33.9	72.8	4.8
SA Irrigation Development Due to Water Trade	SA	Jun-06		0	0	0.1	0.5	16.2	32.2	0.4
SA Irrigation Development Based on Site Use Approvals	SA	Jun-10		0	0	-0.1	0.3	14.9	66.2	0.3
SA Component of Bookpurnong SIS	SA	Mar-06		-6	0	-3	-4.1	-5.9	-6.3	-4
SA Component of Loxton SIS	SA	Jun-08		-1	0	-0.8	-0.8	-0.8	-0.9	-0.8
SA Component of Waikerie Lock 2 SIS	SA	Jun-10		-1	0	-1.2	-0.7	-2	-2.6	-0.7
SA Improved Irrigation Efficiency and Scheme Rehabilitation Reg A*	SA	Jan-00		-36	0	-20.2	-22.1	-26.3	-21.3	-21.9
Qualco Sunlands GWCS	SA	Sep-04		-5	0	-1.8	-4	-6.5	-7.5	-3.7
Pike Stage 1 SIS	SA	Jan-12		-5	0	-1.4	-3.2	-3.3	-3.4	-3
South Australia Sub Total				-47	0	-32	-28.4	20.1	129.1	-28.7
Queensland										
Land Clearing Post 2000	Qld	Jul-05	TBA							
Irrigation Development Post 2001	Qld	Jul-05	TBA							
Queensland Sub Total				0	0					
Balance - Register A				-278	119	-169	-170.7	-129.4	-20.1	-170.5
				Factors for allocating transferred credits to Register B						

Salinity Credits (Interpolation to Current Year Benefits $m/year)						Commonwealth Contribution (EC)	5 Year Rolling Review			Confidence Rating	Comment
NSW	Vic	SA	Qld	ACT	Total		Latest Review	Next Review	Status		
		-0.566			-0.566	0	2012	2017		Low	
		-0.14			-0.14	0	2003	2008		High	
		-0.045			-0.045	0	2013	2018		High	Based on Site Use Approval up tp 2013
		0.454			0.454	0	2013	2018		High	Reviewed 2013
		0.095			0.095	0	2013	2018		High	Reviewed 2013
		0.05			0.05	0	2010	2015		High	
		2.878			2.878	0	2012	2017		Low	Include IIP and RH from 2011 Loxton / Bookpurnong Model
		0.255			0.255	0	2007	2012		High	
		0.463			0.463	0	2012	2017		High	
		3.446			3.446	0					
								2012			
								2011			
5.432	4.871	4.242	0	0	23.194	33					
0.243	0.194	0.563	0	0							

AUTHORITY REGISTER B (Accountable Actions)	Type	Date Effective	Provisional Salinity Credit ($m/yr)	Current Impact on Morgan 95%ile Salinity (EC)	Impact on Flow at Mouth (GL/y)	Salinity Effect (EC at Morgan)				
						2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)
Transfers from Register A										
New South Wales										
Darling Catchment Legacy of History - Macquarie	NSW	Jan-00		0	0	0	0.1	0.3	0.4	0.1
Darling Catchment Legacy of History - Macintyre	NSW	Jan-00		0	0	0	0	0	0	0
Darling Catchment Legacy of History - Gil Gil Creek	NSW	Jan-00		0	0	0	0	0	0	0
Darling Catchment Legacy of History - Gwydir	NSW	Jan-00		0	0	0	0	0	0	0
Darling Catchment Legacy of History - Namoi	NSW	Jan-00		0	0	0	0.2	0.4	0.5	0.2
Darling Catchment Legacy of History - Castlereagh	NSW	Jan-00		0	0	0	0	0	0.1	0
Darling Catchment Legacy of History - Bogan	NSW	Jan-00		0	0	0	0.1	0.2	0.3	0.1
Lachlan Legacy of History	NSW	Jan-00		0	0	0	0	0	0	0
Murrumbidgee Catchment Legacy of History	NSW	Jan-00		0	0	0	0.1	0.2	0.2	0
NSW Mallee - Dryland	NSW	Jan-00		0	0	0	0.3	1.3	3.6	0.2
NSW Mallee - Pre 88 Irrigation	NSW	Jan-00		0	0	0	0.4	1.2	2.3	0.3
Victoria										
Campaspe Catchment Legacy of History	Vic	Jan-00		0	0	0	0.1	0.2	0.3	0.1
Goulburn Catchment Legacy of History	Vic	Jan-00		1	-5	0	0.5	1.1	1.6	0.5
Loddon Catchment Legacy of History	Vic	Jan-00		1	-1	0	1	1.5	2.3	0.9
Kiewa Catchment Legacy of History	Vic	Jan-00		0	0	0	0.1	0	0	0.1
Ovens Catchment Legacy of History	Vic	Jan-00		0	0	0	0	0.6	1.3	0
Victorian Mallee - Dryland	Vic	Jan-00		1	0	0	0.6	2.2	5.9	0.6
Victorain Mallee - Pre 88 Irrigation	Vic	Jan-00		3	0	0	1.4	4.7	8.3	1.2
South Australia										
SA Mallee Legacy of History - Dryland*	SA	Jan-00		6	0	0	4.1	14.5	32.8	3.7
SA Mallee Legacy of History - Irrigation*	SA	Jan-00		73	0	0	46.6	86.9	113.3	41.9
SA Improved Irrigation Efficiency and Scheme Rehabilitation Reg B *	SA	Jan-00		-77	0	0	-49.6	-93.8	-115.4	-44.6
Queensland										
Queensland Legacy of History	Qld	Jan-00	TBA							
Queensland Irrigation Development Pre 1 Jan 2000	Qld	Jan-00	TBA							
Balance - Register B			0	8	-5	0	6	21.5	57.9	5.4
Balance - Register A & B				-270	113	-169	-164.7	-107.9	37.8	-165.2
Basin Salinity Target (Morgan) - Modelled Current Status				781	5,085	483	495	578	731	491

Salinity Credits (Interpolation to Current Year Benefits $m/year)						5 Year Rolling Review			Confidence Rating	Comment
NSW	Vic	SA	Qld	ACT	Total	Latest Review	Next Review	Status		
0.601	0.479	1.391	0	0	2.471					
-0.03					-0.03	2010	2015	In Progress	Medium	
0					0	2010	2015	In Progress	Medium	
-0.001					-0.001	2010	2015	In Progress	Medium	
-0.001					-0.001	2010	2015	In Progress	Medium	
-0.044					-0.044	2010	2015	In Progress	Medium	
-0.006					-0.006	2010	2015	In Progress	Medium	
-0.022					-0.022	2010	2015	In Progress	Medium	
0					0	2010	2015	In Progress	Medium	Little connection Murrumbidgee
-0.016					-0.016	2010	2015	In Progress	Medium	
-0.057					-0.057	2010	2015		Low	
-0.085					-0.085	2010	2015		Low	
	-0.023				-0.023	2011	2016		Medium	
	-0.102				-0.102	2013	2018		Medium	Reviewed 2013
	-0.216				-0.216	2013	2018		Medium	Reviewed 2013
	-0.034				-0.034	2011	2016		Medium	
	0				0	2011	2016		Medium	
	-0.124				-0.124	2010	2015		Low	
	-0.288				-0.288	2010	2015		Low	
		-0.372			-0.372	2012	2017		Medium	
		-5.509			-5.509	2012	2017		Low	
		5.586			5.586	2012	2017		Low	
						2007	2012	In Progress		Low impact - long lag times Modelling required.
							2011			
0.339	-0.306	1.096	0	0	1.128					
5.772	4.564	5.338	0	0	24.322					


Australian Government


MURRAY–
DARLING
BASIN AUTHORITY