Basin Salinity Management Strategy

Operational Protocols

V E R S I O N 2 . 0 – M A R C H 2 0 0 5

MURRAY-DARLING BASIN COMMISSION

SIX GOVERNMENTS WORKING IN PARTNERSHIP WITH THE COMMUNITY

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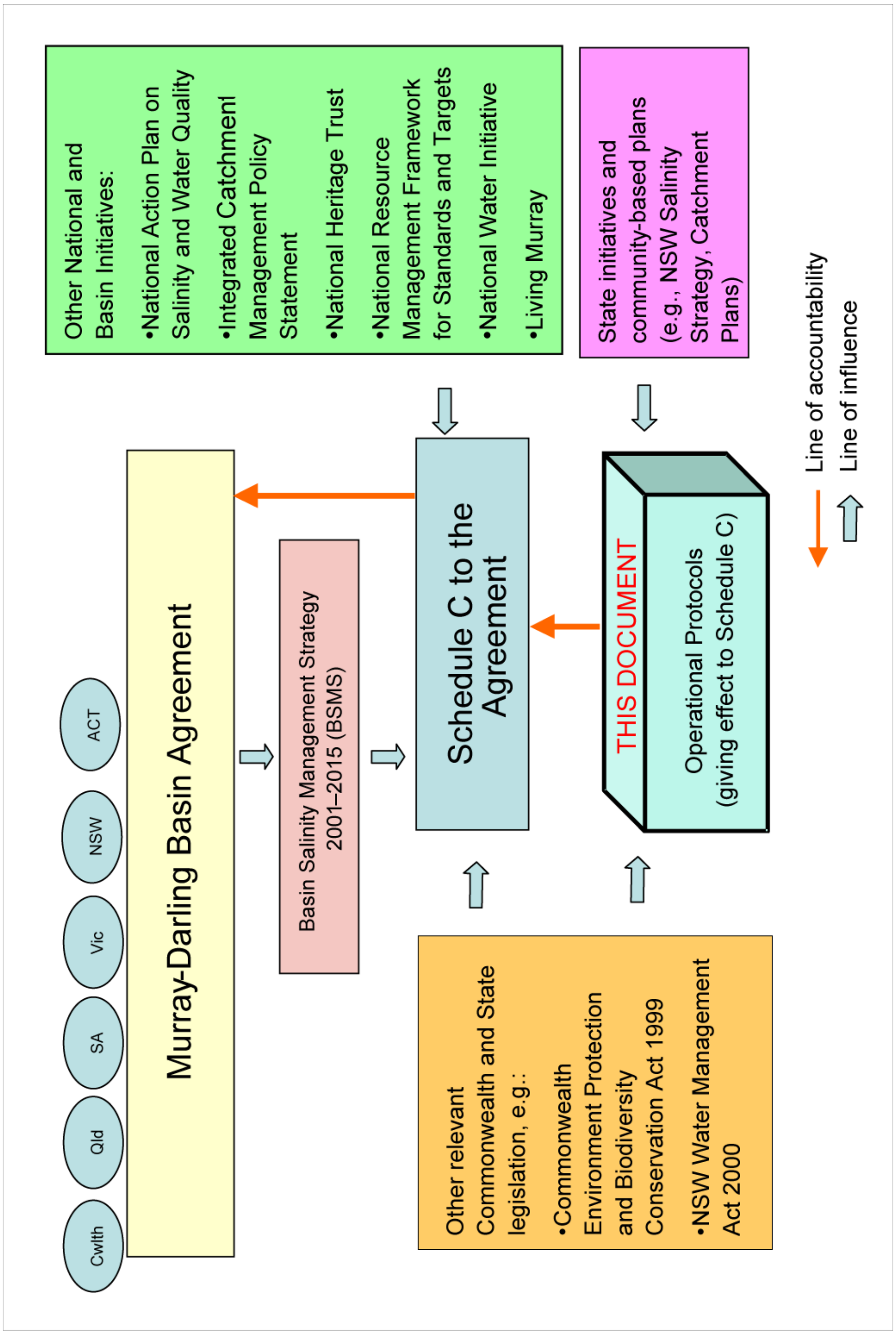
Context of the protocols

Chart 1.1
Basin Salinity Management Strategy—Context of the protocols



1 Principles and Purpose

1.1 The Basin Salinity Management Strategy – Background

In 2001 the Murray-Darling Basin Ministerial Council approved the publication of the *Basin Salinity Management Strategy 2001–2015*. This initiative followed the adoption of the *Salinity and Drainage Strategy* in 1988, and takes into account the 1999 *Basin Salinity Audit* and the *National Land and Water Resources Audit*. While the *Basin Salinity Management Strategy* (BSMS) has a focus on water quality outcomes for the shared rivers, it applies to the Basin as a whole and is consistent with the 2001 *Integrated Catchment Management Policy Statement.*

The objectives of the BSMS are to:

- 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.
- control the rise in salt loads in all tributary rivers of the Murray-Darling Basin and, through that control, protect their water resources and aquatic ecosystems at agreed levels.
- control land degradation and protect important terrestrial ecosystems, productive farm land, cultural heritage and built infrastructure at agreed levels.
- maximise net benefits from salinity control across the Basin.

1.2 Purpose of the protocols

The BSMS has been embodied in the Murray-Darling Basin Agreement, in the form of a revised Schedule C to that agreement that was formally agreed to by the Murray-Darling Basin Ministerial Council in November 2002. Schedule C authorises the Commission to make any protocols that it considers necessary to give effect to the Schedule (Schedule C, Part IX).

This volume contains a set of protocols that has been prepared to provide operational detail and consistency where necessary to give practical form to the principles and accountabilities set out in the Schedule. As the Schedule requires, they are designed to be fully consistent with the provisions of the Schedule itself. The context of the protocols is shown in Chart 1.1.

1.3 Principles

The principles underpinning these protocols are:

- protocols are prepared only where further detail is required to clarify and implement the provisions of Schedule C in a consistent and practical manner
- the protocols respect the rights and powers of the contracting governments and do not attempt to be prescriptive where no such need exists or can be legitimately imposed. Detailed formats or standards are defined only where desirable to ensure consistency in data, and efficiency in processing and information management

- the protocols do not attempt to modify the intent of Schedule C (to the extent that they might do so, they would be invalid).

1.4 How the protocols work

1.4.1 Authority

The Commission is empowered to make (and to amend or revoke) these protocols as stated in Part IX of Schedule C to the Agreement. They therefore carry the authority of the Agreement.

Schedule C provides for each Contracting Government to ‘nominate a person with relevant expertise and experience’ to advise the Commission in the preparation or amendment of the protocols. The BSMS Implementation Working Group provides the jurisdictional and administrative structure to provide that advice, and the protocols have been developed with direction and guidance from the Working Group.

The protocols will be periodically reviewed and updated to reflect operational experience. Protocols may be revoked or amended at any time, but any change requires the approval of the Commission.

The terms of reference and the composition of the Implementation Working Group are given at Appendix 1.1.

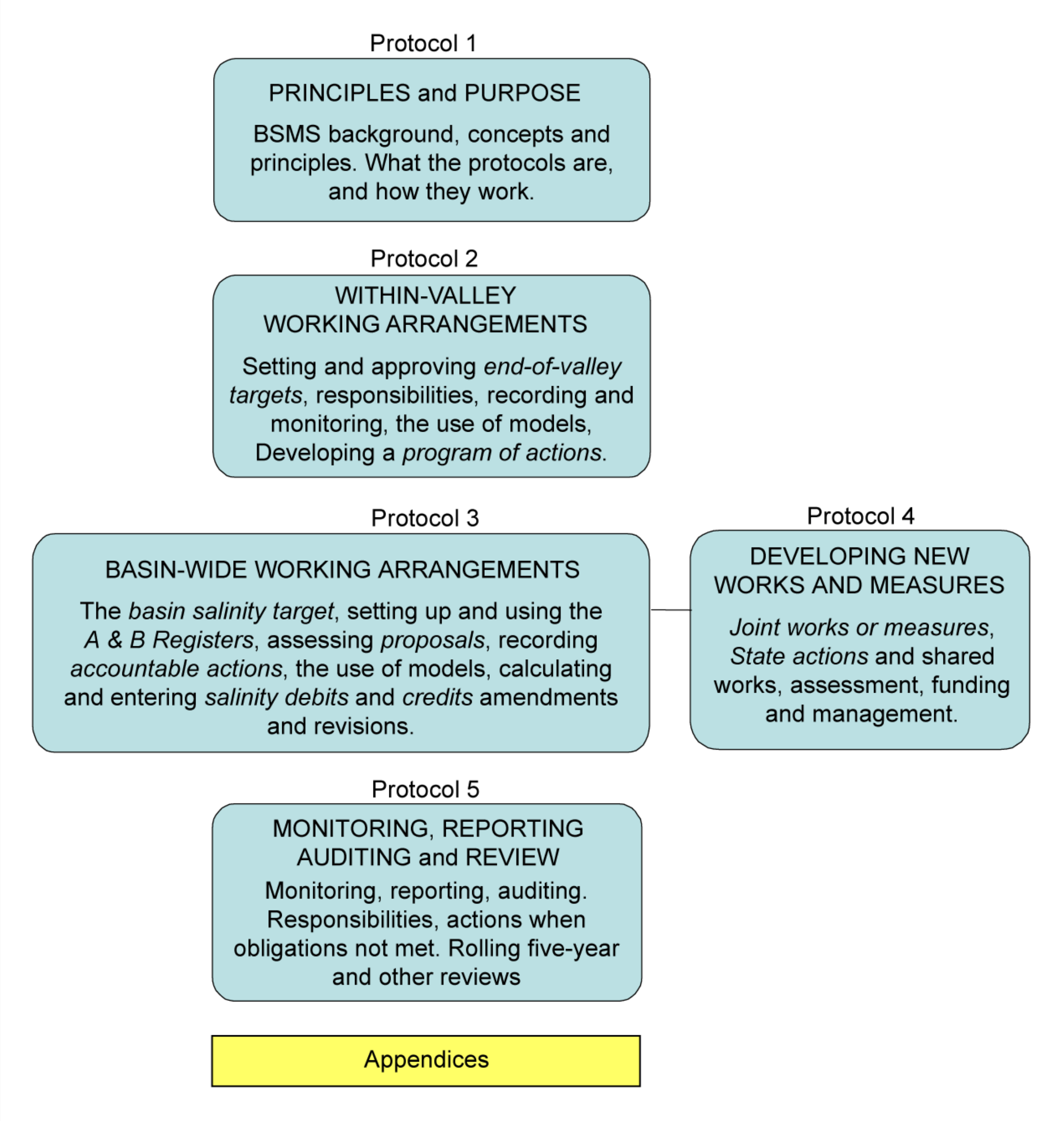
1.4.2 Structure

The protocols assume some familiarity with the *Murray-Darling Basin Agreement* and Schedule C to that Agreement. Some specialised terms are used which are defined in Schedule C or in the agreement itself. Such terms are noted in the protocols using italics.

Where pertinent, a reference to the relevant parts of Schedule C is provided in the text of the protocols. A cross-reference between the Schedule and the protocols is given at the beginning of this volume.

This volume of protocols is likely to be amended over time as knowledge increases and new approaches and techniques emerge. Initially, the volume is divided into five protocols as shown on the following Chart 1.2.

Chart 1.2
Basin Salinity Management Strategy—Protocols structure



1.4.3 Distribution and use

This document is not classified. It is in the public domain, but is aimed primarily at technical and administrative officers in organisations that have a direct interest in implementing the Basin Salinity Management Strategy. A web-based version is available on the Commission's website www.mdbc.gov.au

Use of the protocols relies upon the understanding of some technical concepts and terminology. More detail may be found in the Appendices.

1.4.4 Updating

The web version will be kept up to date and should be regarded as the primary source of information. Printed copies will only be provided on a "print on demand" basis.

Comments or questions relating to these protocols should be addressed to:

Murray-Darling Basin Commission
15 Moore Street
GPO Box 409
Canberra ACT 2601
Telephone (02) 6279 0100
Email info@mdbc.gov.au

2 Within-valley working arrangements

2.1 Purpose

The purposes of this protocol are to:

- define the procedures for setting the end-of-valley targets, preparing a program of actions designed to achieve these targets, and the subsequent management and reporting obligations
- introduce the concepts that underlie the management of salinity in tributary valleys
- define the responsibilities of the partner governments and the Commission, and the relationship to other initiatives such as the Integrated Catchment Management Policy
- describe the process of selecting target sites and end-of-valley salinity targets
- outline the procedures for the approval, review and amendment of the targets
- foreshadow the in-valley reporting requirements that are described in more detail in Protocol 5.

2.2 Introduction

The Basin Salinity Management Strategy builds on the previous 1988 Salinity and Drainage Strategy by strengthening basin-wide accountability for the salinity effects of actions, including monitoring and reporting. A key element is the introduction of salinity targets for selected end-of-valley targets sites in addition to the Basin Salinity Target site at Morgan.

Stream salinity and salt load targets are not ends in themselves but are used because rivers are the integrators of salinity across the landscape. The targets are effectively surrogates that reflect the health of the catchment upstream, provide a basis to identify the benefits to downstream users, and assist in the achievement of the overall basin target.

Primary responsibility for the overall management of catchments lies with State Contracting Governments, and salinity targets are one component of Integrated Catchment Management Strategies that take a range of environmental, social and economic factors into account. *End-of-valley targets* (shown in Appendix 2.1) for salinity have been developed by the States and adopted by the Commission as stated in Schedule C.

2.3 Principles

The principles that guide the operation of this protocol are:

- *End-of-valley targets* are set in water quality terms using non-exceedance limits for in stream salinity concentrations and loads based upon the benchmark period (1975–2000) and adjusted to the baseline conditions.

- The setting of end-of-valley targets will be based on current knowledge and predictions of valley salinity condition and trends.

- The setting of *end-of-valley targets* is a State prerogative.

2.4 Procedures

2.4.1 Scope of this protocol

This protocol, and the term end-of-valley target, refers only to the rivers listed in Appendix 2.1. This Appendix lists the rivers in the basin that are the subject of these protocols and for which interim targets have been set.

2.4.2 Selecting the target sites

Target sites must be chosen so that they provide a good indication of catchment health from a salinity perspective (the target site is likely to be as far downstream as possible to meet this requirement). The site should reflect the characteristics of the bulk of the water generated within the catchment. If large volumes of water are diverted before the catchment outlet, then the implications need to be considered (such as the introduction of one or more intermediate target sites in the valley, or locating the end-of-valley target site where the flows are at a maximum).

Other criteria for the selection of target sites may include:

- Sites should provide a meaningful indication of the salinity conditions affecting key assets and values in the catchment (the target site may need to be located upstream of some key assets, such as a nationally significant wetland, to meet this requirement).

- Sites must be suitable for obtaining reliable measurements of salinity, flow and salt loads (this may preclude locating the target site at the catchment outlet). A representative sampling location in the stream cross-section must also be established.

It may not be possible to fulfil all these criteria and final site selection may involve making trade-offs. These should be explicitly described when the intended sites and targets are nominated to the Commission (see Protocol 2.4.8).

The Ministerial Council has endorsed on an interim basis 23 State-based *end-of-valley target* sites, and 6 interpretation sites to assist with the monitoring of salinity in valleys which cross State boundaries and for locations along the shared rivers. Interpretation sites are shown in italics in Appendix 2.1. All sites are equipped to make continuous flow and salinity measurements from which daily flow, salinity and salt load estimates can be calculated.

A hydrographic review has been undertaken which provides site-specific advice on the facilities and operation of the sites.[1] A detailed list of conditions for an ideal gauging site is

[1] 'Hydrographic Review – End of Valley Monitoring Network', Ecowise Environmental Pty Ltd, August 2002.

given in Appendix 2.2, and recommended minimum standards for monitoring at gauging stations are at Appendix 2.3.

2.4.3 The valley *baseline conditions*

Baseline conditions are the conditions that contribute to the movement of salt through land and water within the basin on 1 January 2000. *Baseline conditions* need to be determined and recorded for individual valleys (relating to the end-of-valley target sites) by State Contracting Governments.

Baseline conditions are defined as:

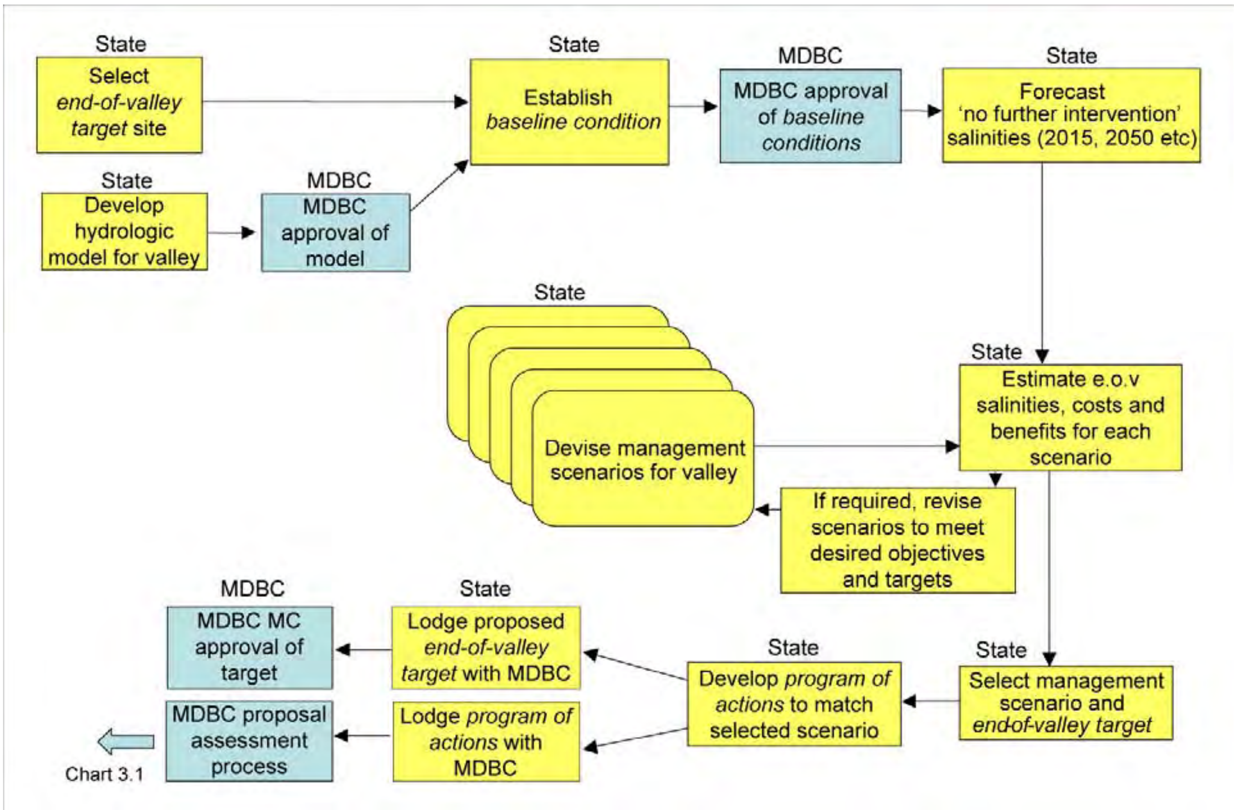
The agreed suite of conditions in place within the catchments and rivers on 1 January 2000 for:

- land use (level of development of the landscape)
- water use (level of diversions from the rivers)
- land and water management policies and practices (including the Murray-Darling Basin Cap agreements and any subsequent flow management agreements)
- river operating regimes
- salt interception schemes
- run-off generation and salt mobilisation processes
- groundwater status and condition.

The relationship between the above conditions and the salinity, salt load and flow regime at the *end-of-valley target* site is established by modelling, using the benchmark period climatic sequence. A more detailed discussion of the application and utilisation of *baseline conditions* is provided in Appendix 3.2. The determination of *baseline conditions* for valleys by State Contracting Governments should follow a similar procedure to that used by the Commission for the determination of the *baseline conditions* associated with the *Basin Salinity Target* (see Protocol 3.5.3).

Note:
The baseline conditions and *end-of-valley targets* were approved by the Commission in June 2004 (see Appendices 3.2 and 3.4).

Chart 2.1
Basin Salinity Management Strategy—End-of-valley targets, programs of actions



2.4.4 The *benchmark period*

The benchmark period is used to standardise for climate variability. It is an observed climatic sequence over a defined period (currently 1 May 1975 to 30 April 2000), which is used consistently in the BSMS as a basis for simulating catchment responses (such as groundwater movements and river behaviour) at other scenario dates (for example 2015, 2050 and 2100). A more detailed description is given in Appendix 3.1.

2.4.5 Developing models

State Contracting Governments are required to develop models to simulate the daily salinity, salt load and flow regime at each proposed end-of-valley target site under the baseline conditions using the benchmark period. The model or models must be capable of predicting the effect of all accountable actions and delayed salinity impacts in each valley at the years 2015, 2050 and 2100 (Schedule C, Clause 37).

Models in this category will be used to determine and monitor progress against *end-of-valley targets*. They are intended to be used on a continuing basis, and are required to be approved by the Commission (Schedule C, Clause 38). The Commission may appoint an appropriately qualified panel to assist with the assessment. The Commission may then approve the model, decline to approve it, or approve it subject to modifications. If approval is not given, the model must be amended within a period of 3 months and the initial model may be used on an interim basis in the meantime.

Models must be reviewed before 31 December 2007 and at intervals of not more than 7 years thereafter. The criteria that will be used by the Commission in assessing models are detailed at Appendix 3.10.

State Contracting Governments may also develop models of more limited scope for specific purposes, such as the assessment of certain types of action or groups of *actions*, or the behaviour of a nominated zone within a catchment. Examples include the assessment of drain construction, water trades, groundwater pumping and irrigation areas.

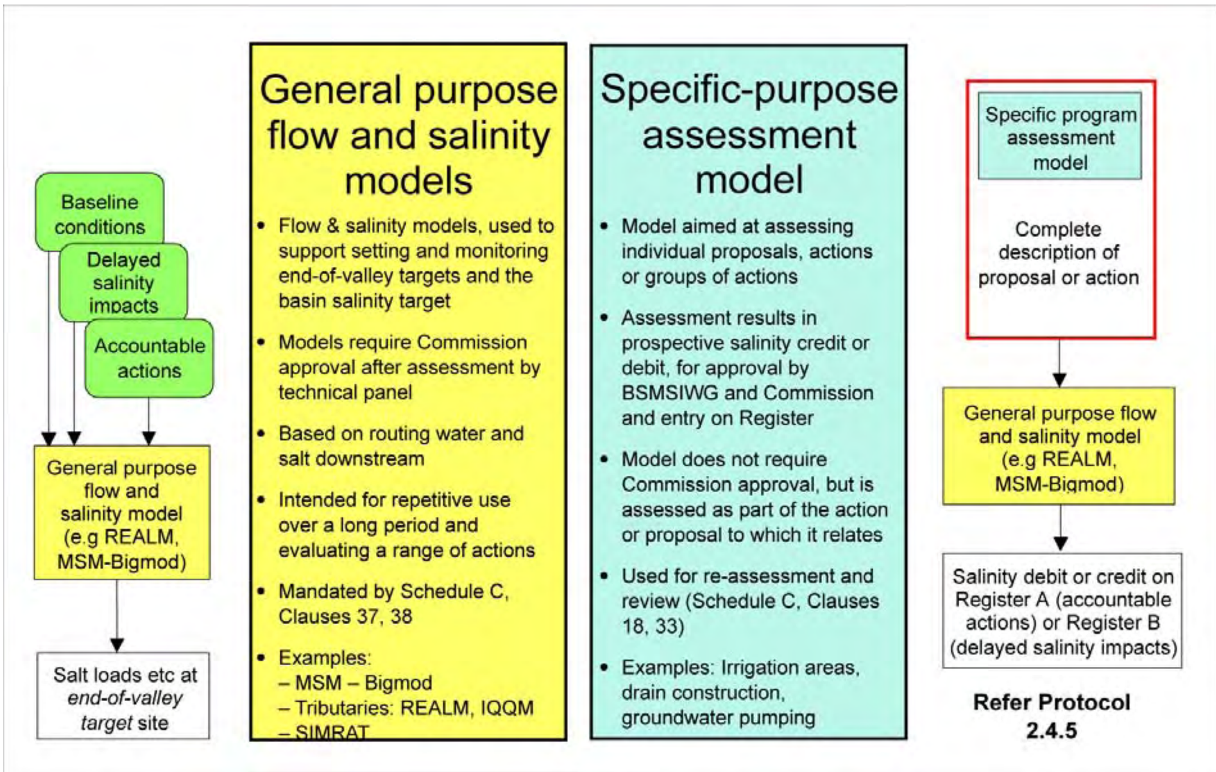
Models of this kind – “specific-purpose” models – do not require Commission approval but are assessed as part of the assessment of the proposal or *action* to which they relate, as set out in Protocols 3.6.3, 3.6.4 and 3.6.5. The distinction between the two types of model is shown in Chart 2.2.

A “Model purposes and classification guide” may be found at Appendix 2.5.

2.4.6 Approval and management of models

The Commission must assess models developed by the States or alterations to them, and appoint an appropriately qualified panel to assist with the assessment. The Commission may then approve the model or alteration, decline to approve it, or approve it subject to modifications. If approval is not given, the model must be amended within a period of 3 months and the initial model may be used on an interim basis in the meantime.

Chart 2.2
Basin Salinity Management Strategy—Types and uses of models



Models must be reviewed before 31 December 2007 and at intervals of not more than 7 years thereafter. The types of models that are subject to this requirement are defined in Protocol 2.4.5, and could include:

- Catchment scale rainfall-runoff, salt mobilisation and export models that can derive sequences of daily stream flows, salinities and salt loads and are capable of taking impacts of land use changes on catchment responses into account.
- Hydrologic models capable of modelling the movement of water and salt in regulated and unregulated river systems on a daily basis.
- Groundwater models capable of modelling the dynamic behaviour of groundwater flow systems at local, intermediate and regional scales.
- Models specific to major actions such as new irrigation developments and Land and Water Management Plans.

Models or alterations to them submitted for approval must be accompanied by full documentation that includes a comprehensive description, a users guide, and the administrative arrangements for custody, responsibilities for operation and version control.

2.4.7 Setting end-of-valley salinity targets

Targets should be based on the median and 80 or 95 percentile daily salinity non-exceedance levels, and the mean annual salt loads, using the flow regime established for the 1975–2000 benchmark period. The overall procedure is shown in Chart 2.1.

The setting of end-of-valley targets should be based on community consultation, supported by expert advice and the results of analyses using models or other relevant tools. The consultation process should involve considering a range of management scenarios that comprise various combinations of *actions*, taking into account local priorities, assets and values to be protected, private and public costs and benefits, and the projected effect on the Basin Salinity Target.

Actions may be of a permanent long-term nature, or short-term interventions (such as engineering works) designed to 'buy time' until the longer-term measures can take effect. These are discussed further in Protocol 2.4.8.

The key objective of the analyses is to estimate realistically the salinity impact of each action and to establish that the combined set of actions can be expected to meet the *end-of-valley target* on a long-term basis with a reasonable degree of confidence. As a guide, the analytical steps may be as follows:

- Predict the trends in daily flows, salinities and salt loads at the proposed target site, assuming that no further actions take place and that delayed salinity impacts continue to accrue. This set of circumstances is based on the results from the latest salinity audit for the valley and is known as 'no further intervention'.

- Taking into account these trend predictions, evaluate 'no further intervention' daily flows, salinities and salt loads at key dates (for example 2015, 2050, 2100). The preferred approach is to employ approved models that use the *benchmark period* climatic sequence; alternative techniques may be used on an interim basis if suitable models are not available. Note that the 'no further intervention' scenario at 2000 is the same as the baseline conditions. Analysis of the 'no further intervention' prediction at other key dates will require adjustments to reflect known trends and actions in the intervening period – see Appendix 3.4.

- Develop a range of management scenarios (typically, combinations of various types of action) in consultation with the community.

- Estimate the daily flows, salinities and salt loads for the alternative management scenarios at key dates (2015, 2050, 2100) using the *benchmark period* climatic sequence. Note that it will be necessary to allow for trend effects and the predicted impacts of the management scenarios on these trend effects when making these estimates.

- For each management scenario estimate the changes in end-of-valley daily salinities as a percentage of the 'no further intervention' value at each key date.

- Compare the analyses of each scenario and identify the scenario that gives the optimal outcome (that is, the scenario that meets the target at the least overall cost to society, taking into account economic, social and environmental criteria). The selected management scenario becomes the basis for a program of actions for the valley (see Protocol 2.4.8), and the changes in salinity and salt load values associated with it support the determination of the *end-of-valley target*.

Further technical detail of this procedure is given in Appendix 3.4.

2.4.8 Within-valley target sites

Within-valley sites and associated targets may be chosen to assist in overall catchment management and to reflect local priorities (such as, for example, setting water quality targets for a town water supply).

The use of within-valley targets is a State matter and notification to the Commission is not required. If desired, reference to the targets may be included in the reports such as the valley annual report (see further detail in Protocol 2.4.10, and Protocol 5). Within-valley targets, where used, should be consistent with the end-of-valley target.

2.4.9 Preparing a *program of actions*

State Contracting Governments are required to give the Commission a proposed *program of actions* for each valley that is designed to meet the adopted end-of-valley targets (Schedule C, Clause 6).

Developing a program of actions requires the consideration of—and probable trade-offs between—a range of options that may include:

- Land management changes, such as revegetation, changed irrigation techniques, and modified agricultural practices.

- Engineering works such as drainage schemes, the piping of channels, reduction of seepage and evaporation losses from existing infrastructure, salt interception schemes and the pumping of fresh groundwater. Some of these works may qualify wholly or in part as a *joint work or measure* (see Protocol 4).

- Changes in the flow regime that may be accomplished by managed storage releases and/or selectively timed diversions.

The *program of actions* for a valley will normally include a combination of the above types of actions, based on the management scenario from which the *end-of-valley target* was derived.

2.4.10 Information to be lodged with the Commission

Information about a proposed program of actions for a valley that is lodged with the Commission must be sufficient to enable the effect of the actions to be assessed as set out in Protocol 3.5.5. *Salinity impacts* and delayed salinity impacts for the valley will be calculated using the Commission's models, using inputs provided by the State Contracting Governments.

Information about a proposed *program of actions* that is lodged with the Commission should include:

- Daily flows, salinities and salt loads under baseline conditions using the benchmark period, and a description of the *baseline conditions*
- estimated daily flows, salinities and salt loads for the years 2015, 2050 and 2100, using the *benchmark period* and assuming no further intervention. This will be a forecast of *delayed salinity impacts*
- the current end-of-valley target
- a description of the proposed actions in the valley, together with their timing, intended effect and estimated daily flows, salinities and salt loads, using the *benchmark period.* Evaluation over a number of dates may be necessary to meet the requirements for the Commission's models (see Protocol 3.5.5)
- whether any of the proposed *actions* should be considered as a potential *joint work or measure* (see Protocol 4 for the criteria for a joint work or measure, and the procedures that follow)
- the key assumptions underpinning the above.

2.4.11 Approval and adoption of *end-of-valley targets*

Proposed end-of-valley target sites, *baseline conditions*, *end-of-valley targets* and the associated programs of actions must be submitted by States to the Commission by 31 March 2004. States should utilise approved models to support the proposals; alternative means may be employed on an interim basis if suitable models are not available.

For baseline conditions, the Commission will appoint an appropriately qualified panel to review them, and on receipt of the advice from the panel, either approve the *baseline conditions*, approve them with modifications, or withhold approval. If approval is given conditionally, or if approval is withheld, a revised estimate must be lodged with the Commission for approval within 6 months.

The State or the Commission may initiate amendments to the *baseline conditions* at any time, and the procedure for approval will be as above.

For *end-of-valley targets*, the Commission will refer the proposed target to the Ministerial Council, together with the Commission's advice. The Council may then adopt the target. The targets must be reviewed by the Commission at intervals of not more than 5 years (Schedule C, Clause 9) and the State or the Commission may request the Council to amend the target at any time.

For a *program of actions*, the Commission will estimate whether the program is 'reasonably certain to meet each *end-of-valley target*' (Schedule C, Clause 6). If the Commission disagrees with the program, it will 'make representations to the Contracting Government'. Amendments to the *program of actions* may be proposed by the relevant State at any time.

2.4.12 In-valley monitoring and reporting

The Basin Salinity Management Strategy requires a comprehensive, in-valley and basin-wide, monitoring, reporting and review regime to operate. Details of the requirements and the responsibilities for them may be found in Protocol 5.

3 Basin-wide working arrangements

3.1 Purpose

The purposes of this protocol are to:

- describe the obligations and procedures relating to actions in the Basin
- define the processes for assessing proposals, and for estimating salinity impacts
- outline the procedures for calculating salinity debits and credits, attributing them, and entering items on Register A and Register B
- provide procedures for operating and managing the Registers.

3.2 Introduction

Schedule C to the Agreement places four key obligations on *Contracting Governments* in relation to implementing the *Basin Salinity Management Strategy*. They are:

- to 'undertake actions… necessary to meet that Government's end-of-valley targets' (State Contracting Governments only - refer Schedule C, Clause 4)
- to 'maintain salinity at or below the Basin Salinity Target' (refer Schedule C, Clause 10)
- to 'keep the total of the salinity credits in excess of, or equal to, the total of any salinity debits attributed to it in Register A' (State Contracting Governments only)
- 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' (State Contracting Governments only - refer Schedule C, Clause 16).

For the purposes of the Registers, *salinity debits* and *salinity credits* are defined as increases or decreases in average salinity costs since the baseline date. (A salinity impact means both the salinity effect and the salinity cost effect.) The *baseline date* is 1 January 1988 for New South Wales, Victoria and South Australia, and 1 January 2000 for Queensland. The baseline conditions are defined as at 1 January 2000 for all States.

The achievement of end-of-valley targets is primarily the responsibility of the State governments. The Commission's role is to review the proposed targets, to advise the Ministerial Council on their adoption, and to monitor actual performance against the targets through the collation of 'Valley Reports' produced by the State Contracting Governments. More detail on this aspect is contained in Protocol 5.

The primary accountability mechanism for tracking the achievement of the Basin Salinity Target is the tracking of salinity levels through the operation by the Commission of *Register A* and *Register B*. The basic assumption is that by managing average salinities in the tributary rivers to meet *end-of-valley targets*, and managing average salinities in the shared rivers so that they do not increase, the salinity at Morgan will also not increase above the 95 percentile. This protocol therefore sets out the procedures for:

- establishment of the Registers
- implementing the obligations of the State Contracting Governments as recorded in Schedule C
- determining whether a proposal has a significant effect
- assessing *salinity impacts*
- estimating *salinity credits* and *salinity debits*
- operating *Register A* and *Register B*
- attributing *salinity credits* and *salinity debits* to Contracting Governments
- timing of entry of credits and debits to the registers
- trading and transfers of *salinity credits* and *salinity debits* between Contracting Governments
- review and amendment of the Registers.

3.3 Principles

The principles that guide the operation of this protocol are:

- Contracting Governments are accountable for the future salinity impacts of actions which are undertaken after the relevant baseline date and which have a significant effect as defined in Schedule C.
- Contracting Governments are jointly responsible for offsetting the delayed salinity impacts in the shared rivers (that is, impacts occurring after 1 January 2000) of actions which occurred prior to the *baseline dates.*
- The Registers must be operated in a transparent and co-operative way.
- The Registers must be auditable. Entries must be based on the best information available at the time and be verifiable by reference to supporting documentation.
- The effort required for the assessment of proposals should be commensurate with the likely extent of potential salinity impacts and their associated uncertainty.
- The assessment approach must search for the 'most likely' outcome, be objective, professional and impartial, and not allow personal preferences or value judgments to creep into the analysis.

The following procedures reflect the above principles.

3.4 The A & B Registers

3.4.1 Definition

Register A and Register B are operated by the Commission and are the primary record of the jurisdictional accountability for salinity debits and credits. The Registers track all actions that are assessed to have a significant effect. A *significant effect* is a change in average daily salinity at Morgan which the Commission estimates will be at least 0.1 EC within 100 years after the estimate is made (Schedule C, Clause 18).

A *significant effect* can result from a change in the magnitude or timing of either or both of salt loads and water flows. The 0.1 EC change may occur at any time within the 100 years, not necessarily at the end of the 100 year period, and could be either an increase or a decrease. Some types of action that lead to an improvement in the long term can have an adverse impact in the short term, and vice versa. This is discussed further in Appendix 3.5.

Register A contains details of any *actions* after a nominated baseline date that are considered to have a *significant effect*, excluding those actions that have the express purpose of offsetting delayed salinity impacts. *Register A* also brings forward information about works carried out under the former Salinity and Drainage Strategy.

Credits allocated to Contracting States through their contribution to the joint program for offsetting future *delayed salinity impacts* are also entered in *Register A*. Entries in *Register A* will include *actions* taken after 1988 and the impacts that result from them, as shown in Chart 3.1.

Register B records *delayed salinity impacts* due to *actions* taken before the *baseline date* applicable to each state (the 'legacy of history' for which the Contracting Governments accept joint responsibility). It also contains details of the predicted future effects of *actions* aimed at addressing delayed salinity impacts, including contributions from joint works and measures, and their salinity costs.

Delayed salinity impacts that result from a pre-1988 action but for which the impact does not begin to occur until after 1988 should be entered in Register B, but only for that part of the impact that occurs after 1 January 2000. That part of the impact which occurs before 1 January 2000 becomes part of the baseline conditions. See Chart 3.1.

Credits for relevant management *actions* undertaken after 1 January 2000 are also entered in *Register B*. Relevant *actions* include the programs of actions proposed by each state to meet *end-of-valley targets* in that State where the *actions* are aimed at addressing *delayed salinity impacts*.

Typical actions that may give rise to an entry in *Register B* include:

- land use changes, including revegetation, afforestation and conversion to deep rooted pastures and irrigation improvement

- transfers from *Register A* arising from actions that are determined to have made a whole or partial contribution to the mitigation of delayed salinity impacts in the shared rivers.

Samples of Registers A and B are at Appendix 3.8.

3.4.2 Register entries

Entries of salinity credits and salinity debits in the Registers are primarily recorded in dollars as salinity cost effects. Where the salinity impacts are initially computed in EC units, they are converted to costs using cost functions (see following Protocol 3.4.3). For inspection purposes only, the entries may be viewed as ‘Equivalent EC’ as described in Protocol 3.4.4.

New entries in Register A may be *salinity credits* or *salinity debits*, arising from deliberate future actions after the baseline date. They are based on the projected effect of an *action*, averaged over 30 years from the time that the *action* takes effect, and updated every 5 years. More detail may be found in Appendix 3.5.

Entries in Register B relating to *salinity debits* are determined from projected delayed salinity impacts, using the approach described in Appendix 3.6. Entries relating to *salinity credits* in *Register B* arise from *actions* designed to offset *delayed salinity impacts*, and are based upon the projected *salinity impact* of that *action* averaged over 30 years from the date that the *action* is declared effective by the Commission.

More detail about the timing of Register entries, including the treatment of actions with progressive or staged implementation over an extended period, is given in Protocol 3.7.2. All entries are subject to periodic reviews in accordance with the five-year rolling review procedures (Protocol 5.7.2).

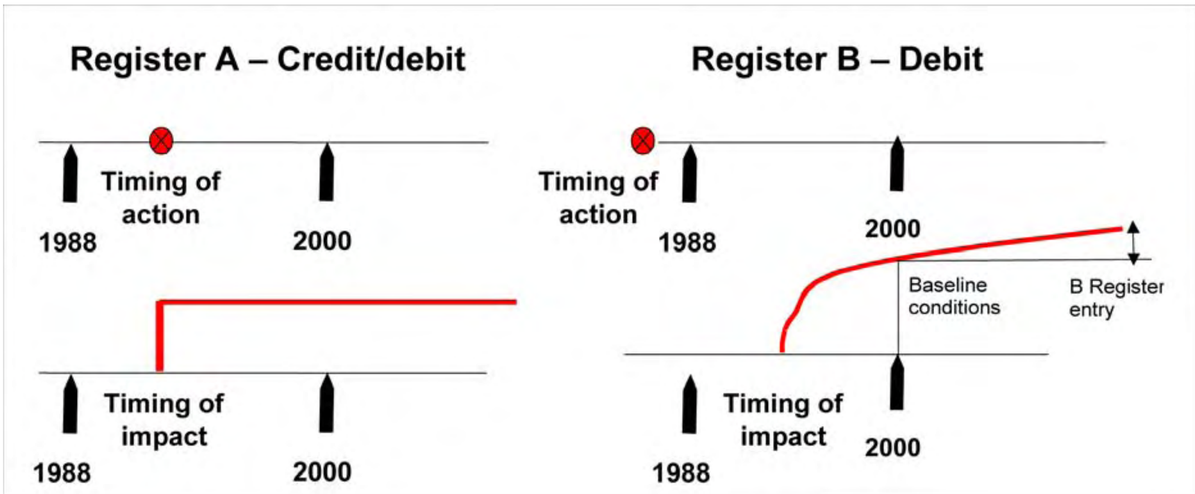
3.4.3 Cost functions

Cost functions are used in modelling to relate levels of river salinity to the economic impact on the various River Murray water users. They have been developed over a period of time and consider agricultural, household, commercial and industrial consumers and government instrumentalities. They are expressed in year 2000 dollars.

An accountable action generates salinity credits and salinity debits based on the changes in salinity levels that are attributable to its implementation. Cost functions are then used to assess the estimated costs or benefits to the users of water from the River Murray.

Cost functions must be approved by the Commission, and the cost or benefit assessments are estimated by the Commission’s models. A description of cost functions may be found at Appendix 3.7.

Chart 3.1
Basin Salinity Management Strategy—Timing of entries in registers



3.4.4 'Equivalent EC'

'Equivalent EC' credits/debits are a device used as a convenient way of expressing a Contracting Government's credit balance on one or both of the two Registers in EC units. They are computed by dividing the salinity cost effect in dollars for a scheme (as assessed above) by the dollar benefits per EC salinity reduction at Morgan achieved from all the jointly funded schemes undertaken under the former Salinity and Drainage Strategy or the BSMS.

$$\textit{Equivalent EC} = \frac{\text{Salinity cost effect of proposal}}{\text{Salinity cost effect per EC from all jointly funded schemes undertaken under the provisions of Schedule C}}$$

The current salinity cost effect per equivalent EC is $112,000 per year.

3.4.5 Initialising the registers

Register A is established directly from the former Salinity and Drainage Strategy Register, and adjustments made where necessary to recognise:

- the results of any reviews or reassessments of existing salt interception schemes and accountable actions (such as those arising from the previous Salinity and Drainage Strategy)
- the upgrade and data calibration of the basin salinity model (that consolidates a number of previously independent models)

- extension of the benchmark period from 1975–1985 to 1 May 1975 – 30 April 2000
- changes to the approved salinity cost functions
- recalculation of salinity impacts as the average over 30 years from the projected effective date of the action).

Register B is established by recording the delayed salinity impacts that occur after 1 January 2000 and that result from actions or decisions taken before 1 January 1988 (1 January 2000 in the case of Queensland). They are the basis for the Register B salinity debits, and the initial predictions have been derived from the 1999 Salinity Audit and the approved 2000 revision for Queensland. These estimates of the delayed salinity impacts will be used until the Commission adopts any revised predictions as the result of an annual report or new salinity audit under the program of 5-year rolling audits.

Debits associated with the ‘no further intervention’ or ‘legacy of history’ assessments will be increases in *salinity costs* (in accordance with the definition in Clause 2 of Schedule C, but expressed in equivalent EC units) and will be assigned to the *Register B* on an annual basis.

3.5 Definitions

3.5.1 The *benchmark period*

The benchmark period is used to standardise for climate variability. It is an observed climatic sequence over a defined period that has been chosen to be hydrologically representative. The *benchmark period* is used consistently in the BSMS as a basis for simulating catchment responses (such as groundwater movements and river behaviour) at specified scenario dates (for example 2015, 2050 and 2100). A more detailed description is given in Appendix 3.1.

The benchmark period is currently 1 May 1975 to 30 April 2000. It is intended to review the benchmark period climatic sequence in conjunction with the periodic reviews of the operation of Schedule C (in 2007 and every 7 years thereafter – see Protocol 5.7.3). The review may include extending the sequence to a longer period such as 30 years.

3.5.2 The *Basin Salinity Target*

The Basin Salinity Target is defined in Schedule C, Clause 7 as follows:

1. ‘The *Basin Salinity Target* is to maintain the average daily salinity at Morgan at a simulated level of less than 800 EC for at least 95% of the time, during the benchmark period.
2. Achievement of the *Basin Salinity Target* must be assessed by the Commission from time to time using one or more of the models developed under Clause 36, adapted to simulate the land and water conditions at the time the assessment is made.’

3.5.3 *Baseline conditions* for the basin

The Commission is required to prepare an estimate of the baseline conditions as at 1 January 2000 relating to salinity, salt load and flow regime at the Basin Salinity Target site (Morgan) by 31 March 2003 (Schedule C, Clause 5).

Baseline conditions are the conditions that govern the movement of salt through land and water within the basin on 1 January 2000. They are defined as the agreed suite of conditions in place within the catchments and rivers on 1 January 2000 for:

- land use (level of development of the landscape)
- water use (level of diversions from the rivers)
- land and water management policies and practices (including the Murray-Darling Basin Cap agreements and any subsequent flow management agreements)
- river operating regimes
- salt interception schemes
- run-off generation and salt mobilisation processes
- groundwater status and condition.

The relationship between the above conditions and the salinity, salt load and flow regime at the *Basin Salinity Target* site is established by modelling, using the benchmark period climatic sequence. A more detailed discussion of the application and utilisation of *baseline conditions* is provided in Appendix 3.2.

The concept of *baseline conditions* applies also to valleys and end-of-valley targets, as described in Protocol 2.4.3.

Note: The *baseline conditions* and *end-of-valley targets* were approved by the Commission in June 2004 (see Appendices 3.2 and 3.4).

3.6 Initiating and recording proposals

3.6.1 What is a *proposal*?

In the context of this protocol a proposal is any work or measure in the basin that could have a s*ignificant effect* as defined above. If an initial appraisal of a Proposal indicates that it is likely to have a s*ignificant effect*, then the *proposal* will be declared an accountable action and trigger its detailed assessment and possible entry on the Register.

Proposals must clearly identify the nature of the action and the consequential salinity impacts at the basin target site at Morgan. For this purpose, similar or associated actions that may not individually produce a significant effect should be aggregated and treated collectively.

The consideration of a *proposal* will normally be initiated by the *Contracting Government* of the State in which the proposed work or measure would take place. A program of actions designed to meet an end-of-valley target is likely to include a range of *proposals* that could produce a significant effect (see Protocol 2.4.8).

If the Commission becomes aware of an action that it believes may have a s*ignificant effect*, and about which it has not been informed, then the Commission may direct the appropriate State to bring it forward for assessment.

A *proposal* should be brought forward for assessment before a decision is taken to proceed with it. Claims may be made for past actions undertaken for a purpose not directly connected with salinity impacts but which may have incurred salinity debits or salinity credits. Such retrospective claims may be brought forward at any time. Types of proposed works or measures that (either individually or collectively, as in a *program of actions*) should be brought to the Commission under this provision may include (but are not limited to):

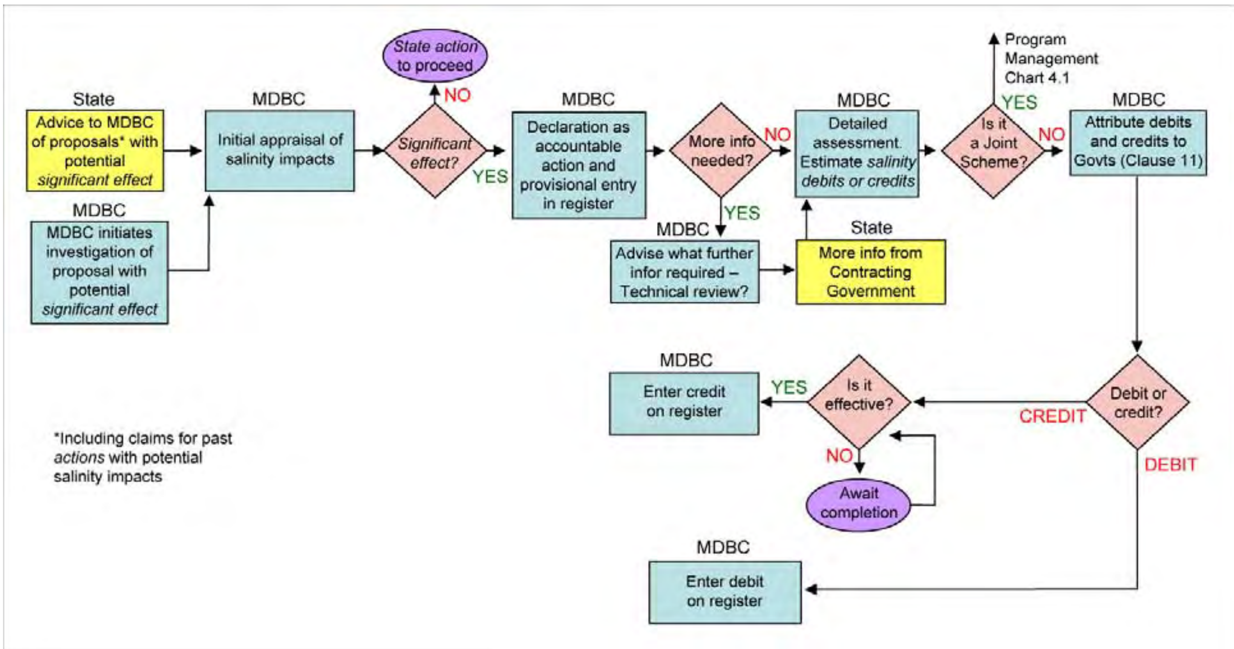
- new surface or sub-surface drainage works, groundwater pumps, or significant alterations (such as deepening and widening) to existing drainage works
- reductions in drainage accessions due to changes in irrigation management practices
- permanent and temporary water trade, including changes in salt accessions (surface drainage and groundwater inflows) and dilution flows due to the departure, transit and arrival of water
- broad scale land use change including revegetation and clearance
- landforming and changes to the runoff characteristics of catchments including the construction of farm dams
- salt interception schemes
- new irrigation development
- growth in groundwater diversions and consequent effects on river flows
- changes in water management operating policies or consumptive use of water in the system, including changes resulting from government approved water management plans to provide changed bulk allocations or environmental flow provisions
- environmental flow releases
- management of wetlands to meet ecological goals
- infrequent, intermittent or one-off discharges to rivers
- other direct human induced activity for which the impact on river salinity is ‘significant’ and that would either occur immediately, or will start occurring within 100 years of undertaking the action

- *programs of actions* , or significant changes in them.

Proposals for assessment will need to identify whether they are expected to generate *salinity debits* or *salinity credits*, and whether they are designed to deal with current salt accessions or intended to avert future predicted salt accessions. If a proposal is expected to generate credits, then it must be indicated whether it is designed to address current salinity problems (and whether these problems are a "legacy of history" or not) or intended to avert predicted future salinity problems. If the proposal is aimed at future salinity impacts, then it should be stated whether the proposal is designed to offset delayed salinity impacts or to offset the impacts of new developments.

The Commission should also be kept informed of likely salinity impacts of events such as large scale fires, floods and droughts and associated rehabilitation activities. If such events are not notified as potential *significant effects* at the time of occurrence, they must be included in the annual overall State report (Protocol 5.5.1.2).

Chart 3.2
Basin Salinity Management Strategy—Proposal assessment flowchart



3.6.2 The assessment of *proposals*

Proposals are assessed in two steps (see flow chart 3.2):

- An initial appraisal that determines whether the proposal is likely to incur a *significant effect* with sufficient confidence to support a Commission declaration of an *accountable action.*
- If the initial appraisal results in the declaration of an accountable action, a detailed assessment, with more complete information, is carried out. This assessment determines

- o a more accurate estimate of the average salinity impact that the action will cause (at the end-of-valley target site, and at Morgan as appropriate)
- o the estimated salinity cost effect that the action is most likely to incur averaged over the 30 years from the time that the *action* takes effect, based on cost functions approved by the Commission
- o whether the debits or credits should be entered on Register A or Register B, or apportioned to both
- o whether the *proposal* should become part of the Joint Program (in whole or in part). For more details of Joint Works and Measures see Protocol 4 (refer Schedule C, Clause 10).

3.6.3 Initial appraisal

The initial appraisal of a proposal may be undertaken by relating the predicted change in local salt loads to salinity levels and salinity cost effects using a 'ready reckoner' as described in Appendix 3.9. The ready reckoner considers a range of actions at different locations based on annual salt loads and provides a preliminary indication of the indicative salinity impacts at the end-of-valley sites and at Morgan. As an alternative, the Commission is able to provide its hydrologic models for use by the proponent.

If the initial appraisal indicates that a significant effect is likely to be incurred as a result of the *proposal*, then the Commission will:

- provisionally declare the *proposal* as an accountable action
- request the proposing government to provide more comprehensive information so that a more detailed assessment can be carried out
- make an entry of the prospective salinity debits or salinity credits in a provisional column in Register A and/or Register B.

3.6.4 Information required for detailed assessments

Proposals must clearly identify the nature of the action and the consequential salinity impacts, both at the end-of-valley target site and at the basin target site at Morgan, as appropriate.

The information required for assessing the salinity impacts cannot be prescribed in a detailed manner for all of the various kinds of proposals that there might be. However, in a typical case the information supplied at the time of detailed assessment should include as a minimum:

- synthesised data on the expected addition or reduction in flow and salt load contributions to local river and subsequently to the shared rivers due to the proposed action. The data should be sufficient to enable calculation of the greatest *salinity impact* within 100 years, and the average *salinity impact* at Morgan over 30 years from the time that the *action* is expected to take effect.

A time series of daily flows and salt loads for the nearest location at which the water and salt loads affected by the *proposal* enter the shared rivers will usually be required. The estimates must be for key dates (for example 2015, 2050, 2100) using the benchmark period for a 'pre-action' set of conditions at each key date that recognises the baseline conditions, the effect of subsequent *actions* completed or in progress, and the delayed salinity impacts at the time. The impact of the *proposal* itself at each key date can then be estimated.

- information about any consequences that may erode the benefits of previous actions
- the methodology adopted, and its assessed strengths and limitations
- comments on the adequacy and quality of data available for carrying out the analysis
- discussion on the confidence limits of the results achieved (where relevant and possible)
- recommendations on the proposed monitoring program for assisting future reviews. The recommended monitoring program should include design of monitoring network, data collection and analysis protocols, and the methodology for assessment.

The level of detail provided must be commensurate with the extent of the potential salinity impact. Initial appraisals may be undertaken without the full detail as described above, but they cannot be considered as final until the full information is provided to and assessed by the Commission. The Commission will respond to the proponent with a preliminary reaction and comment on the proposed assessment approach, and outline the steps necessary to progress with the assessment.

3.6.5 Detailed assessments

The primary method for the detailed assessment of proposals is the use of approved Commission models for the Murray, assuming an agreed climatic sequence (otherwise known as the benchmark period—the period from 1 May 1975 to 30 April 2000). More detail of the procedure may be found in Appendix 3.4.

The analysis has two main requirements:

1. To evaluate the impact on average salinity at Morgan over the 100 years after the analysis date in order to establish whether the *proposal* reaches the 0.1 EC threshold at any time in the 100 years or not.

2. If the 0.1 EC threshold is reached, then it is necessary to evaluate the average impact on the average salinity over 30 years from the time that the *proposal* is expected to take effect, and to use this information to calculate the salinity debits or salinity credits for entry in the appropriate Register. In the case of a potential entry on Register B, a *proposal* can only generate a *salinity credit*, since the *salinity debits* on *Register B* can only originate from delayed salinity impacts.

3. The salinity impacts will be assessed using the suite of hydrologic models including (where appropriate) the State's tributary models and the basin model of the Murray and Lower Darling. A description of the models may be found at Appendix 3.3.

The key steps are then:

1. Obtain information on the trends for the 'no further intervention' case over 100 years from the analysis date (*delayed salinity impacts*). This data will come from the latest Salinity Audit.

2. Develop a set of 'pre-action conditions' that reflect the *salinity impacts* of actions since the baseline date that have been declared effective, or are in progress.

3. Calculate the trend over 100 years for the case with the proposed work or measure implemented ('post-action' conditions). In a typical case this would involve:

    - applying models in valleys to evaluate stream flows, salt loads and salinities at the end-of-valley target sites at key dates (for example 2015, 2050 and 2100)

    - transferring the end-of-valley stream flows and salinities to the relevant point of input to the basin model using an in-stream salt transport model or other technique as appropriate

    - running the basin models (using the *benchmark period*) for each key date to determine the impact at Morgan. From the results obtained the average salinity at Morgan for each scenario can be extracted and the difference between the 'pre-action' and 'post-action' conditions can be calculated. Differences in percentile salinities can also be extracted if required.

4. It is then necessary to derive an estimate of the impact on the average salinity over 30 years in order to generate the prospective salinity debits or salinity credits to be entered in the Registers. The initial assessment of the salinity impact curve should be based on 3 points – the time at which the action commenced or is expected to take effect, and 15 years and 30 years thereafter. Should these points be insufficient to determine the shape of the curve with sufficient precision, then further assessments at intermediate 5-year points may be made and the average impact calculated as shown in Appendix 3.5.

5. For Register B items, it is then possible to compare the salinity impact curve with the 'no intervention' projection. The value of within-valley salinity offsets for *delayed salinity impacts* resulting from the implementation of a program of actions for the valley adopted by a State can then be determined.

Assessments will be rolled forward every five years so that actions which result in a delayed impact beyond 30 years will be progressively taken into account and the appropriate salinity offsets will be periodically reappraised. In order to avoid an unexpected future liability, the assessments will be extended to the next 100 years and the results retained as an additional informative entry on the A and B registers.

3.7 Entries in the Registers

3.7.1 Attribution of *salinity debits* and *salinity credits*

Salinity credits and salinity debits are attributed as follows (refer Schedule C, Clauses 11 and 21):

For a State Action:
To the Contracting Government that undertakes the action: note that there is a provision for two or more Contracting Governments to undertake an action together, and to share the resultant debits or credits in a proportion agreed between them.

For a joint work or measure:
As a component of the strategy the partner governments have agreed to undertake a joint program and to allocate 61 EC credits to it (see more detail in protocol 4.2). A total of 30 EC credits is available to offset accountable actions, and 31 EC credits to address delayed salinity impacts. As a result, for any joint work or measure that has been declared effective, the *salinity credits* from the project are attributed as follows:

Register A (Accountable actions—total available 30 EC)		
New South Wales	16.39%	(10/61)
South Australia	16.39%	(10/61)
Victoria	16.39%	(10/61)
Sub-total Register A	49.17%	(30/61)

Register B (Delayed salinity impacts—total available 31 EC)		
New South Wales	8.61%	(5.25/61)
South Australia	8.61%	(5.25/61)
Victoria	8.61%	(5.25/61)
Commonwealth	25.00%	(15.25/61)
Sub-total Register B	50.83%	(31/61)
Total	**100.00%**	**61 EC**

Details of an interim agreement that has been made for the attribution of Commonwealth *salinity debits* and *salinity credits* are provided in Appendix 3.6.

For a Shared Work:
In proportions reflecting the contributions of State Actions and joint works or measures, as agreed by the Commission.

3.7.2 Timing of entries in the Registers

Salinity debits are to be entered in the appropriate Register prior to beginning the action that gives rise to them. In the case of *actions* that are subject to formal approval prior to commencement, the entry should be made at the time the approval is given. Debits on *Register* B due to delayed salinity impacts (see Appendix 3.6) are entered on an annual basis.

Salinity credits are to be entered when the *action* that gives rise to them is declared *effective* (normally when the works are completed, but the Commission may declare a work or measure to be *effective* at any time after it has begun). When entries are made, any prior provisional entries are deleted.

When a proposed *action* is anticipated to generate salinity credits, and to be implemented progressively over several years (such as a program of actions), the assessment should include a time-based salinity impact response curve which shows how salinity impacts are expected to vary over 100 years as the various components of the action progressively take effect (see Appendix 3.5). The provisional entry in the Register will be the expected average *salinity impact* over the next 30 years, and the first entry can be made as soon as:

- the first stage has been reported complete by the relevant State Contracting Government (either as it occurs, or as part of the Annual Report), and
- the Commission has agreed to declare that stage of the action *effective*.

Subsequent stages may follow a similar procedure. Register entries will be reviewed annually by comparing actual progress in annual reporting with planned progress, and adjusting the time-based *salinity impact* response curve accordingly. Otherwise, Register entries will be revised at five yearly intervals (see Protocols 5.7.1 and 5.7.2) taking into account the time-based response curve and any subsequent reviews.

3.7.3 Assessment and recording of the impacts of irrigation development arising from water trade

The treatment of the impacts of irrigation development is to be consistent with Schedule C and the Protocols, with particular attention to:

- The immediate recognition of any water trade transaction as having potentially a significant effect, leading to its declaration as an accountable action
- The aggregation of similar or associated actions that may not individually produce a *significant effect* in order to treat them collectively (Protocol 3.6.1)
- The level of detail provided, and the effort employed to assess, proposals should be commensurate with the potential salinity impact (Protocols 3.3 and 3.6.4)
- The Commission's approval of the use of SIMRAT (Salinity Impact Rapid Assessment Tool), with its associated documentation and administrative arrangements, as a modelling tool for the assessment of water trades in the Mallee Zone.

The key steps in estimating the salinity impacts of new irrigation development (using SIMRAT, or other approved model) are:

- identify the volume of water being traded

- locate the irrigation licence to which the water is trading
- identify the actual area to be irrigated (if not known assume an area based on usage of 10 ML/Ha, and located on the nearest portion of the property to the irrigation supply source)
- assume that 85% of the total water traded is used by the crop, with the 15% remaining partitioned into 5% losses (e.g. evaporation) and 10% Root Zone Drainage (RZD)
- assess the salinity impacts of the 10% RZD across the irrigated area and record impacts on the Salinity Registers.

As with all *accountable actions*, initial estimates of the salinity impacts of new irrigation development will be based on a number of theoretical assumptions (such as the location of the irrigated area, and root zone drainage rates). Monitoring of *accountable actions* (Protocol 5.4.2) should focus on testing key assumptions, with estimated impacts revised, as appropriate, through the Five Year Reviews (Protocol 5.7.5).

More details of SIMRAT and its administrative arrangements are given in Appendix 3.11. The following provisions apply to the use of SIMRAT:

- SIMRAT may be used for the assessment of arrival site debits
- SIMRAT may be used for the assessment of departure site credits when the history of water use at a disposal site can be proved
- Assessments must be based on using the best available data for each specific trade, with jurisdictions ensuring that best available input data is made available for use in SIMRAT
- SIMRAT may be used in areas of high confidence without conditions
- SIMRAT may be used in areas of lower confidence in a conservative manner under the following conditions:
    - Trades into these areas are initially designated with a provisional entry pending detailed assessment
    - All data shall be submitted for these trades as is necessary to make the assessments in future
    - trades into these areas can be assessed using an alternative (and approved) method if available;
    - if an alternative method for assessing a trade is not agreed within one year of the transaction, the trade in question will be assessed using SIMRAT as the best available model.

The cumulative transactions for each region are to be reviewed every 5 years as part of the program for rolling 5 year reviews (see Protocol 5.7.2). Reviews will take into account actual irrigation development areas and practices, and entries in the Registers adjusted if necessary.

3.7.4 Changes in Register entries

Changes in entries in the Registers may be effected in three ways:

- Amendments to entries may be made as a result of re-estimates of the salinity impacts of any accountable action. The Commission must do this at intervals of not more than 5 years, and may do so at any other time (Schedule C, Clause 24)
- Amendments may also follow from an annual audit by an independent party (Schedule C, Clause 34) or a rolling five-year review (Clause 33)
- Salinity debits and salinity credits may be transferred from one Contracting Government to another, if both parties agree (Schedule C, Clause 23). Note that if the transfer relates to Register B, then the prior written approval of the Commission is required.

4 Works and Measures

4.1 Purpose

The purposes of this protocol are:

- to describe the principles and procedures for designating a work or measure as a joint, state or shared work or measure
- to describe the procedures for the approval arrangements for works and measures.

4.2 Introduction

In accordance with Schedule C (Clause 19) of the Murray-Darling Basin Agreement, the Murray-Darling Basin Commission must provisionally designate any *proposal* with a significant effect as a joint work or measure, a *state action* or a combination of both (a shared work or measure).

A program of *joint works and measures* has been established to offset the predicted future increase on the average salinity at Morgan, arising from accountable actions and delayed salinity impacts, by a total of 61 EC credits[2] by 31 December 2007.

4.3 Principles

The following principles provide the basis for this protocol:

- Contracting Governments are accountable for the future salinity impacts of actions which are undertaken after the relevant baseline dates and which have a significant effect
- Contracting Governments are jointly responsible for offsetting the delayed salinity impacts of activities which occurred prior to the *baseline dates*
- salt interception schemes are a central component of the BSMS that will provide immediate benefits while broader long term landscape change is investigated, implemented and takes effect
- a joint approach to works and measures acknowledges the joint responsibility for *delayed salinity impacts*
- works and measures should be developed consistent with the Integrated Catchment Management principles and should take into account the local planning processes
- works and measures should look for innovative approaches including the use of salt as a resource

[2] An average of 61 EC units over 30 years – made up of 31 EC to address impacts of past actions and 10 EC to each of South Australia, Victoria and New South Wales to assist in offsetting accountable actions.

- the benefits arising from any new action should not erode the credits assigned to an existing joint work or measure on Register A or Register B without prior agreement by the Commission.

4.4 Procedures

4.4.1 Classification of works and measures

The following should guide the classification of works and measures as a Joint, State or shared work or measure:

Joint work or measure

A *joint work or measure* should:

- have a primary (but not necessarily exclusive) purpose of addressing *delayed salinity impacts*
- be infrastructure based typically, and have an immediate (within 2 years) and direct salinity benefit for the River Murray (as measured at Morgan). Works or measures that are not primarily infrastructure may be considered if the other criteria are met.
- deliver demonstrable benefits and be cost-effective considering all expected salinity, environmental, economic and social benefits achievable from the scheme
- meet the land use, environmental and statutory requirements of the Commonwealth and the relevant State as well as any international treaty and statutory obligations.

For a *joint work or measure*iver Murray Water will exercise management and financial control over construction, operation, maintenance and renewals. In accordance with the provisions of the *Agreement*, State Constructing Authorities will carry out the day-to-day activities associated with construction, operation and maintenance.

State action

A State action:

- should comprise predominantly accountable actions providing demonstrable local, regional and/or commercial benefits[3]
    - may comprise an individual action or a program of actions to meet end-of-valley targets, including on-farm implementation works or measures and/or structural

3 Note that a State action may address delayed salinity impacts, offset impacts of new developments, be a new development, and contribute to meeting an end-of-valley target and/or the Basin Salinity Target. It is possible for actions to have a significant effect in relation to an *end-of-valley target* but have a negligible effect on the *Basin Salinity Target*.

adjustment. The types of works or measures in a *State action* ate listed in Protocol 3.6.1.

The State that implements a State work or measure shall operate, maintain and manage such works and measures to an agreed standard to maintain any benefits attributed to these works and measures.

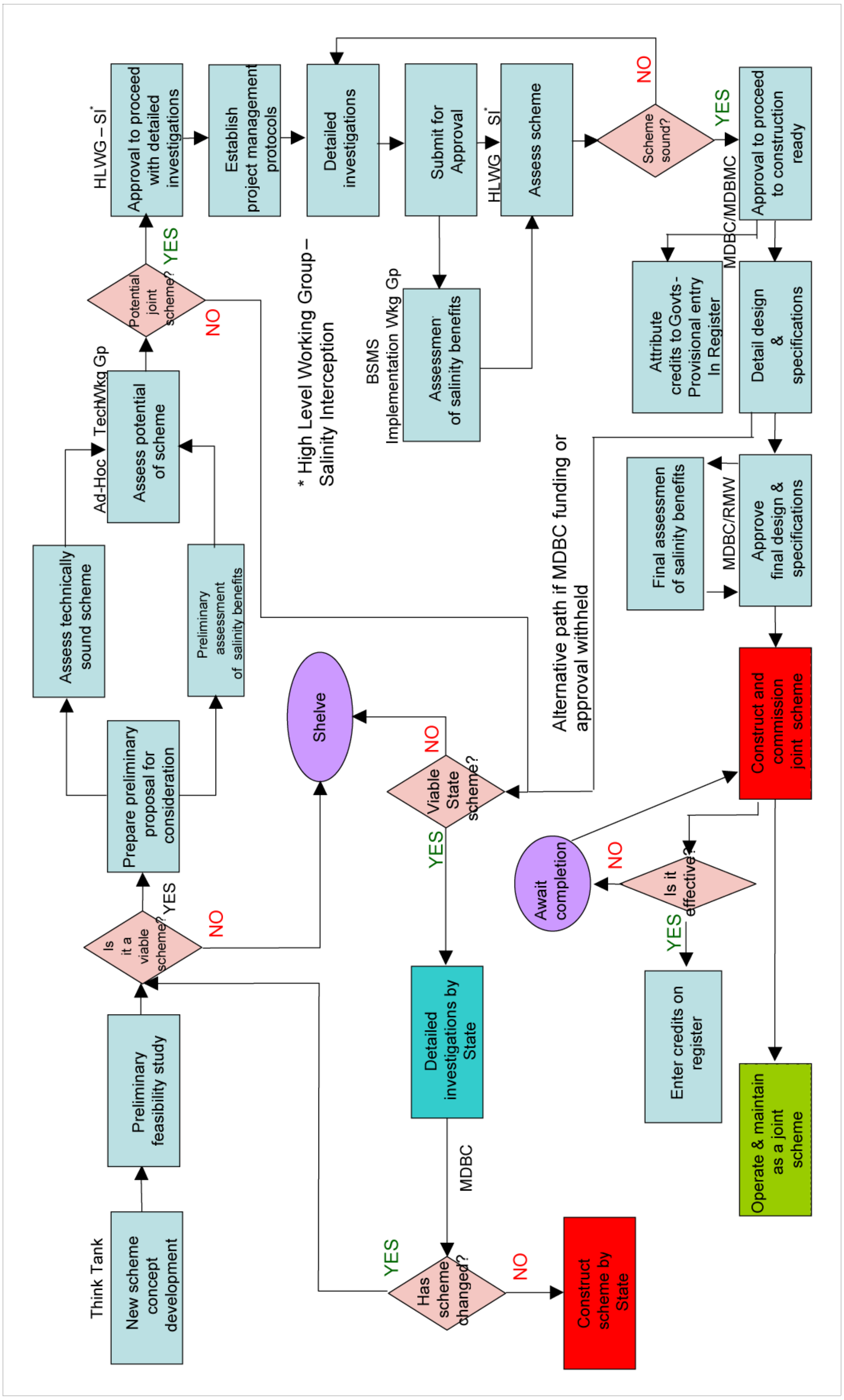
Shared work or measure

Where a work or measure comprises a combination of joint works and *State actions*, the work or measure may be designated as a shared work or measure. In this case the cost (capital, operations and maintenance and renewals) and the benefits gained would be in direct proportion to the split between the joint works component and State actions, or in any other proportion that the Commission may agree to from time to time.

Any variation in the sharing arrangements of a work or measure arising from a change in a *State action* must not adversely impact the *joint work or measure*. In the event that a change in the *accountable action* component of the work threatens the capacity of the joint component of a shared work or measure, the State will be responsible for ensuring that the capacity of the shared work or measure to meet the objectives of the joint component is protected.

For a shared work or measure, River Murray Water will exercise management and financial control over construction, operation, maintenance and renewals of the work or measure regardless of final salinity benefit sharing arrangements. In accordance with the provisions of the *Agreement*, State Constructing Authorities will carry out the day-to-day activities associated with construction, operation and maintenance. A policy for the funding and management of renewals is to be developed by River Murray Water.

Chart 4.1
Salt Interception Joint Works Program—Program management flowchart



4.4.2 Transfer of a work or measure

Works or measures can be transferred wholly or in part from either State action to joint work or measure, or from *joint work or measure* to *State action*. Any transfer should consider benefits to the State or the Commission that would include but not be limited to:

- improvements in the efficiency and effectiveness of operations, maintenance and management of works and measures
- change of focus of the works and measures.

Any transfer should be preceded by a competence and due diligence process to ensure that any additional investment required will provide cost-effective additional salinity and/or efficiency benefits for all contracting governments, and that existing benefits and efficiencies are not eroded.

4.4.3 Assessment of *proposals*

States are to provide advice to the Commission on all potential works or measures (new, refurbishment or augmentation) that have a significant effect and appear to warrant further investigation as a preliminary feasibility study. More detail on the assessment of proposals is given in Protocol 3.5.2. Once a preliminary feasibility study is completed the work or measure is to be formally presented to the Commission for designation as a joint, shared or state work or measure. The procedure is shown in Chart 4.1.

On receipt of a presentation, the Commission must either:

- prioritise the potential works or measures for detailed investigation as a joint/shared work or measure to be included in the Commission's program of works, or
- designate the proposal as a State action.

4.4.4 Prioritising works and measures

Joint or shared works or measures included in the Commission's program of works are to be prioritised on:

- preliminary estimates of the net present value per EC potential benefit (evaluated over a period of 30 years from the expected completion of the work, at a discount rate of 4%)
- the extent and distribution of all benefits including salinity, environmental, economic and social benefits
- risks, including issues associated with salt disposal where applicable.

If, following the acceptance of the work or measure, the Commission does not provide adequate funding to progress investigations of the joint or shared work or measure within a timeframe agreed between the Commission and the State, the originating State can proceed to investigate and implement works as a State Action.

If, on completion of the detailed investigation, the nature or anticipated benefits of a potential work or measure vary significantly from the preliminary feasibility study, the work or measure will, without prejudice, be reconsidered by the Commission. The progression of a work or measure from concept to construction is outlined in the attached ‘Project Management Flowchart’. Chart 4.1.

4.4.5 Timing of entries in Registers

Joint works and measures and shared works and measures may be undertaken in stages (Schedule C Clause 22). Staged schemes must be assessed as a whole, but individual stages may be declared effective progressively as they are commissioned.

The timing of Register entries is defined in Protocol 3.7.2.

4.4.6 Operations and maintenance

Joint works and measures and shared works and measures will be operated, maintained and managed to standards as prescribed from time to time by River Murray Water.

5 Monitoring, reporting, auditing and review

5.1 Purpose

The BSMS is founded on the principles of partnership, shared responsibility and accountability for actions affecting salinity that are undertaken by the partner governments. Whilst the strategy has a focus on water quality outcomes for the shared rivers, the strategy is basin-wide and covers the full range of salinity management outcomes.

It follows that the monitoring of the strategy must be effective and that the reporting be comprehensive, as accurate as reasonably possible, transparent and reliable. It will also be necessary to review the strategy from time to time and to amend it where necessary in the light of experience and technical progress.

This protocol details the actions and respective responsibilities for undertaking monitoring, reporting, audit and review functions.

5.2 Introduction

Monitoring involves the collection, analysis, reporting and use of information about the progress of the strategy. It is undertaken so that the governments can be satisfied that actions that have been taken are producing the effects intended when the decision to take the action was made. Monitoring is intended to highlight strengths and weaknesses in implementation and to enable the identification and resolution of problems.

As examples, Schedule C (Clauses 26 and 27) obligates State Contracting Governments to monitor the degree to which end-of-valley targets are being achieved, and to monitor the salinity impacts of an accountable action. Monitoring therefore includes the monitoring of in-stream water quality and each of the programs of actions in order to track progress towards achieving targets.

Reporting is the mechanism for communicating achievements, successes and failures. Regular reporting on the key aspects of the strategy is a central component of the Contracting Governments' accountability to each other, and is necessary to inform further decisions that they may take. The strategy calls for a hierarchical reporting arrangement that culminates in annual reports to the Ministerial Council, with an emphasis on exception reporting (see Chart 5.1).

Behind this overall annual reporting are reports at a catchment (valley) scale from States, reports from the Commission, reports of *accountable actions*, and the status of Registers A and B. The intention is to provide a transparent reporting process that advances understanding and gives the overall outcomes, while providing the ability to track down to individual components of the strategy.

Auditing involves the objective examination of records, procedures and systems to confirm their accuracy and effectiveness in meeting the objectives of the strategy. The independent verification of the entries of salinity debits and salinity credits in Register A and Register B is an example of an audit.

Reviews are undertaken to determine whether the objectives of the strategy—or a component of the strategy—are being achieved, and to assess the overall strengths and weaknesses of the strategy. Reviews generate information and perspectives on the strategy that are useful in maintaining its currency and relevance.

As an example, the Commission is required to review the operation of Schedule C every 7 years, and to report on 'its usefulness and effectiveness in implementing aspects of the strategy' (Schedule C, Clause 35).

5.3 Principles

The principles that underlie these protocols are:

- reporting should be clear and easily verifiable, so that end users can have a high level of confidence in the reports
- so far as practicable, report formats and the basis of reporting should be consistent across the basin regardless of the location or jurisdiction
- within-valley monitoring and reporting is a State responsibility and is outside the scope of these protocols
- reporting arrangements should be consistent with and avoid duplication in relation to State salinity strategies and national program reporting needs (such as the National Action Plan for Salinity and Water Quality and the National Heritage Trust Stage 2)
- review mechanisms should be flexible and constructive so that beneficial changes may be made when necessary in the light of increased knowledge and understanding of salinity, and to take advantage of technological change
- independent auditing must be undertaken in a way that ensures probity.

5.4 Monitoring

5.4.1 General

Monitoring of salinity within valleys is an important feature of the State and Basin salinity strategies. It serves a number of purposes:

- to support and enhance the calibration and validation of the hydrologic models that are fundamental to evaluating the performance of the strategy
- to indicate where existing data might limit the level of accuracy of the definition of baseline conditions and the data for the benchmark period

- to support the evaluation of progress towards achieving end-of-valley targets and the Basin Salinity Target.

The results from tributary model studies may also identify needs for additional within-valley monitoring.

Monitoring obligations as stated in Schedule C focus on the monitoring of targets and actions. It is important to maintain in-stream measurements of flow, salinity and salt load at other critical locations across the Basin to assist in attributing salinity to its source. Currently identified critical locations are categorised as interpretation sites and are listed in Appendix 2.1 (in italics). Others may be introduced where necessary to increase understanding of river behaviour.

Where possible, monitoring should be based on direct in-stream measurements of both pre-action and post-action salt load and salinity levels in the rivers, taking account of the prevailing stream flow conditions. Where direct measurement is not possible, surrogate measures of ‘cause and effect’ may be used as an alternative. Surrogate monitoring and reporting requires:

- identification of local ‘cause and effect’ relationships which will result in an identifiable change in salt loads to the rivers. For example, this might require groundwater level and salinity measurements or measurements of pump duty against predetermined operating rules or targets

- analysis of these surrogate measurements with the appropriate local process modelling tool (such as groundwater or drainage analyses)

- conversion of the results of the analysis into a local salt load reduction

- comparison with the model assessment for the particular action (adjusting for *baseline conditions* over the *benchmark period*)

- reporting the results of this monitoring and analysis using a performance indicator such as percentage contribution to the *end-of-valley target*.

Schedule C (Clauses 26 and 27) requires *Contracting Governments* to monitor the following:

- the salinity impacts of all accountable actions (both *joint works or measures* and *state actions*)

- the degree to which *end-of-valley targets* are being achieved.

The results of the monitoring must be provided to the Commission when requested, and at least annually (by 30 November of the following financial year).

5.4.2 Monitoring of *accountable actions*

Monitoring of accountable actions must be undertaken in accordance with a monitoring program that is prepared by the Contracting Government and accepted by the Commission. Proposed monitoring programs must be provided to the Commission:

- in the case of a joint work or measure, within 3 months of the nomination of a State government to undertake the work (to be reviewed at periods not exceeding 12 months until the works are complete)
- in the case of a *state action*, within 3 months after the action has been completed.

The requirements for a monitoring program for a *joint work or measure,* a shared work or measure or an *accountable action* should be established at the time of assessing the proposal that gives rise to it (see Protocol 3.6.4 – 'Information required for detailed assessments').

Where an *action* comprises a program of actions to meet an end-of-valley target, it will be necessary in practice to implement the monitoring program at the *end-of-valley targets* site before the *action* is completed to satisfy annual reporting requirements. In these circumstances information on the proposed monitoring program at the *end-of-valley target* site will have to be submitted to the Commission before the *action* is completed.

5.4.3 Monitoring progress towards *end-of-valley targets*

The degree to which end-of-valley targets are being met is determined by using modelled outcomes. The modelling will be based on the results of monitoring actual physical progress of the agreed program of actions as determined in Protocol 5.4.2.

The monitoring procedures should be developed so that the information required to meet the annual reporting requirements for each valley (as set out in Protocol 5.6.1) is readily available.

5.5 Reporting

5.5.1 Annual Reporting – State Contracting Governments

5.5.1.1 Valley Reports

State Contracting Governments must prepare an annual report for each valley for which an end-of-valley target has been adopted (Schedule C, Clause 30) as part of the overall State report.

Valley annual reports should detail progress with implementation of the program of actions, with a progressive estimate of salinity effect (at end-of-valley and/or Morgan as appropriate) due to those actions actually implemented to date. The annual valley reports should normally include:

- end-of-valley salinity assessed salt load and flow regimes under baseline conditions and modelled over the benchmark period. (This information should normally be a restatement of analyses undertaken previously, unless the definition of the *baseline conditions* and/or the *benchmark period* have changed during the year.)

- a description of expected delayed salinity impacts on salinity, salt loads and flow at the end-of-valley target site for the years 2015, 2050 and 2100, assuming that the land and water management regime as at 1 January 2000 continues indefinitely into the future. This information should normally be based on existing data and special modelling for reporting purposes is not required

- the agreed *end-of-valley target* for salinity and salt load

- a report on the status of the current *program of actions*, indicating the progress made during the year and the status of each action in the program at year end. The report should indicate the estimated salinity impact that each *action* has had or is expected to have. For each *action* completed, the report should indicate the effect that the *action* has had on salinity, salt load and/or flow regime in relation to the *end-of-valley target.*

  Each *action* will have been assigned a value in contributing towards the *end-of-valley target* using the assessment technique described in Protocols 2.4.9 and 3.6.5. The extent to which the target is being met should be reported using a pro-rata value proportionate to the progress with each *action*. The progress towards the target will then be expressed as a percentage of the contribution previously agreed as necessary to meet the *end-of-valley target*

- details of any reviews that have taken place during the year.1

A sample end-of-valley report summary is shown at Appendix 2.4.

5.5.1.2 Overall State Reports

State Contracting Governments must prepare and give to the Commission an annual report on all activities relevant to the BSMS for which they are responsible. The overall State report must be lodged as soon as practicable after the end of each financial year, and not later than 30 November (Schedule C, Clause 29).

State reports must include:

- all of the valley reports (see Protocol 5.5.1.1)

- to the extent that they are not covered in the valley report, details about the progress of
    - *accountable actions*
    - *proposals* that have been notified to the Commission
    - *joint works and measures* and shared works and measures
    - any other matters relevant to the BSMS for which they are responsible.

- an overall report that discusses all regional *actions*, based on the 9 themes of the BSMS (see Appendix 5.1)

5.5.2 Annual Reporting by the Commonwealth

The Commonwealth government will provide the Commission with a report annually (by 30 November in the following financial year) with information about the progress of any relevant work or measure for which it is the responsible Government (Schedule C, Clause 31 refers).

Given the Commonwealth's role in facilitating salinity management outcomes, a Commonwealth report could include details of actions at a national level that have particular relevance to the Basin such as national research, monitoring and mapping programs.

5.5.3 Reporting by the Commission

5.5.3.1 Exception reporting and default

The Commission may at any time determine that a State Contracting Government is in default of its obligations under the agreement (Schedule C, Clauses 43 and 44). The Commission may form this view in the event of:

- failure to meet any end-of-valley target, or a likelihood that it may not be met
- failure of any government to keep its total of all salinity credits greater than or equal to the combined total of salinity debits on Registers A and B
- failure of any government to keep its total of salinity credits greater than or equal to the total of salinity debits on Register A
- any other circumstance where a government has not met its obligations as set out in Schedule C.

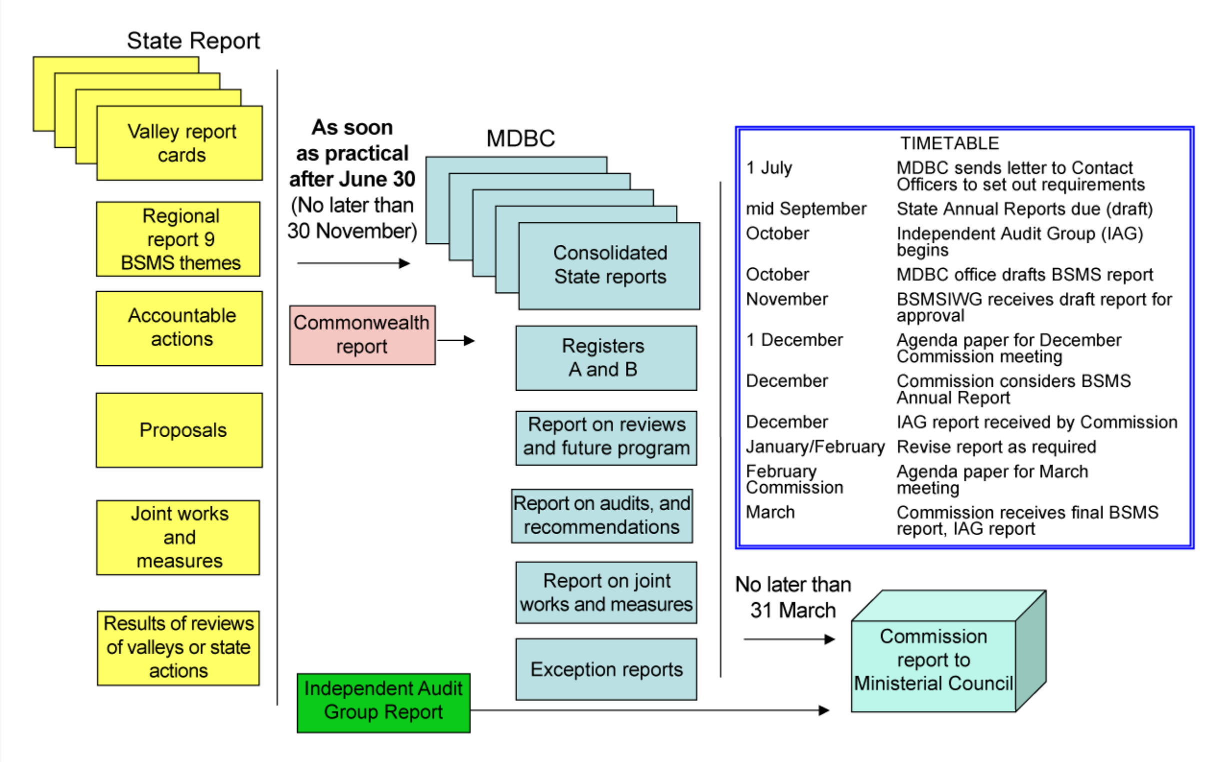
Should this occur the Commission must:

- consult with the relevant State Contracting Government with a view to remedying the situation
- prepare an exception report, with proposals for remedial action, and present it to the next meeting of the Ministerial Council.

In the event that the Commission makes a default report to the Ministerial Council the relevant State Contracting Government must:

- provide a report to the next meeting of the Ministerial Council that explains the circumstances, indicates the remedial action taken or proposed to be taken, and estimates how long it will be before the situation is rectified
- report annually to the Commission until the Commission's determination is revoked.

Chart 5.1
Basin Salinity Management Strategy—Annual reporting



5.5.3.2 Contents of annual report

The Commission must report to the Ministerial Council by 31 March every year (Schedule C Clause 32). The report is to relate to the preceding financial year and must include the following items:

- copies of all reports received from governments relative to the BSMS
- a consolidated summary of the valley reports from States (see Protocol 5.6.1)
- a summary of the results of audits conducted, and any audit recommendations
- a summary of all reviews conducted, and any recommendations arising from them, including any unresolved items from previous reviews (see Protocol 5.6.1)
- a program of reviews to be carried out in the next financial year
- a copy of Register A and Register B (as at 30 November of the preceding calendar year)
- a report on joint works and measures and shared works and measures completed and in progress
- any exception reports that may have been made during the year.

The necessary information flows and annual timetable are shown in Chart 5.1.

5.6 Auditing

5.6.1 Scope of audits

Schedule C, Clause 34 requires the Commission to appoint independent auditors annually to carry out audits of:

- any review undertaken by a State Contracting Government or the Commission in the preceding financial year (as part of the rolling five-year review program—see Protocol 5.6.2)
- Register A and *Register B,* as part of an annual independent auditing cycle focussed on the operation of the registers.

5.6.2 Selection of auditors

The qualities to be sought in the selection of auditors include:

- independence (for example, the selected auditor should have had no prior connection with any of the work being audited)
- value for money
- an understanding of natural resource management issues using the concepts of targets in natural resource management and the application of complex analytical models.

Auditors should be appointed through a commercial selection process for a period of three years and may be retained for further annual periods provided the total duration of the appointment does not exceed five years.

5.6.3 Audit reports

The independent auditors are required to produce an audit report, which must include as a minimum:

- an overall report on the performance of the State Contracting Governments and of the Commission in implementing the provisions of Schedule C
- an assessment of whether the Commission has fairly and accurately recorded the salinity impacts in Register A and Register B
- any recommendations arising from the above, including any recommendation to vary the entries in the registers.

5.7 Reviews

Schedule C provides for a number of reviews to be undertaken on a periodic basis. The reviews are:

5.7.1 Rolling reviews of *joint works and measures*

A review of each joint work or measure must be undertaken by the Commission every 5 years (Schedule C, Clause 33). The review must include an estimate of the cumulative effect of the work or measure on the salinity, salt load and flow regime (where relevant) in the River Murray in the current year and in 2015, 2050 and 2100.

Reviews of works must also include an assessment of the project by River Murray Water in its role as the ultimate operating and maintenance authority.

5.7.2 Rolling five-year reviews of valley predictions and *state actions*

A review of each valley that has an end-of-valley target, and the *state actions* in that valley, must be made by the appropriate State Contracting Government at least once every 5 years (Schedule C, Clause 33). The report for each valley resulting from the review must include:

- an estimate of the delayed salinity impacts at the *end-of-valley target* site at 2015, 2050 and 2100 if no further action is taken, in relation to the 50 and 80 percentile non-exceedance limits. The estimates should be based upon appropriate landscape salt mobilisation predictions related to in-stream salinity using the approved tributary hydrologic models

- the best current information available about the salinity, salt load and flow regime at the *end-of-valley target* site

- an estimate of the effect in the current year and in 2015, 2050 and 2100 of completed elements of the valley program of actions

- an estimate of the effect in 2015, 2050 and 2100 of elements of the *program of actions* that have yet to be completed

- any comment on the adequacy and appropriateness of the current *end-of-valley target.*

Landscape salt mobilisation predictions should be related to the values and assets within the catchment such as biodiversity, agricultural productivity and cultural heritage to the extent these are available (see Appendix 5.2). Where possible, the results should be presented in a mapped format with datasets in an agreed GIS compatible format and matched to the appropriate catchment landscape salinity management units (to the level of third-order catchments or equivalent).

The methodology for the salt mobilisation predictions needs to be appropriate to the landscape, land use and severity of the salinity issue. Different methodologies are likely to be used for upland dryland regions and irrigated regions. The methodology and an assessment of the confidence levels realised should be provided with the predictions.

The Commission will maintain a coordinated salinity reporting database that relies upon distributed data within each of the Contracting Governments. This database will allow transparency in the reporting arrangements and provide an accountability trail for statements within any of the BSMS reporting products.

5.7.3 Review of Schedule C

The Commission must review the operation of Schedule C by 31 December 2007 and at least every 7 years thereafter. The report must include (Schedule C Clause 35):

- a summary of delayed salinity impacts, and the salinity impacts of every accountable action undertaken in the Murray-Darling Basin before the date of the report
- a description of any proposed changes to the joint program designed to ensure that the Basin Salinity Target is met
- any circumstances where a State Contracting Government has not met its obligations under the Schedule

The report should contain conclusions about the usefulness and effectiveness of the Schedule, and any recommendations that might improve its operation.

5.7.4 Review of *end-of-valley targets*

The Commission must review the adequacy and appropriateness of each end-of-valley target at intervals of not more than 5 years (Schedule C, Clause 9).

A review may result in a proposal to vary the target. In that event the Commission must consult the relevant State Contracting Government and may then request the Ministerial Council to amend the target. A recommendation for amendment should be based on new or amended information used when the target was set.

5.7.5 Review of estimates of *salinity impacts*

The Commission must, at intervals of not more than 5 years, re-estimate the salinity impacts of each accountable action. If the re-estimated salinity impacts differ from those entered on Register A or Register B, then they must be recalculated and re-attributed, with appropriate amendments made on the Registers (Schedule C, Clause 24).

5.7.6 Review of models

All models developed to support the BSMS by the Commission or the State Contracting Governments must be reviewed before 31 December 2007 and at intervals of not more than 7 years thereafter. The report of the review must propose any amendments considered appropriate (Schedule C, Clause 39).

Appendices

Appendix 1.1

Basin Salinity Management Strategy (Implementation) Working Group

Terms of Reference (2 February 2005)

Preamble

The *Basin Salinity Management Strategy* (BSMS) provides a guideline for communities and governments to work together to control salinity and protect key natural resource values in the Murray-Darling Basin, and is consistent with the principles of the *Integrated Catchment Management Policy Statement* (ICM). It establishes targets for river salinity of each tributary valley and the Murray-Darling system, reflecting the shared responsibility for actions between valley communities and between States. The BSMS establishes a 15-year strategy within an accountable framework to achieve these targets.

The Strategy **objectives** are to:

- 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
- control the rise in salt loads in all tributary rivers of the Basin and, through that control, protect their water resources and aquatic ecosystems at agreed levels
- control land degradation and protect important terrestrial ecosystems, productive farm land, cultural heritage, and built infrastructure at agreed levels Basin-wide
- maximise net benefits from salinity control across the Basin.

Under the BSMS, the partner Governments are committing to the following nine elements of strategic action, to be implemented over the next 15 years:

- developing capacity to implement the Strategy
- identifying values and assets at risk
- setting salinity targets
- managing trade-offs with the available within-valley options
- implementing salinity and catchment management plans
- redesigning farming systems
- targeting reforestation and vegetation management
- constructing salt interception works

- ensuring Basin-wide accountability: monitoring, evaluating, and reporting.

As part of this action the Commission will manage a comprehensive knowledge generation program, coordinate and enhance further research and development (R&D) on farming and forestry systems, construct and operate salt interception schemes, further develop the vegetation bank concept and establish Basin-wide monitoring, evaluation and reporting arrangements.

The BSMS Implementation Working Group (BSMSIWG) will oversee the monitoring, evaluation and reporting components, essential to ensure accountability under Strategy implementation. The working group will provide the necessary quality assurance and auditing, and will liaise closely with the High-Level inter-jurisdictional Working Group (HiLWG) on salt interception schemes.

General

- Advise on coordinated implementation of all aspects of the Basin Salinity Management Strategy.

- Manage the reporting and accountability arrangements for implementation of the Strategy.

- Advise on revisions to Schedule C of the Murray Darling Basin Agreement to implement the Strategy.

- Advise on the preparation of reports and audits to the Council.

- As an early priority, develop reporting and accountability protocols for consideration and endorsement of the Commission.

End-of-Valley Targets

- In close collaboration with State Agencies, develop and implement reporting arrangements and protocols for assessing progress towards the Basin end-of-valley salinity, salt load and flow targets.
- Advise on the finalisation and modification of end-of-valley targets.
- Establish the modelling framework upon which assessments will be made and advise on the accreditation of models, valley by valley.
- Establish protocols and arrangements for recording the effect of actions (works and measures) in making progress towards each target.

Basin Salinity Target at Morgan

- Establish a reporting arrangement for assessing the cumulative effect of actions contributing to each of the end-of-valley targets towards meeting the Basin salinity target at Morgan.

Joint Works and Measures for Salinity Mitigation

- Recommend standard methods, procedures and protocols for assessment of proposals/works or measures with salinity implications.

Salinity registers

- Establish reporting and accountability arrangements for salinity credits and salinity debits in accordance with Schedule C to the Agreement.
- Advise on the integration of the existing Salinity Drainage Strategy Register into the new Council Registers, and on the operation of the A and B Registers themselves.
- Establish protocols for identifying the value of *salinity credits* and *salinity debits* associated with the cumulative impact of actions within each valley.
- Establish auditing arrangements for items on the Registers.

Modus Operandi

Membership skills

Membership of the Basin Salinity Management Implementation Working Group will consist of senior staff from Contracting Governments having technical or policy development responsibility for salinity management. States may choose two members if this is necessary to cover the representational needs and skills required. Additional expertise can be co-opted as necessary to meet the terms of reference, (including access to short-term consultancy contracts).

Short-term focus

The Basin Salinity Management Strategy Working Group will initially focus on the design, development and trialing of the BSMS reporting arrangements leading to the adoption of assessment and accountability protocols by the Commission. Initially, this will require an intensive effort, involving more frequent meetings, commitments of State resources and the supervision of technical studies.

Strategy operation

In the longer term, as the Strategy becomes operational, the Working Group will advise on coordinated implementation of all aspects of the Strategy, to the Commission. There will be access to Commission technical support and external contract or consultancy skills.

Independent audits

The Basin Salinity Management Strategy will be subject to independent audits which shall be managed elsewhere in the Commission arrangements but will have access to all the data, model results, workings and deliberations of the Working Group.

Executive support

The Commission Office will be responsible for convening the Working Group meetings and providing the executive support including the management of any technical investigations necessary in developing the protocols and interim reporting.

Membership

The members of the group as at December 2005 are:

South Australia
Cole, Phil
Group Manager, Salinity, Strategic Policy Division
DWLBC
Email: cole.phil@saugov.sa.gov.au

Kirk, Judith
Senior Policy Officer Salinity
Department of Water, Land and Biodiversity Conservation
Email: kirk.judith@saugov.sa.gov.au

Victoria
Critchell, Stuart
DSE
Email: Stuart.Critchell@dse.vic.gov.au

Hood, Adam
Landscape Scientist, Land and Catchments, DSE
Email: Adam.Hood@dse.vic.gov.au

New South Wales
Black, Dugald
Manager, Resource Processes
DIPNR
Email: dugald.black@dipnr.nsw.gov.au

Pendlebury, Paul
Manager, Surface and Groundwater Processes
Email: ppendlebury@dipnr.nsw.gov.au

Queensland
Power, Ed
Manager, Catchment and Regional Planning
DNRM
Email: Ed.Power@nrm.qld.gov.au

Australian Government
Smalley, Simon
General Manager, Water Reform
DAFF
Email: simon.smalley@daff.gov.au

Gary Davis (interim)
DAFF

Australian Capital Territory
Chapman, Stewart
ACT MDBC Coordinator
Office of Sustainability
Canberra
Email: stewart.chapman@act.gov.au

Kym Nixon
Office of Sustainability, Canberra
Email: kym.nixon@act.gov.au

Community Advisory Committee
Broster, Leon
Email: lbroster@internode.on.net

Hayden, Rodney
Email: rodhay@iinet.net.au

MDBC
Keyworth, Scott, Chairman
Director, Strategy Implementation
Email: scott.keyworth@mdbc.gov.au

Kendall, Matt, Executive Officer
Salinity Manager, Strategy Implementation
Email: matt.kendall@mdbc.gov.au

Appendix 2.1

APPROVED END-OF-VALLEY SALINITY TARGETS

Valley	Baseline Conditions (1 Jan 2000) Salinity (EC µS/cm)		Salt Load (t/yr)	End-of-Valley Targets (as percentage of Baseline) Salinity (EC µS/cm)		Salt Load (t/yr)	End-of-Valley Targets (as absolute value) Salinity (EC µS/cm)		Salt Load (t/yr)	Valley Reporting Site	AWRC Site Number	Map EoV Site ID
	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean			
All PARTNER GOVERNMENTS												
Murray-Darling Basin	570	920 (95%ile)	1,600,000	110%	87% (95%ile	110%	627	**800^** (95%ile)	1,760,000	Murray R @ Morgan (Salinity) Murray R at Lock 1 (Flow)	426554 426902	96
SOUTH AUSTRALIA												
SA Border	*380*	*470*	*1,300,000*	-	*88%*	-	-	*412*	-	*Flow to SA*	*426200*	*92*
Lock 6 to Berri	450	600	1,500,000	-	91%	-	-	543	-	Murray R @ Lock 4 (Flow) Berri Pumping Station (Salinity)	426514 426537	94
Below Morgan	600	820	1,600,000	-	94%	-	-	770	-	Murray R @ Murray Bridge	426522	98
NEW SOUTH WALES												
Murrumbidgee	150	230	160,000	108%	112%	106%	162	258	169,600	Murrumbidgee R d/s Balranald Weir	410130	58
Lachlan	430	660	250,000	107%	105%	103%	460	693	257,500	Lachlan R @ Forbes (Cottons Weir)	412004	55
Bogan	440	490	27,000	132%	93%	129%	581	456	34,830	Bogan R @ Gongolgon	421023	78
Macquarie	480	610	23,000	105%	122%	112%	504	744	25,760	Macquarie R @ Carinda (Bells Bridge)	421012	77
Castlereagh	350	390	9,000	105%	-	99%	368	-	8,910	Castlereagh R @ Gungalman Bridge	420020	76
Namoi	440	650	110,000	108%	110%	116%	475	715	127,600	Namoi R @ Goangra	419026	75
Gwydir	400	540	7,000	103%	101%	100%	412	545	7,000	Mehi R @ Bronte	418058	74
NSW Border Rivers	250	330	50,000	100%	100%	100%	250	330	50,000	Macintyre R @ Mungindi	416001	70
Barwon-Darling	*330*	*440*	*440,000*	*118%*	*103%*	*131%*	*389*	*453*	*576,400*	*Darling R @t Wilcannia Main Channel*	*425008*	*90*
NSW Upper Murray	*54*	*59*	*150,000*	-	-	-	-	-	-	*Murray R @ Heywoods*	*409016*	*10*
NSW Riverine Plains	*310*	*390*	*1,100,000*	-	-	-	-	-	-	*Murray R @t Redcliffs*	*414204*	*60*
NSW Mallee Zone	*380*	*470*	*1,300,000*	-	-	-	-	-	-	*Flow to SA*	*426200*	*92*
VICTORIA												
Wimmera	1,380	1,720	31,000	100%	100%	100%	1,380	1,720	31,000	Wimmera R @ Horsham Weir	415200	34
Avoca	2,060	5,290	37,000	102%	-	-	2,096	-	-	Avoca R @ Quambatook	408203	32
Loddon	750	1,090	88,000	95%	-	-	711	-	-	Loddon R @ Laanecoorie	407203	24
Campaspe	530	670	54,000	78%	-	-	412	-	-	Campaspe R @ Campaspe Weir	406218	22
Goulburn	100	152	166,000	99%	-	-	99	-	-	Goulburn R @ Goulburn Weir	405259	18
Broken	100	130	15,000	141%	-	-	141	-	-	Broken Ck @ Casey's Weir	404217	16
Ovens	72	100	54,000	100%	100%	101%	72	100	54,540	Ovens R @ Peechelba-East	403241	14
Kiewa	47	55	19,000	100%	100%	100%	47	55	19,000	Kiewa R @ Bandiana	402205	12
Vic Upper Murray	*54*	*59*	*150,000*	-	-	-	-	-	-	*Murray R @ Heywoods*	*409016*	*10*
Vic Riverine Plains	*270*	*380*	*630,000*	-	-	-	-	-	-	*Murray R @ Swan Hill*	*409204*	*30*
Vic Mallee Zone	*380*	*470*	*1,300,000*	-	-	-	*+15EEC*	-	-	*Flow to SA*	*426200*	*92*
QUEENSLAND												
Qld Border Rivers	250	330	50,000	100%	100%	100%	250	330	50,000	Barwon R @ Mungindi#	416001#	70
Moonie	140	150	8,700	100%	100%	100%	140	150	8,700	Moonie R @ Fenton	417204A	71
Condamine-Balonne	170	210	4,200	100%	100%	100%	170	210	4,200	Ballandool R @ Hebel-Bollon Rd	422207A	83
	170	210	5,000	100%	100%	100%	170	210	5,000	Bohkara R @ Hebel	422209A	82
	150	280	6,500	100%	100%	100%	150	280	6,500	Braire Ck @ Woolerbilla-Hebel Rd	422211A	84
	170	210	29,000	100%	100%	100%	170	210	29,000	Culgoa R @ Brenda #	422015 #	85
	160	210	10,000	100%	100%	100%	160	210	10,000	Narran R @ New Angeldool #	422030#	81
Paroo	90	100	24,000	100%	100%	100%	90	100	24,000	Paroo R @ Caiwarro	424201A	88
Warrego	101	110	4,800	100%	100%	100%	101	110	4,800	Warrego R @ Barringun No.2 #	423004 #	86
	100	130	5,500	100%	100%	100%	100	130	5,500	Cuttaburra Ck @ Turra #	423005 #	87
AUSTRALIAN CAPITAL TERRITORY												
ACT	tba	tba	tba	tba	tba	tba	tba	tba	tba	Murrumbidgee R at Hall's Crossing	410777	52

Notes
^ 95th percentile target
# - These sites are operated by New South Wales on behalf of Queensland.

NOTES

New South Wales Targets as advised in letter from Peter Sutherland to Don Blackmore dated 17 February 2004.

Queensland Targets as advised in letter from Terry Hogan to Don Blackmore dated 3 March 2004.

South Australian targets as advised in SA River Murray Salinity Strategy (August 2001) (P.Cole pers comm 10/5/04)

Victorian targets as advised in letter from Sue Jaquinot to Wendy Craik received 10 August 2005

ACT has advised that its target is interim and when finalised will be based on net salt balance for the ACT (P.Donnelly per comm 21/4/04)

Appendix 2.2

HYDRAULIC CONDITIONS FOR AN IDEAL GAUGE SITE FOR DETERMINING STREAM FLOW

1. The general course of the stream is straight for about 100 m upstream and downstream of the gauge site.
2. The total flow is confined to one channel at all stages, and no flow bypasses the site as subsurface flow.
3. The stream bed is not subject to scour and fill and is free from aquatic growth.
4. Banks are permanent, high enough to contain floods, and free of brush.
5. Unchanging natural controls are present in the form of bedrock outcrop or other stable riffle for low flows and a channel constriction for high flows or a falls or cascade that are submerged at all times.
6. A pool is present upstream from the control site at extremely low stages to ensure recording at low flow.
7. The gauging site is far enough upstream from a confluence with another stream or from tidal effect to avoid any variable influence at the site.
8. A satisfactory reach for measuring discharge at all stages is available within reasonable proximity of the gauge site.
9. The site is readily accessible for installation and operation.
10. The site is not susceptible to man-made disturbances, nearby tributaries or point discharges.

The above conditions for river flow are seldom fully realised in natural streams, particularly the low gradient streams of the central to western Murray-Darling Basin that have highly variable flows and very large floodplains.

Acknowledgement: Taken from Rantz, S.E. et al. (1982). Measurement and computation of stream flow: Volume 1: Measurement of stage and discharge. US Geological Survey Water Supply Paper 2175, US Government Printing Office.

Appendix 2.3

RECOMMENDED MINIMUM STANDARDS AND PROTOCOLS TO BE ADOPTED FOR END-OF-VALLEY SALINITY MONITORING GAUGING STATIONS

Level information shall be collected to better than ± 10mm.

EC readings shall be collected to better than ± 10% of reading.

EC reading shall be obtained at each visit via calibrated portable sensors or grab sample analysed by traceably calibrated instrument for the purpose of verifying recorded data.

Recorded EC data is presented as EC compensated to 25°C (ensure portable field unit is compensated or calculate compensated reading).

Portable EC sensors (such as Horiba or WTW) shall be calibrated over the full range at least once every two years and a two-point reference check spanning the expected EC range conducted before use.

All level and EC sensors shall be calibrated over their full range at least once every two years. Pressure sensors shall be calibrated using a traceable pressure calibrator.

All equipment calibrations shall be documented and traceable to a national standard. This includes, but is not limited to:

- EC sensors
- level sensors
- portable water quality instruments
- reference instruments
- current meters
- survey equipment.

Gauge boards shall be maintained at ±3mm for the 80 percentile of flows.

Inspection of gauge plate levels shall be undertaken annually and after each high flow event.

Data shall be downloaded at least weekly via telemetry where available.

EC sensors shall be cleaned at each station visit.

95% data capture shall be maintained for each parameter at each site.

Operational telemetry shall be installed at each site (if possible) to assist in data capture rates.

EC and temperature shall be recorded at each site.

A minimum of 6 gaugings shall be taken per annum (this number will be highly variable as some sites will require more).

Quality coded rating tables shall be developed to cover the full range of recorded flows.

Verified data shall be delivered quarterly to MDBC in a yet to be advised web-based format. The minimum data requirement is time series level, flow and EC. Delivered data shall be no more than 6 months old.

Each site shall be visited at least once every 8 weeks.

EC readings delivered shall be temperature corrected to 25°C.

All provided data shall be appropriately quality coded (any changes to suppliers' quality coding system shall be advised to MDBC).

EC profiling shall be taken at each EC recording cross section at low medium and high flows.

EC profiling shall be undertaken along a stream before the selection of any new sites to determine the most appropriate cross-section for EC measurement.

Flow measurement shall be undertaken in accordance with the appropriate sections of AS3778.

Quarterly performance report shall be provided with each data delivery showing:

- number of gaugings taken
- loss of record
- percentage of data provided in each quality code band
- instrument calibration status
- rating table status
- list of tasks undertaken in past quarter
- results of EC profiling taken at each site.

Source: Hydrographic Review – End of Valley Monitoring Network. Ecowise Environmental Pty Ltd, August 2002.

Appendix 2.4

Basin Salinity Management Strategy – End of Valley Summary Report Card - *Example*

Valley	2015 Target[1] (% of 2000 Benchmark Conditions)			Valley Reporting Site	Assessed Baseline Conditions – 1/1/2000	“Do Nothing” Legacy of History Impact – 2015 Effect	Agreed 2015 Target	Progress Given Actions To-Date				Current year Effect at Morgan (Equivalent EC)	
								Current Year	2015 Outlook	2050 Outlook	2100 Outlook	Morgan “A” Items	Morgan “B” Items
	Salinity		Salt load	*(Shared resource sites shown in italics)*	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	Morgan: Flow, Salinity, Salt Load	Morgan: Flow, Salinity, Salt Load
South Australia	Median	95%ile	Average										
Lock 6 to Morgan	**tba**	**tba**	**110%**	*Murray at Morgan*									
Below Morgan	**tba**	**tba**	**tba**	Murray at Murray Bridge									
NSW	Median	80%ile	Average										
Murrumbidgee	**108%**	**112%**	**107%**	Murrumbidgee at Balranald									
Lachlan	**108%**	**106%**	**103%**	Lachlan at Forbes									
Bogan	**137%**	**93%**	**133%**	Bogan at Gongolgon									
Macquarie	**108%**	**126%**	**114%**	Macquarie at Carinda									
Castlereagh	**105%**	**99%**	**100%**	Castlereagh at EoV									
Namoi	**108%**	**110%**	**116%**	Namoi at Goangra									
Gwydir	**103%**	**101%**	**100%**	Gwydir at Collarenebri									
NSW Border Rivers	**100%**	**100%**	**100%**	*Barwon at Mungindi*									
NSW Upper Murray	**tba**	**tba**	**tba**	*Murray at Heywoods*									
Barwon-Darling				*Darling at Wilcannia*									
NSW Riverine Plains				*Murray at Redcliffs*									
NSW Mallee Zone				*Murray at Lock 6*									
Victoria	Median	80%ile	Average										
Wimmera	**tba**	**tba**	**tba**	Wimmera at Horsham Weir									
Avoca	**102%**	**102%**	**102%**	Avoca at Quambatook									
Loddon	**103%**	**101%**	**101%**	Loddon at Laanecoorie									
Campaspe	**101%**	**101%**	**101%**	Campaspe at Pumps									
Goulburn	**100%**	**100%**	**100%**	Goulburn at Goulburn Weir									
Broken	**136%**	**136%**	**136%**	Broken at Casey's Weir									
Ovens	**100%**	**tba**	**101%**	Ovens at Peechelba East									
Kiewa	**100%**	**tba**	**100%**	Kiewa at Bandiana									
Vic Upper Murray	**tba**	**tba**	**tba**	*Murray at Heywoods*									
Vic Riverine Plains				*Murray at Swan Hill*									
Vic Mallee Zone				*Murray at Lock 6*									
Queensland	Median	80%ile	Average										
Qld Border Rivers:	**tba**	**tba**	**tba**	*Barwon at Mungindi*									
Moonie	**tba**	**tba**	**tba**	Moonie at Fenton									
Condamine Balonne	**tba**	**tba**	**tba**	Culgoa at Hastings									
Warrego	**tba**	**tba**	**tba**	Warrego at Cunnamulla									
Paroo	**tba**	**tba**	**tba**	Paroo at Caiwarro									
ACT	Median	80%ile	Average										
ACT				*Murrumbidgee at Hall's Crossing*									

Appendix 2.5

MODEL PURPOSES AND CLASSIFICATION GUIDE

PURPOSE OF MODEL	DESCRIPTION	Specific model characteristics required
1. *Enhance Understanding* • flow and salinity characteristics • flow and salinity processes • the influence of catchment characteristics and climate on flows and salinities *(Refer Clauses 4, 6, 8, 16–25, 27–32 & 35–37 of Schedule C of the M-DB Agreement).*	To enhance the understanding of the flow and salinity characteristics and processes within the surface water systems of a valley. Models allow gaps in flow and salinity records to be filled in, and data records extended. By testing hypotheses of the flow/salinity transport processes, it is possible to determine the dominant physical processes. When the dominant processes have been identified, the manner in which the system will respond to changes imposed on it can be more accurately predicted.	• process-based models are preferred • replication of recorded historical behaviour of flow and salinity establishes confidence in model predictions • complex hydrological data associated with models must be presented in easy-to-understand formats • ability to test 'what if' scenarios.
2. *Estimate Flow and Salinity Values* • to prepare baseline conditions at the end-of-valley target site • estimate absolute values of flow and salinity at other locations, under other catchment conditions and under other climatic conditions. *(Refer Clauses 5–8, 26, 29–32 & 35–37 of Schedule C of the M-DB Agreement).*	The States and the MDBC must model the daily salinity, salt load and flow at each end-of-valley target site under the baseline conditions over the *benchmark period*. The median and 80 percentile salinities, as well as the average salt load need to be determined at the target site. (For the MDBC, the target site is Morgan and the 95 percentile salinity is required in lieu of the 80 percentile). To assist in fulfilling the requirements of Schedule C, predictions of flow and salinity at locations other than the target site, and under conditions other than *baseline*, will often be required.	• ability to represent not only the mean flows and salinities but also the variations likely to be experienced over the climatic conditions represented by the *benchmark period* • capability to simulate baseline conditions (i.e. Year 2000) • simulation of accurate flow and salinity estimates at the target site • estimates at other locations may also be needed • ability to test how various works and measures would meet agreed targets

<table>
<tr><th>PURPOSE OF MODEL</th><th>DESCRIPTION</th><th>Specific model characteristics required</th></tr>
<tr><td>3. Estimate Changes in Flow and Salinity Values
to assess the impacts of actions including the no-intervention scenario
to provide for the establishment and updating of Registers A and B.
(Refer Clauses 6, 10, 11, 15, 16, 29–32 & 35–37 of Schedule C of the M-DB Agreement).</td><td>Each State must develop models capable of predicting the flow and salinity effects of all accountable actions and any delayed salinity impacts. In addition, the Commission’s model must also be capable of predicting the salinity impacts at Morgan. The Commission will also establish and maintain RegistersA and B based on the results of its model and the various valley models operated by the States. Whilst there may be considerable uncertainty with the model predictions of absolute salinities, a higher accuracy usually results when the models predict the relative salinities (eg. the change in salinity resulting from accountable actions or delayed salinity impacts).</td><td>ability to simulate the relevant salt generation and salt transport processes relating to accountable actions and the no-intervention scenario.
where not all of these processes are simulated internally, the model must be capable of interfacing with other land-use, groundwater or catchment models that can simulate these processes.
ability to generate salinities with sufficient accuracy and rigour to engender confidence in Registers A and B that are established and maintained using the model results</td></tr>
<tr><td>4. Integrate With Upstream and Downstream Models in the Basin
to allow flows and salinities generated by upstream models to be included
to simulate the flow and salinity contributions to downstream valleys.
(Refer Clauses 7, 10, 11, 15, 16, 29–32 & 35–37 of Schedule C of the M-DB Agreement).</td><td>It would be impractical to establish a single model for the whole basin that could incorporate all the tributary systems and all the salt generation and transport processes. A variety of models have been developed in different geographical areas and for different salinity management purposes. Where processes and management strategies span model boundaries, integration of models is essential if a basin-wide understanding and management of salinity is to be achieved.</td><td>as well as predicting flow and salinity at the end-of-valley target site (which is rarely located at a valley outlet), models must be capable of predicting the flow and salinity at the valley outlet (or at the boundary with the next most downstream model)
similarly the model must have the ability to integrate flows and salinities from upstream models.</td></tr>
</table>

Notes: The table indicates the typical characteristics of each class of models, and the appropriate uses of the model. Use as a guide only.

CLASSIFICATION GUIDE

MODEL CLASS	TYPICAL MODEL CHARACTERISTICS AND DATA ENVIRONMENT			USE OF MODEL FOR SCHEDULE C PURPOSES			
	Availability of Flow and Salinity Data. Understanding of Salt Processes	**Flow and Salt Inputs from Upstream Models**	**Uncertainty in Model Results**	**Enhance Understanding of Data and Processes** [1]	***Baseline Conditions* and Target Compliance** [2]	**Maintaining *Registers* and Assessing the Impacts of Actions** [3]	**Integration with Other Models** [4]
CLASS 1	Data rich with typically at least 20 years[5] of flow and salinity records and a range of climatic variability typical of the *benchmark period*. Valley processes well understood. Model is process-based and verified against observed data.	Majority of modelled flow and salt inputs are from Class 1 models	Uncertainty in key model outputs quantified and found to be acceptable.	Reproduces all flow/salt characteristics and processes competently. Valuable aid to enhance understanding.	High confidence established in the means and statistical variability of the baseline conditions generated by the model.	Model can be confidently used to maintain *registers* and to predict the impacts of *actions* in the valley.	The high confidence in the model outputs at the outlet will reduce uncertainty in the downstream model's predictions.
CLASS 2	Extensive flow data and sufficient salinity data to define salinity characteristics at key valley locations for about 5 to 15 years[5] with a limited range of climatic conditions. Flow processes are well understood, but not all salinity processes. Some salinity components of model are empirical or based on processes from other valley models with limited verification to observed data.	Majority of modelled flow and salt inputs are from Class 2 models	Uncertainty not quantified. Sensitivity of key model parameters investigated. Qualitative description of potential sources of model uncertainty provided.	Simulates most characteristics and processes. Valuable aid to enhance understanding subject to known limitations of model. Use to enhance understanding and identify further data collection and model development.	High confidence established in the means and lesser confidence in the statistical variability of the *baseline conditions*. Percentile salinity values are published and used tentatively for the BSMS subject to on-going review every few years as more data becomes available.	Model likely to predict salinity changes more accurately than absolute values. Where entries need to be made on the *registers* or average EC changes need to be simulated, model results can be used with some confidence. Revision may be necessary every 3-5 years as more data becomes available.	The medium confidence in the model outputs at the outlet may reduce or increase uncertainty in the downstream model's predictions.

MODEL CLASS	TYPICAL MODEL CHARACTERISTICS AND DATA ENVIRONMENT			USE OF MODEL FOR SCHEDULE C PURPOSES			
	Availability of Flow and Salinity Data. Understanding of Salt Processes	**Flow and Salt Inputs from Upstream Models**	**Uncertainty in Model Results**	**Enhance Understanding of Data and Processes 1**	***Baseline Conditions* and Target Compliance 2**	**Maintaining *Registers* and Assessing the Impacts of Actions 3**	**Integration with Other Models 4**
CLASS 3	Data very limited, particularly salinity, with typically less than 5 years**5** of record. Climatic conditions over the recorded data period are not representative of variability in the *benchmark period*. Valley processes poorly understood. Salinity components of model are assumed/empirical or based on processes from other valley models.	Majority of modelled flow and salt inputs are from Class 3 models	Not quantified. Only a qualitative description of potential sources of uncertainty can be provided.	Low confidence in many of the key flow/salt characteristics and processes simulated by the model. Use cautiously to enhance understanding and identify further data collection and model development.	Little confidence in the statistical variability of the *baseline conditions*. Only possible to publish a typical range of salinity values not percentile values. Some confidence that the mean salt load is of the right order.	Model likely to predict salinity changes more accurately than absolute values. Where entries need to be made on the *registers* or average EC changes need to be simulated, model results tentatively used subject to on-going review every 1–2 years as more data becomes available.	The low confidence in the model outputs at the outlet will increase uncertainty in the downstream model's predictions.

Appendix 3.1

The Benchmark Period

Definition

As used in the BSMS, the 'Benchmark period' defines a climatic sequence that is used consistently in models to predict the effects of various combinations of actions at specified times. The period initially selected was from 1 May 1975 to 30 April 2000. Schedule C, Clause 2 authorises the Commission from time to time to determine a modified period.

The benchmark period will be reviewed from time, in the light of the best available data, in order to keep it as hydrologically representative as possible. The present intention is to review it in conjunction with the review of the operation of Schedule C itself, to be undertaken in 2007 and every 7 years thereafter.

Background

The climate of the Murray-Darling Basin, as for most of Australia, is highly variable. In fact on a global scale, Australia (together with South Africa) experiences higher runoff variability than any other continental area (McMahon et al. 1992). These variations in rainfall and evaporation have a significant influence on the dynamics of river flow and salinity (see Figure 3.1).

In order to assess the current and future salinity and flow behaviour of the landscapes and rivers within the Murray-Darling Basin, it is necessary to consider an appropriate range of climatic events (wet, dry and average years). To do this the Murray-Darling Basin Ministerial Council has agreed to standardise the climate sequences used for input into these assessments through the use of a *benchmark period*.

The *benchmark period* is the 25-year period from 1 May 1975 to 30 April 2000. This period was chosen because it adequately covers the typical range of climate variability that can be expected both now and in the future, and for which there are both stream flow and salinity records for the major rivers in the basin.

To illustrate the range of wet, dry and average years during the *benchmark period* the historical rainfall and evaporation from Hume Reservoir is shown in Figure 3.1. The response of the landscape and rivers of the Murray-Darling Basin to the *benchmark period* climatic events can be seen in the graphs of flow and salinity for the River Murray at Morgan.

It is recognised that more extreme climate events than those recorded during the *benchmark period* may be observed in the future. While it would be preferable to use 100 or more years to define the *benchmark period*, the available salinity data (and flow data to a lesser extent) within the Murray-Darling Basin is limited. Thus the 25 years with relatively good records has been selected as an appropriate compromise. The *benchmark period* may be reviewed or extended in future if deemed appropriate by the Commission.

In addition it is recognised that other factors such as climate change may affect climate variability in future. While climate change and other factors are not currently accounted for in the use of the benchmark period, these issues may require further consideration in the longer-term assessment of catchment and river response to future climate variability.

Through the use of the *benchmark period*, flow and salinity models (refer Appendix 3.3) can be established to estimate the range of salinity and flow response due to catchment and river scenarios including the baseline conditions (see Appendix 3.2) and future scenarios (‘no further intervention’, or the implementation of a program of actions) for various years including 2015, 2050 and 2100.

Use of the *benchmark period*

The use of the *benchmark period* is tied directly to the definition of the basin salinity target (Schedule C, Clause 7). This is because:

- The biggest influence on the variability of flows, salinities and salt loads in the rivers of the Murray-Darling Basin is climate variability (i.e. periods of floods, droughts, intermediate conditions, and their sequencing).

- Due to climate variability effects, data on flows, salinities and salt loads recorded over periods such as one year will not be directly useful in determining whether a target expressed in terms of a percentage probability of non-exceedance over the long term is being met or not. This applies equally to the basin salinity target and to end-of-valley targets. The minimum period of record that is likely to be directly useful for this purpose is about 20 years.

- As we cannot afford to wait for 20 years to ascertain whether we have achieved (or preserved) a target or not, we use a combination of modelling and monitoring to enable progress to be checked much earlier and at more frequent intervals.

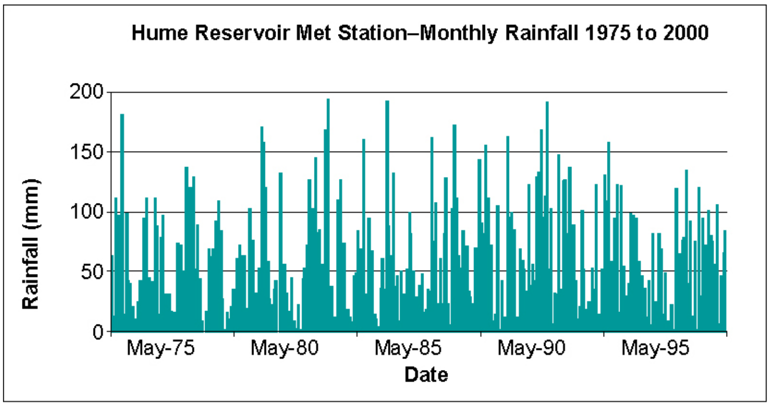
- Therefore, Clause 7(2) refers to the use of models, and the observed data collected over time can be used to progressively refine these models.

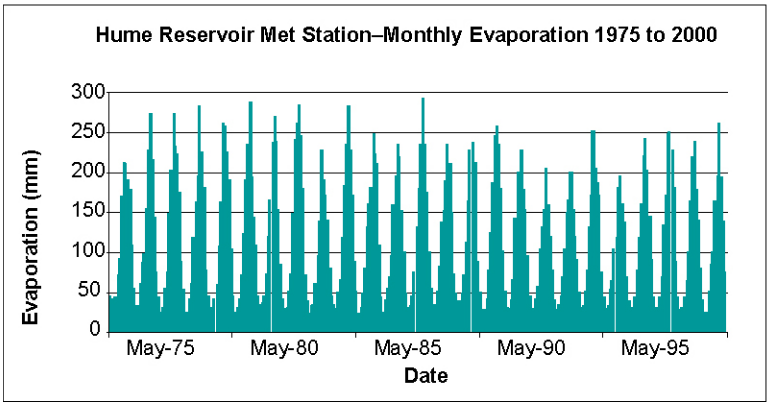
- The *benchmark period* is important because, by using data from this period as input to all the models used across the basin, we can evaluate all actions and whether we have achieved targets or not, on a consistent basis as far as climate variability effects are concerned.

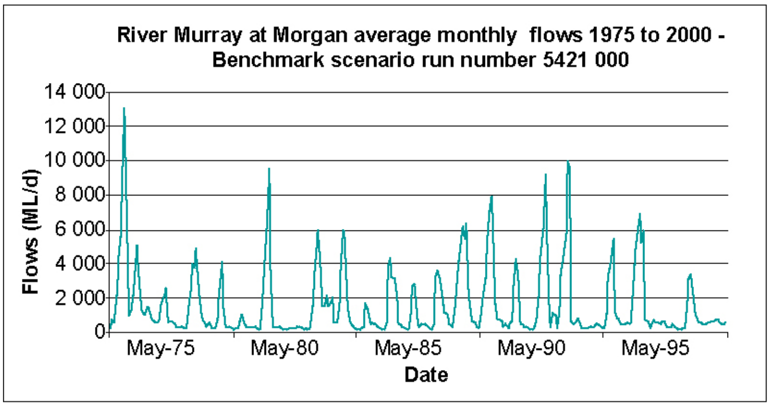
- This eliminates the biggest influence on variability of flows, salinities and salt loads, which would otherwise completely confuse all our assessments and make comparisons meaningless.

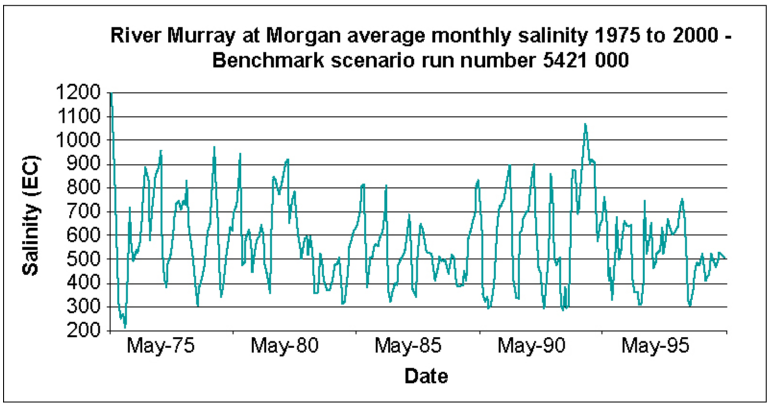
- If the *benchmark period* changes then our assessment of whether we are achieving targets or not may also change, and the targets themselves may change as well.

Figure 3.1
BSMS "*benchmark period*" - 1 May 1975 to 30 April 2000 (example only of climate and hydrological sequence)









Appendix 3.2

Defining the *Baseline Conditions*

Context

Schedule C, Clause 5 establishes the process for determining the baseline conditions contributing to the movement of salt through land and water upstream of all end-of-valley target sites and the Basin Salinity Target site at Morgan, but does not refer to the *baseline conditions* defined in Clause 2 of Schedule F of the Agreement (Cap on Diversions).

Each State Contracting Government must, by 31 March 2004, prepare and give to the Commission estimated *baseline conditions* relating to the salinity, salt load and flow regime at each site at which it proposes to measure that government's achievement of an *end-of-valley target* (if adopted) for the portion of the Murray-Darling Basin within that State, as at 1 January 2000.

The Commission must, by 31 March 2003, prepare estimated *baseline conditions* relating to the salinity, salt load and flow regime at the Basin Salinity Target site at Morgan, as at 1 January 2000.

Background

The accountability arrangements of the Basin Salinity Management Strategy (BSMS) rely on the definition and adoption of agreed *baseline conditions* across the Murray-Darling Basin.

An accurate definition of the *baseline conditions* is critical as end-of-valley salinity and salt load targets (Schedule C, Appendix 1) are expressed as a percentage of the *baseline conditions* and the delayed salinity impacts for which all partner governments are jointly accountable are calculated as the salinity impact which occurs after the baseline conditions date of 1 January 2000.

In the case of the Basin Salinity Target site at Morgan and most of the Tributary Valleys for which there is an *end-of-valley target* site, flow and salinity models (see Appendix 3.3) are being used to assist in defining the *baseline condition*s and also to provide a basis for analysing the impacts of actions.

For the purposes of the BSMS the *baseline conditions* are defined as the agreed suite of conditions in place within the catchments and rivers on 1 January 2000 for:

- land use (level of development of the landscape)
- water use (level of diversions from the rivers)
- land and water management policies and practices (including the Murray-Darling Basin Cap agreements and any subsequent flow management agreements)
- river operating regimes
- salt interception schemes
- run-off generation and salt mobilisation processes
- groundwater status and condition.

The salinity, salt load and flow regime and the conditions within the catchments and rivers should be recorded as thoroughly as practicable within the documentation supporting the hydrologic modelling studies. The relationship between the above conditions and the salinity, salt load and flow regime at the basin salinity target site is established by modelling, using the benchmark period climatic sequence (see Table 1).

The process for the establishment of the *baseline conditions* is summarised in Figure 1. Although the Commission has agreed that the *baseline conditions* for the River Murray tributaries will not be finalised until March 2004, an interim set of *baseline conditions* for the River Murray at Morgan has been defined (Table 1 and Figure 2). Table 1 also shows the historical flow, salinity and salt loads for Morgan and the various *end-of-valley target* sites.

Figure 1
Process for approving the BSMS *baseline conditions*

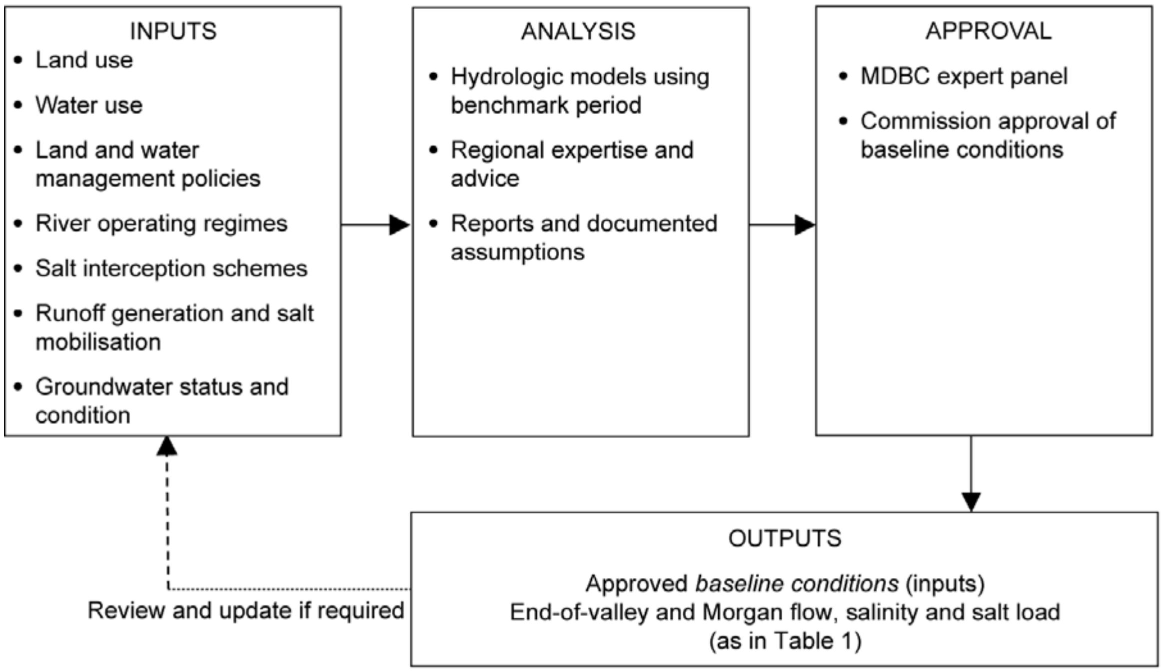


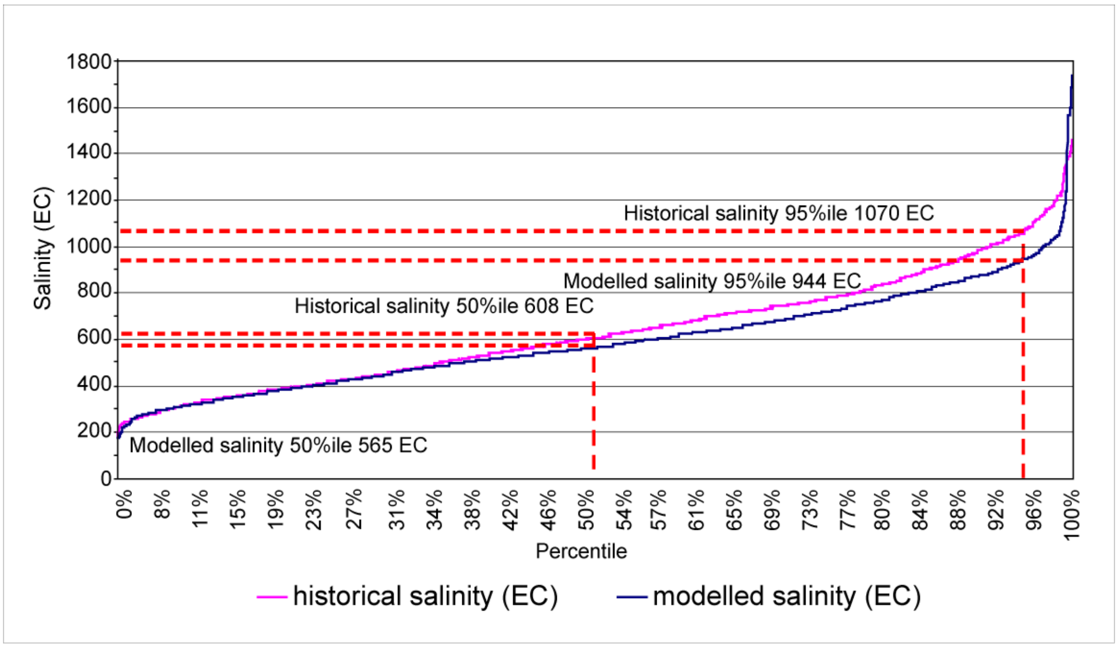
Table 1
Approved baseline conditions for salinity at end-of-valley and basin target sites

Valley	Baseline Conditions (1 Jan 2000)			End-of-Valley Targets (as percentage of Baseline)			End-of-Valley Targets (as absolute value)			Valley Reporting Site	AWRC Site Number	Map EoV Site ID
	Salinity (EC µS/cm)		Salt Load (t/yr)	Salinity (EC µS/cm)		Salt Load (t/yr)	Salinity (EC µS/cm)		Salt Load (t/yr)			
	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean			
All PARTNER GOVERNMENTS												
Murray-Darling Basin	570	920 (95%ile)	1,600,000	110%	87% (95%ile	110%	627	**800^** (95%ile)	1,760,000	Murray R @ Morgan (Salinity) Murray R at Lock 1 (Flow)	426554 426902	96
SOUTH AUSTRALIA												
SA Border	380	470	1,300,000	-	88%	-	-	412	-	*Flow to SA*	*426200*	*92*
Lock 6 to Berri	450	600	1,500,000	-	91%	-	-	543	-	Murray R @ Lock 4 (Flow) Berri Pumping Station (Salinity)	426514 426537	94
Below Morgan	600	820	1,600,000	-	94%	-	-	770	-	Murray R @ Murray Bridge	426522	98
NEW SOUTH WALES												
Murrumbidgee	150	230	160,000	108%	112%	106%	162	258	169,600	Murrumbidgee R d/s Balranald Weir	410130	58
Lachlan	430	660	250,000	107%	105%	103%	460	693	257,500	Lachlan R @ Forbes (Cottons Weir)	412004	55
Bogan	440	490	27,000	132%	93%	129%	581	456	34,830	Bogan R @ Gongolgon	421023	78
Macquarie	480	610	23,000	105%	122%	112%	504	744	25,760	Macquarie R @ Carinda (Bells Bridge)	421012	77
Castlereagh	350	390	9,000	105%	-	99%	368	-	8,910	Castlereagh R @ Gungalman Bridge	420020	76
Namoi	440	650	110,000	108%	110%	116%	475	715	127,600	Namoi R @ Goangra	419026	75
Gwydir	400	540	7,000	103%	101%	100%	412	545	7,000	Mehi R @ Bronte	418058	74
NSW Border Rivers	250	330	50,000	100%	100%	100%	250	330	50,000	Macintyre R @ Mungindi	416001	70
Barwon-Darling	*330*	*440*	*440,000*	*118%*	*103%*	*131%*	*389*	*453*	*576,400*	*Darling R @t Wilcannia Main Channel*	*425008*	*90*
NSW Upper Murray	*54*	*59*	*150,000*	-	-	-	-	-	-	*Murray R @ Heywoods*	*409016*	*10*
NSW Riverine Plains	*310*	*390*	*1,100,000*	-	-	-	-	-	-	*Murray R @t Redcliffs*	*414204*	*60*
NSW Mallee Zone	*380*	*470*	*1,300,000*	-	-	-	-	-	-	*Flow to SA*	*426200*	*92*
VICTORIA												
Wimmera	1,380	1,720	31,000	100%	100%	100%	1,380	1,720	31,000	Wimmera R @ Horsham Weir	415200	34
Avoca	2,060	5,290	37,000	102%	-	-	2,096	-	-	Avoca R @ Quambatook	408203	32
Loddon	750	1,090	88,000	95%	-	-	711	-	-	Loddon R @ Laanecoorie	407203	24
Campaspe	530	670	54,000	78%	-	-	412	-	-	Campaspe R @ Campaspe Weir	406218	22
Goulburn	100	152	166,000	99%	-	-	99	-	-	Goulburn R @ Goulburn Weir	405259	18
Broken	100	130	15,000	141%	-	-	141	-	-	Broken Ck @ Casey's Weir	404217	16
Ovens	72	100	54,000	100%	100%	101%	72	100	54,540	Ovens R @ Peechelba-East	403241	14
Kiewa	47	55	19,000	100%	100%	100%	47	55	19,000	Kiewa R @ Bandiana	402205	12
Vic Upper Murray	*54*	*59*	*150,000*	-	-	-	-	-	-	*Murray R @ Heywoods*	*409016*	*10*
Vic Riverine Plains	*270*	*380*	*630,000*	-	-	-	-	-	-	*Murray R @ Swan Hill*	*409204*	*30*
Vic Mallee Zone	*380*	*470*	*1,300,000*	-	-	-	*+15EEC*	-	-	*Flow to SA*	*426200*	*92*
QUEENSLAND												
Qld Border Rivers	250	330	50,000	100%	100%	100%	250	330	50,000	Barwon R @ Mungindi#	416001#	70
Moonie	140	150	8,700	100%	100%	100%	140	150	8,700	Moonie R @ Fenton	417204A	71
Condamine-Balonne	170	210	4,200	100%	100%	100%	170	210	4,200	Ballandool R @ Hebel-Bollon Rd	422207A	83
	170	210	5,000	100%	100%	100%	170	210	5,000	Bohkara R @ Hebel	422209A	82
	150	280	6,500	100%	100%	100%	150	280	6,500	Braire Ck @ Woolerbilla-Hebel Rd	422211A	84
	170	210	29,000	100%	100%	100%	170	210	29,000	Culgoa R @ Brenda #	422015 #	85
	160	210	10,000	100%	100%	100%	160	210	10,000	Narran R @ New Angeldool #	422030#	81
Paroo	90	100	24,000	100%	100%	100%	90	100	24,000	Paroo R @ Caiwarro	424201A	88
Warrego	101	110	4,800	100%	100%	100%	101	110	4,800	Warrego R @ Barringun No.2 #	423004 #	86
	100	130	5,500	100%	100%	100%	100	130	5,500	Cuttaburra Ck @ Turra #	423005 #	87
AUSTRALIAN CAPITAL TERRITORY												
ACT	tba	tba	tba	tba	tba	tba	tba	tba	tba	Murrumbidgee R at Hall's Crossing	410777	52

Notes
^ 95th percentile target
\# - These sites are operated by New South Wales on behalf of Queensland.

Figure 2
Interim *baseline conditions* for the River Murray at Morgan (based on the MSM-BIGMOD). Historical salinity is also shown.

Modelled and historical salinity at Morgan from 1 May 1975 to 30 April 2000—Modelled data from MSM-BIGMOD run number 5684000



Appendix 3.3

Flow and Salinity Models

Context

The framework for the development of models for the River Murray and its tributaries is given in Schedule C, clauses 36 and 37.

Commission models

Using the benchmark period, the Commission is required to develop one or more models to simulate the salinity, salt load and flow regime, each on a daily basis, and the economic effects on water users of the simulated salinity, salt load and flow regime in the Upper River Murray and the River Murray in South Australia.

These models must be capable of predicting any salinity impacts of *joint works and measures* and *state actions* as well as any delayed salinity impacts, at Morgan and such other relevant locations as the Commission may determine. The Commission may alter these models from time to time.

State models

State Contracting Governments are required to develop one or more models to simulate, under baseline conditions, the daily salinity, salt load and flow regime, over the *benchmark period*, at each site at which compliance with an end-of-valley target is to be measured.

A model developed by a State Contracting Government must be capable of predicting the effect of all accountable actions undertaken in the State, and of any delayed salinity impacts, on the salinity, salt load and flow regime at each site at which compliance with an end-of-valley target is to be measured in each of 2015, 2050, 2100, and in such other years as the Commission may determine. A State Contracting Government may alter the model from time to time.

Background

As specified in Schedule C, the Commission and its partner governments are developing a suite of hydrologic models for the River Murray and its tributary rivers which will assist in the establishment of the *baseline conditions* and the analysis of salinity intervention actions against a no-further-intervention scenario. The specific objectives for the models include the following tasks:

- the establishment of the agreed *baseline conditions* by
    - supplementing or infilling missing historic flow and salinity data using appropriate flow/salinity relationships
    - interpolating flow and salinity data to key locations where data has not been measured

  - providing for the removal of trends from the historic data which are determinable through the application of relevant data (a prime example is the adjustment of stream flows to account for observed water consumption trends)

  - identifying the elements of the landscape which have been the source of water and/or salt

  - identifying the elements of the landscape which have been sinks for water and/or salt

  - providing a basis for the consideration of uncertainty within the salinity reporting arrangements by allowing for sensitivity analyses for such issues as climate variability, climate change, uncertainty in no-intervention predictions, uncertainty in the credibility of available calibration data

- the predictions for ‘no-further-intervention scenarios’ for 2015, 2050 and 2100

- the finalisation of end-of-valley salinity and salt load targets by providing a baseline and identifying the quantum of no further interventions and the impact of a suite of intervention actions (interim targets have been set without hydrologic computer models in some tributaries

- the assessment of salinity management interventions by providing the opportunity to link landscape salt mobilisation models to the stream models (see Figures 3 and 4)
- the operation of the A&B registers which are based upon the Commission’s hydrologic model MSM-BIGMOD (see Figure 2)

- the support of the rolling 5-year review and audit of salinity management programs at a valley scale through assessing the theoretical contributions of a *programof actions* towards meeting the agreed salinity targets

- the implementation and review of the Strategy by providing a stable link between landscape salt mobilisation, impacts on stream salt loads and salinity, assessment of impacts on values and assets, in particular the in-stream assets such as irrigation supply and wetlands, and the costs of salinity to irrigation and urban users

- the assessment of progress in meeting end-of-valley salinity and salt load targets and in meeting the Basin Salinity Target at Morgan (see Figure 3).

Examples of what the models will be used for are highlighted in Figures 2, 3 and 4. The examples highlight the linkages of the different scale models, the catchment salt mobilisation or within-valley processes linked to the River Murray tributaries and eventually to the River Murray at Morgan.

Figure 1
The Murray-Darling Basin—The River Murray

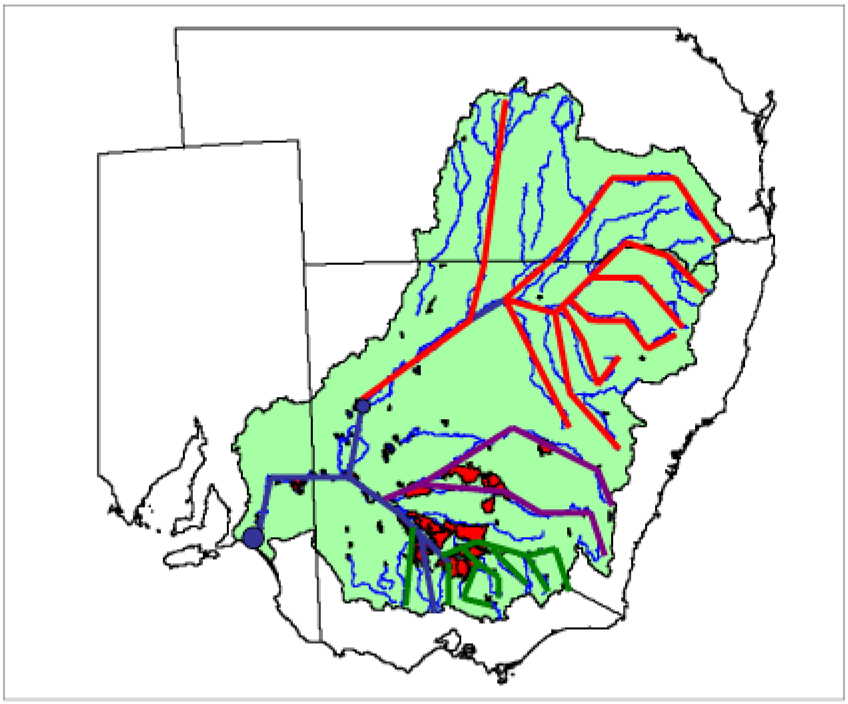
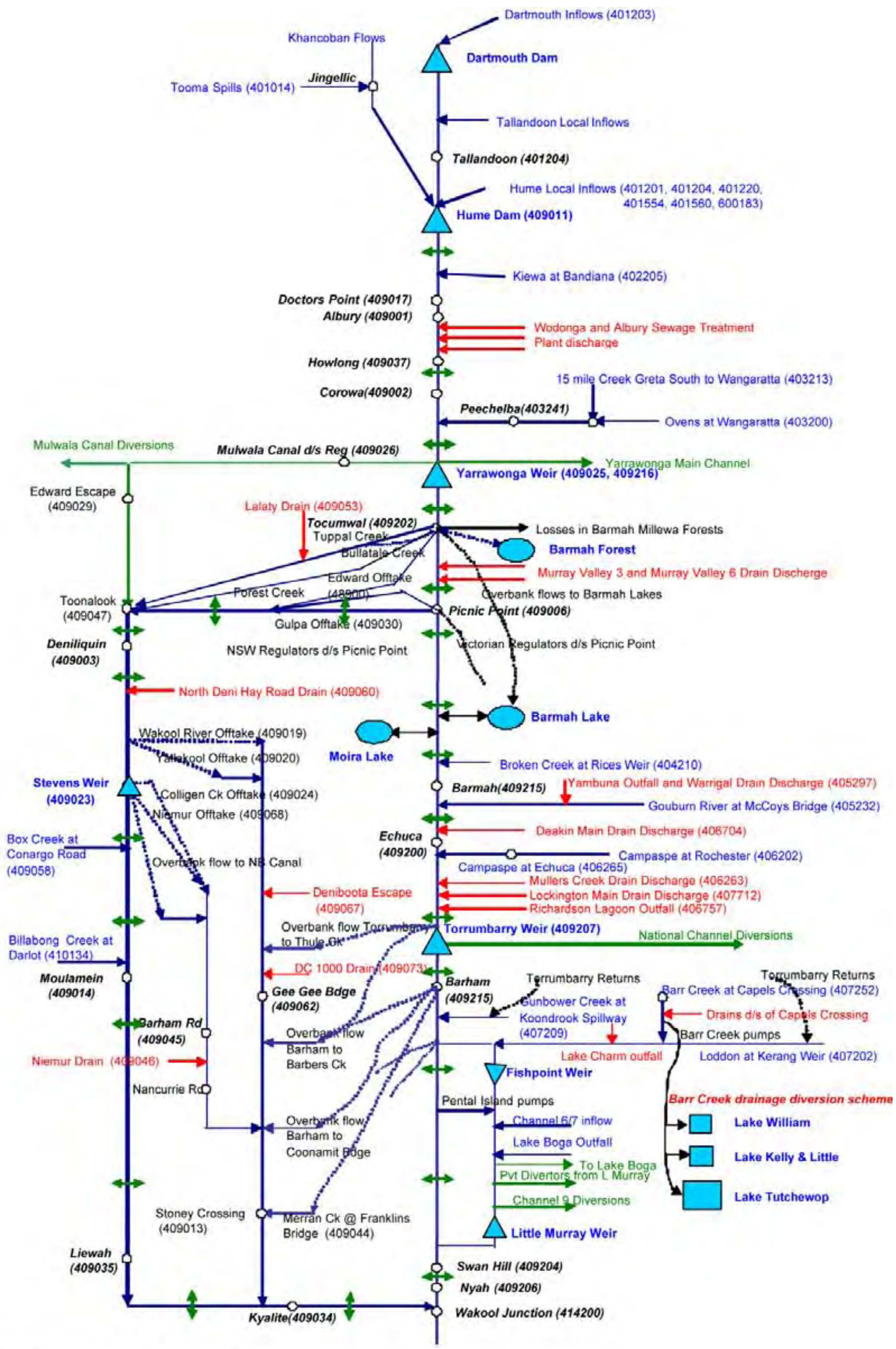
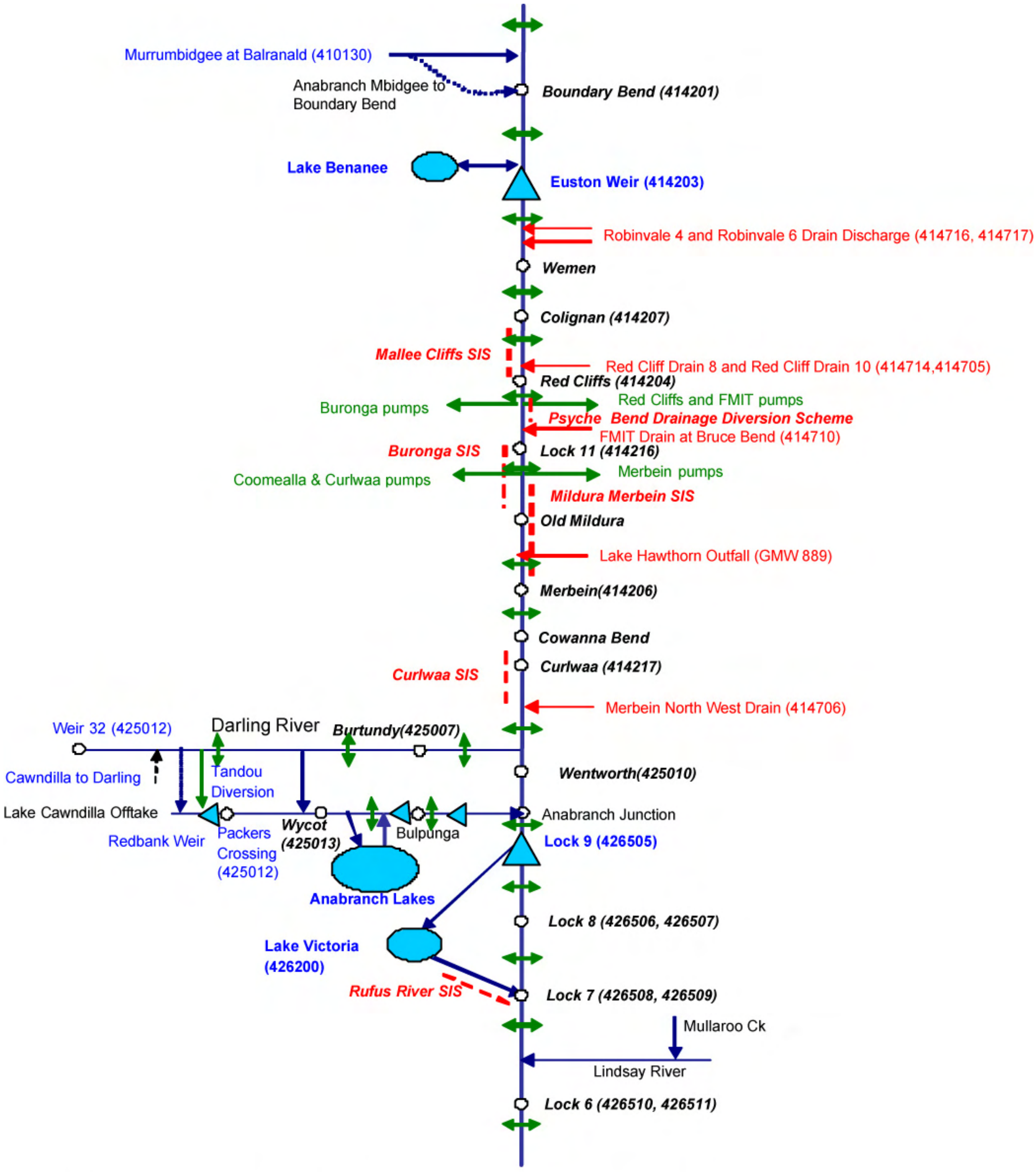


Figure 2
Shows a schematic diagram of how the MDBC suite of models for the River Murray (now superseded by MSM-BIGMOD) were used to provide assessments of the salinity impacts at various points along the river under the Salinity & Drainage Strategy. The impacts were put onto an accountability register.

Schematic Representation of System Modelled by BIGMOD Model



Schematic Representation of System Modelled by BIGMOD Model (continued)



Schematic Representation of System Modelled by BIGMOD Model (continued)

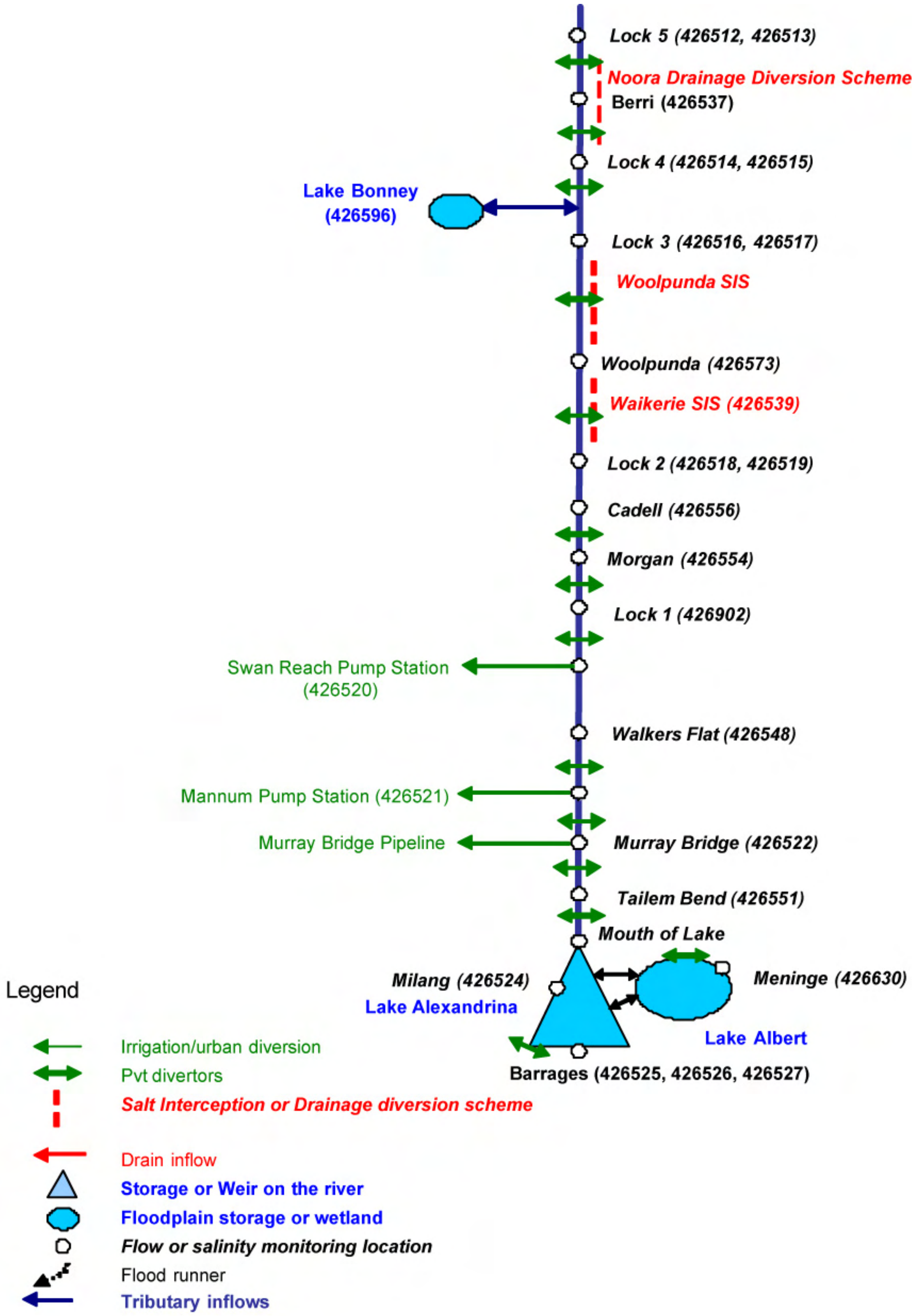
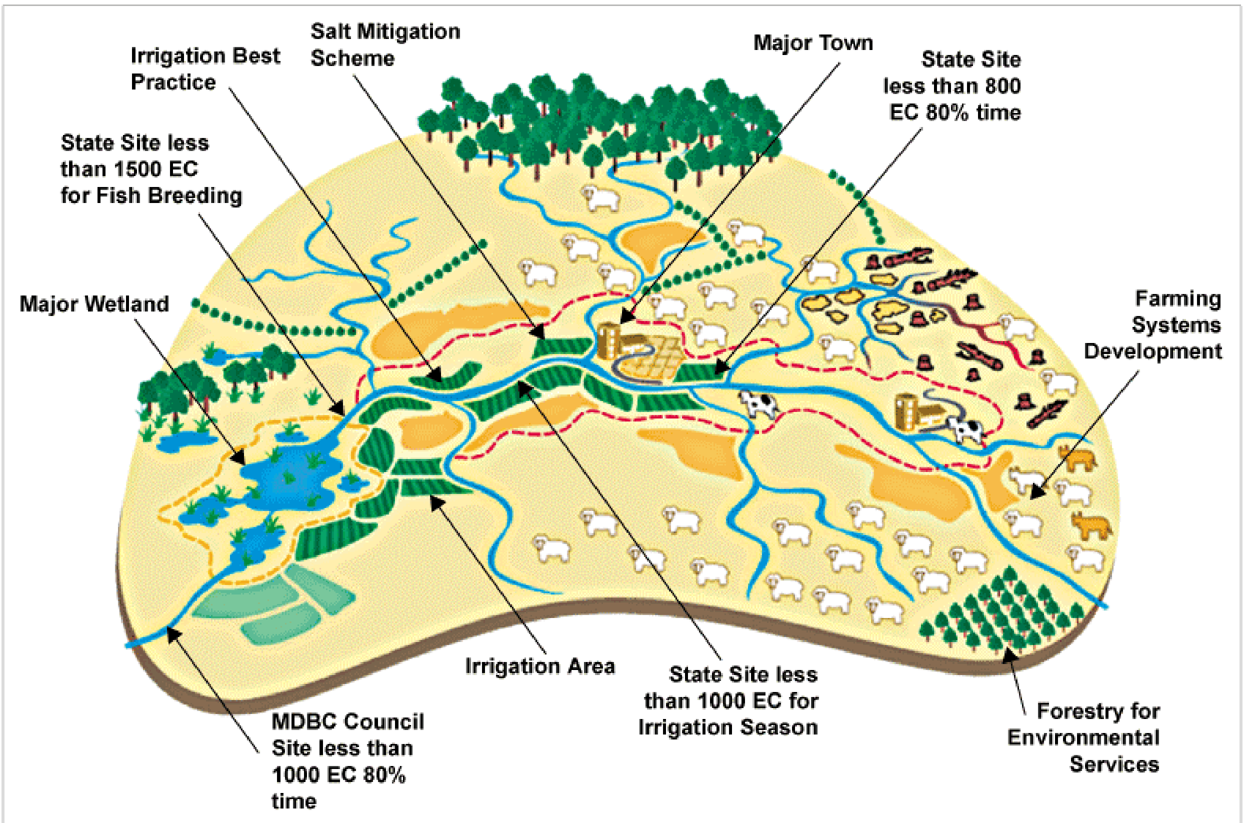


Figure 3
Basin scale hydrologic models. Shows the State tributary models linking into the River Murray model MSM-BIGMOD. This integrated modelling approach allows the salinity impacts of any intervention within the Basin to be assessed at end-of-valley and further downstream in the River Murray at Morgan.

Figure 4
Catchment scale processes: salt mobilisation into rivers and eventually to the end-of-valley target site. The impacts of these are modelled through the various tributary models that link to the River Murray model and eventually to Morgan (see Figure 3).



Hydrologic Models – key features

The key features of the suite of models currently used are given below:

The Commission Office Model – MSM-BIGMOD

The MSM-BIGMOD modelling suite has been developed for simulating flow and salinity in the Murray Lower Darling river system. In this suite MSM and BIGMOD models are run sequentially to simulate water management decisions such as operation of storages, water accounting, resource assessment and irrigation demand computations on a monthly time-step by the MSM model while flow and salinity routing from downstream of Hume Dam to Murray Mouth is carried out by the BIGMOD model on a daily time-step. The flow modelling is carried out for the 1891 to 2000 period while salinities are modelled for the BSMS *benchmark period* of 1975–2000.

The model has been calibrated and verified with the flow and salinity data from 1971 to 2003 and has been set up for *baseline conditions* of the BSMS. Within this modelling suite, computations for the economic impacts of salinity on irrigation and on domestic and industrial water users, and statistics for a whole range of environmental indicators, water demands, flow and salinity are computed at a number of locations including basin salinity target site and interpretation sites.

The NSW Hydrologic Models IQQM

The NSW IQQM models are daily salt and water balance models covering the benchmark period 1975 to 2000. There are models for the Macquarie, Gwydir, Namoi, Border Rivers, Barwon-Darling, Lachlan and Murrumbidgee systems. The water balance part of the model is based on the suite of models used in the 2001–2003 NSW Water Sharing Plan (WSP) process. This suite of WSP models was built, calibrated and validated to represent the major water flow related processes of resource assessment and allocation, reservoir operation, channel constraints, crop water requirement, irrigation water ordering and diversion, and environmental flow rules and delivery.

The salt balance part of the models was added to the WSP models. This involved the incorporation of flow load relationships for the systems unregulated tributary inflows. The salinity sub-models were validated against all available salinity data in the *benchmark period*. These typically comprised about 10 years of periodic grab sample data and a few years of continuous data. The end of system outputs from the Barwon-Darling and Murrumbidgee systems become inputs to the MSM-BIGMOD model previously described.

The Victorian models REALM

The Victorian REALM models are daily salt and water balance models covering the BSMS benchmark period of 1975 to 2000. There are models for the Upper Loddon, Wandella Creek, Kerang Lakes, Campaspe and Goulburn-Broken River systems (Figure 2). They were developed using historical demand data to provide salinity for the *benchmark period*. The demands and model configurations are at 1988 and 2000 levels of development allowing for direct comparison between pre and post implementation of schemes listed on the MDBC Salinity and Drainage Strategy (S&DS) Register.

The Queensland Hydrologic Models IQQM

The Queensland IQQM models are daily salt and water balance models covering the benchmark period 1975 to 2000. There are models for the Condamine-Balonne, Border Rivers, Warrego, Paroo and Moonie systems. The water balance part of the model is based on the suite of models used in the Queensland Water Resource Planning (WRP) process. This suite of WRP models was built, calibrated and validated to represent the major water flow related processes of resource assessment and allocation, reservoir operation, channel constraints, crop water requirement, irrigation water diversion, overland flow and flood harvesting, and environmental flow rules and delivery.

The salt balance part of the models has been added to the WRP models. This involved the incorporation of flow load relationships for the systems unregulated tributary inflows. The salinity sub-models were validated against all available salinity data in the *benchmark period*. These typically comprised about 15 - 20 years of periodic grab sample data and a few years of continuous data. The end of system outputs from the Queensland streams become inputs into the NSW Barwon-Darling system IQQM models, which in turn become inputs to the MSM-BIGMOD model previously described.

The models listed below were approved by the Commission in June 2004.

Geographic Area	Flow and Salinity Process Models
Murrumbidgee	Murrumbidgee Integrated Quantity/Quality Model (IQQM)
Lachlan	Lachlan IQQM
Macquarie	Macquarie IQQM
Namoi	Namoi IQQM
Gwydir	Gwydir IQQM
Barwon Darling	Barwon Darling IQQM
Border Rivers	Border Rivers IQQM
Moonie	Moonie IQQM
Paroo Condamine-Balonne Goulburn-Broken	Paroo IQQM Condamine-Balonne IQQM Goulburn-Broken REsource Allocation Model (REALM)
Campaspe	Campaspe REALM
Upper Loddon	Upper Loddon REALM
Wandella Creek	Wandella Creek REALM
Kerang Lakes	Kerang Lakes REALM
Upper River Murray and River Murray in South Australia	Monthly Simulation Model – Bigmod (MSM Bigmod) Pilot Interstate Water Trading Zone
Salinity Impacts Rapid Assessment Tool (SIMRAT)	

Appendix 3.4

ASSESSING FUTURE SALINITY AND SALT LOADS, AND *END-OF-VALLEY TARGETS*

The Basin Salinity Management Strategy requires the consideration of future salinity impacts in the short, medium and long term. When assessing future salinities, estimates should normally be produced for the years 2015, 2050 and 2100.

As outlined in Appendix 3.2, both salinities and flows within the Murray-Darling Basin are highly variable and the use of the benchmark period climatic sequence (1 May 1975 – 30 April 2000) is essential to account for a range of responses in wet, dry and average years.

The assessment of future salinity and salt loads should maintain a focus on the median and peak (80 or 95 percentile non-exceedance) salinity levels, while for salt loads a focus should be maintained on the average salt load.

The steps for assessing future salinity and salt loads are as follows:

- predict the salinity trend at the proposed target site for the ‘no further intervention’ scenario. The ‘no further intervention’ scenario assumes that the current land and water management regime will continue indefinitely into the future, and provides the basis for predicting future delayed salinity impacts (‘legacy of history’ impacts). The trend prediction should be based on the results from the latest salinity audit for the valley, which will be progressively updated under the five-year rolling audit program. Where the trends are evaluated at the proposed target site in the latest salinity audit, it is expected that the results from the audit would be used directly, otherwise some further analysis will be required

- from these results evaluate ‘no further intervention’ daily salinities and salt loads at key dates (for example, 2015, 2050, 2100) using models established for climate variability over the *benchmark period*. Other decision support tools and expert opinion may also be used, such that the statistics of the resultant daily time series (mean, median, percentiles) at each key date match the statistics from the trend predictions. Extract any additional statistics needed from the results that are not available from the trend predictions

- for each of the key dates, define a set of ‘pre-action conditions’ that reflect the *salinity impacts* of approved actions since the baseline date that have been declared effective, or are in progress

- develop a range of management scenarios that will consider local priorities, assets and values to be protected, private and public costs and benefits, and the projected effect on the *basinsalinity target*. Scenarios may include a number of possible interventions including changes in land management, engineering works, changes in flow management and modified agricultural practices

- estimate the daily salinities and salt loads at key dates (for example, 2015, 2050, 2100) using the *benchmark period* climatic sequence for the alternative management scenarios, the ‘pre-action conditions’, and the same models, other decision support tools, and expert opinion as employed for the ‘pre-action conditions’. This will generate a set of ‘post-action conditions' for each management scenario. Evaluate the required statistics of the resultant time series (mean, median, percentiles) at key dates and use these to derive trend predictions for each scenario

- further analyses may involve community consultation, and investigations of biophysical, economic, social and other environmental impacts consistent with the local Catchment Management Strategy or its equivalent
- for each management scenario estimate the end-of-valley salinity levels as a percentage of the 'no intervention' value at the assessment date. Compare the analyses of each scenario and identify the scenario that gives the optimal outcome (that is, the scenario that meets the target at the least overall cost to society, taking into account economic, social and environmental criteria). The selected salinity levels become the end-of-valley target and the management scenario associated with it become the basis for a program of actions for the valley (see Protocol 2.4.8).

Figure 1
Schematic diagram for no further intervention scenario for 2015, 2050 and 2100 – Flow, salinity and salt load

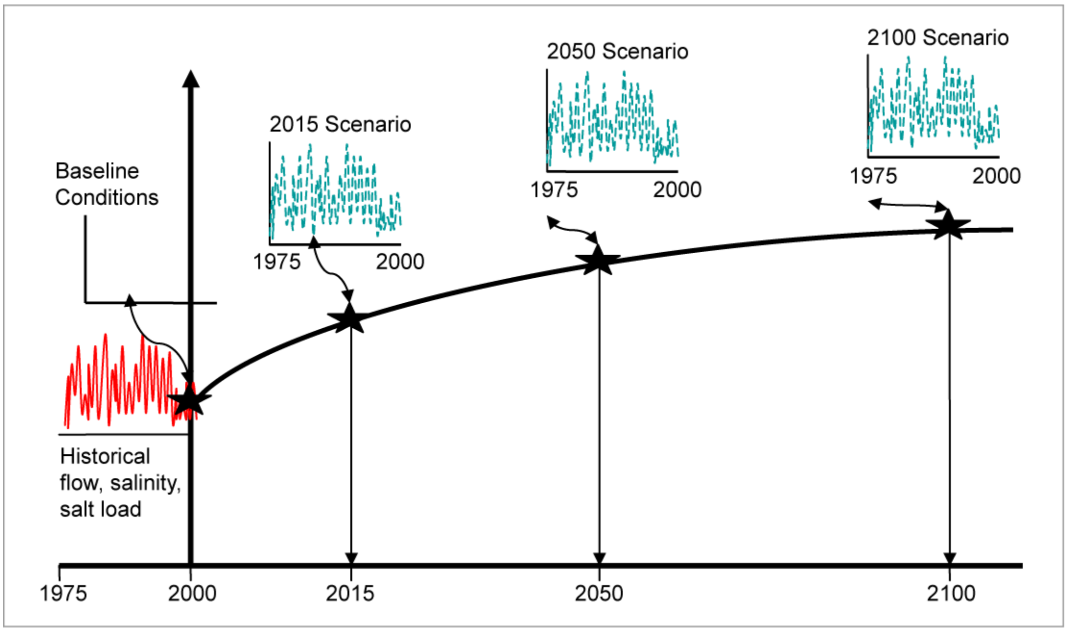


Figure 2
Setting Salinity Targets Using a Benchmark Period

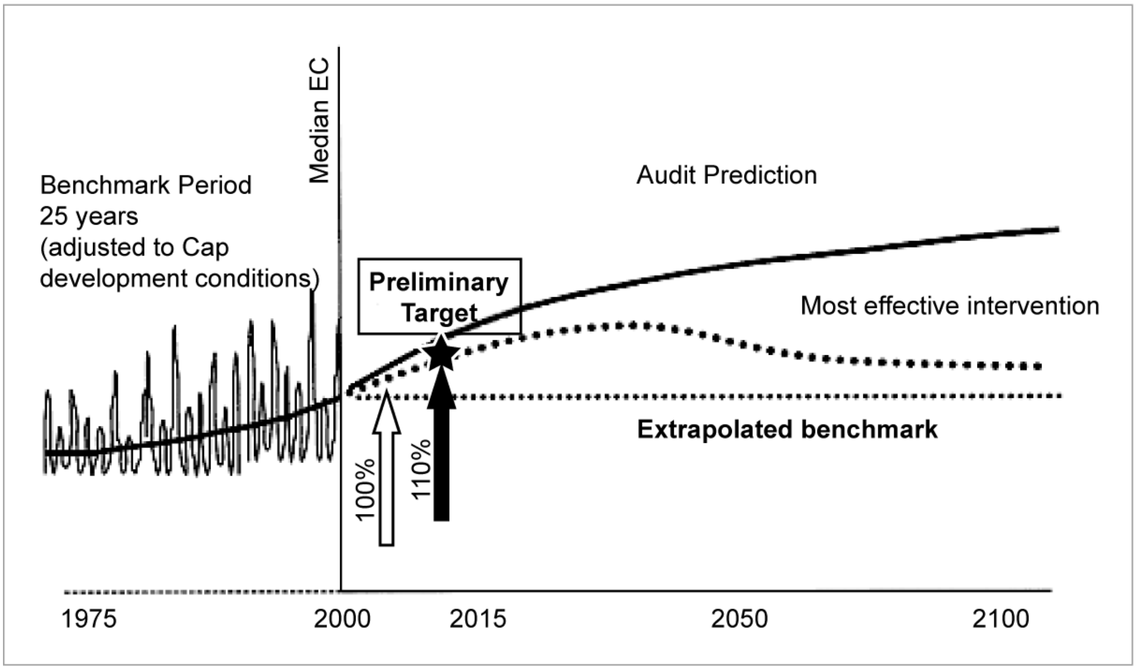
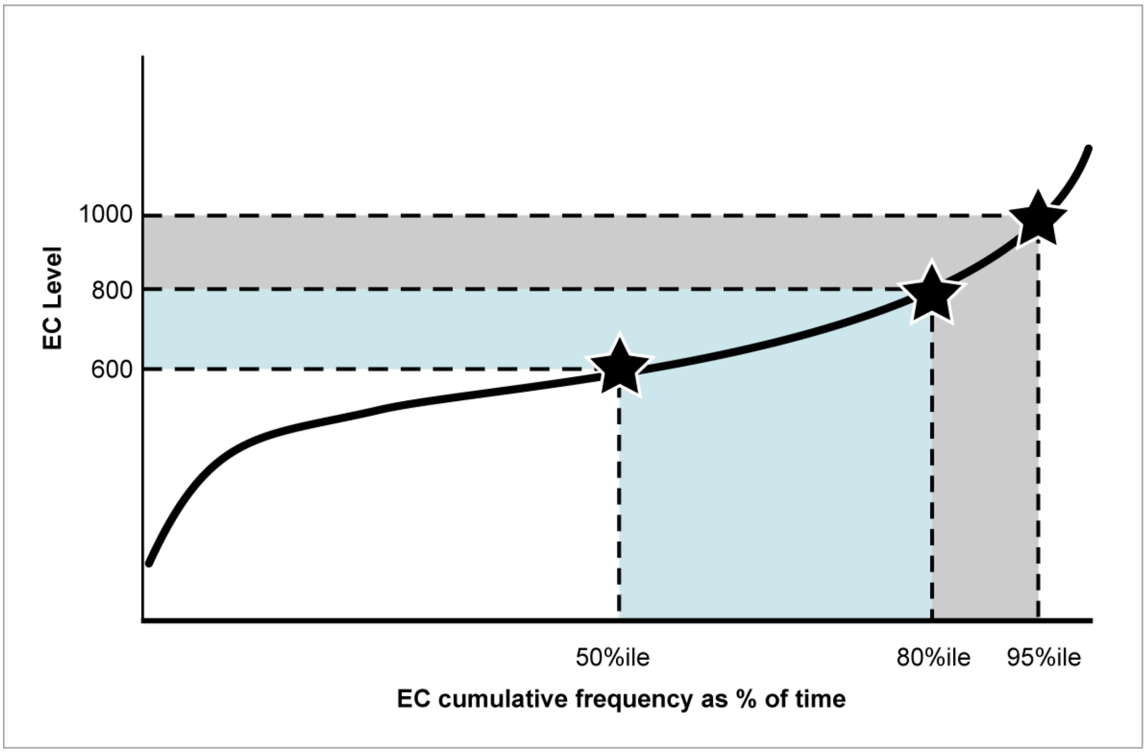


Figure 3
Typical salinity variability graph



Appendix 3.5

CALCULATING AND ATTRIBUTING *SALINITY CREDITS* AND *SALINITY DEBITS*

Estimated salinity credits and salinity debits are entered in the Registers in different ways depending on their origin. If the entry is initiated by an accountable action (that is, a proposal having a significant effect) it will require an entry in Register A. If the entry is a delayed salinity impact or an *action* designed to offset a *delayed salinity impact* it will require an entry in Register B.

Entries in *Register A* (*salinity credits* and *salinity debits*) are based upon the average impact over the 30 year period from the time that the initiating action is expected to take effect. The entry is reviewed every 5 years and the average over the next 30 years is reassessed. This may result in a changed entry for the same *action*.

Entries of *salinity credits* in *Register B* are also based on a 30 year average as for *Register A*, and are reviewed every 5 years in the same way.

Entries of *salinity debits* in *Register B* (*delayed salinity impacts*) are those which occur after 1 January 2000, but are attributable to an action taken or a decision made before 1 January 1988 (1 January 2000 in the case of Queensland) and that are considered by the Commission to have a significant effect. Debit entries are made annually in equal increments, based on the most recent 50 year projection.

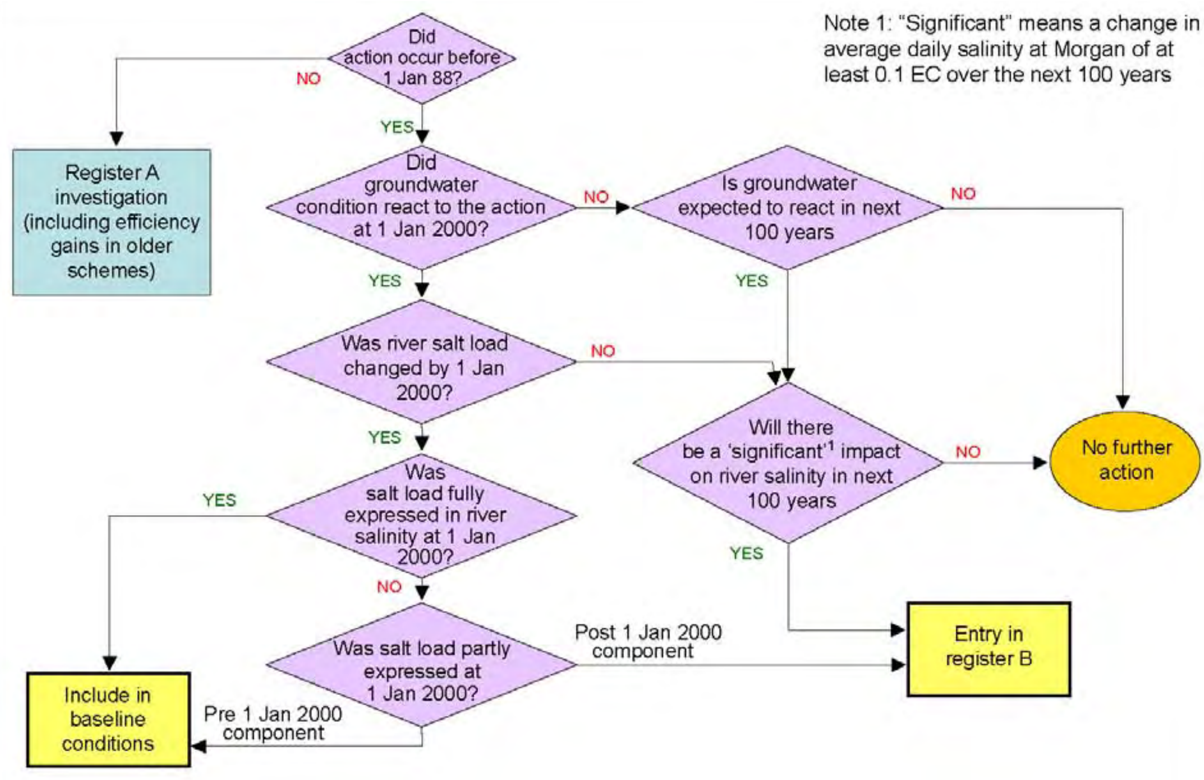
A review at any time (at least every 5 years) may modify the 50 year projection for *delayed salinity impacts*. When this occurs the annual increments for *salinity debits* in *Register B* will be adjusted to match the new projection, including adjustments to retrospective entries.

Register B debit entries are computed on a linear 50 year basis (instead of a 30 year rolling average) because:

- *delayed salinity impacts* typically take many decades to take effect, and their salinity response curve is not linear in the first 30 years. In such cases a 30 year average can give a misleadingly high debit result which may distort investment towards short term outcomes.
- a key premise of the BSMS is that capital works projects (such as salt interception schemes) may be employed to “buy time” until longer term measures (such as revegetation) take effect. The 50 year approach reflects this philosophy, and encourages actions that focus on long term improvement in salinity levels.

The following decision tree (Figure 1) illustrates the logic behind entries in the *B Register*.

Figure 1
Basin Salinity Management Strategy—Decision tree for entries in *Register B*

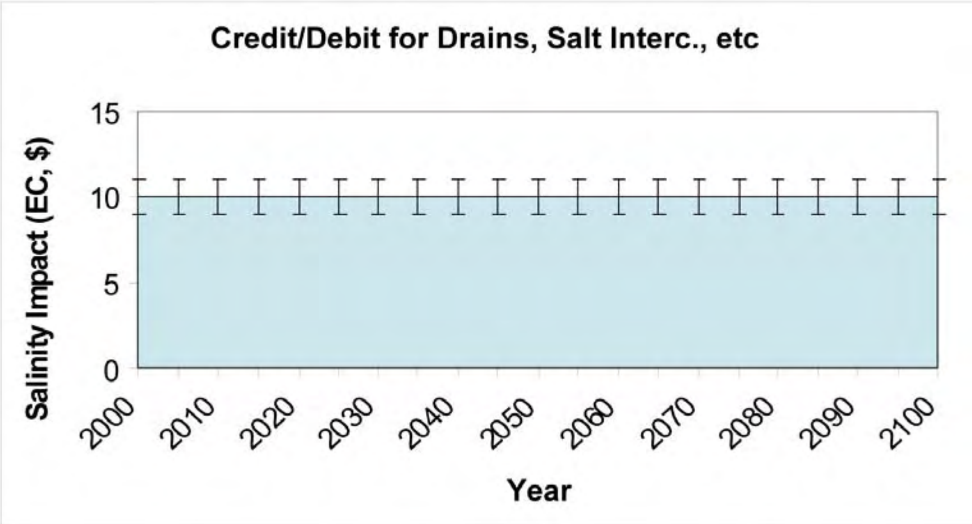


When a proposed *action* is anticipated to generate *salinity credits*, and to be implemented progressively over several years (such as a staged development, or a program of actions), the assessment should include a time-based *salinity impact* response curve over 100 years from the date that the action is expected to take effect. The provisional entry in the Register will be the average *salinity impact* over the next 30 years for the whole action, and the actual entries of *salinity credits* for each stage can be made as soon as:

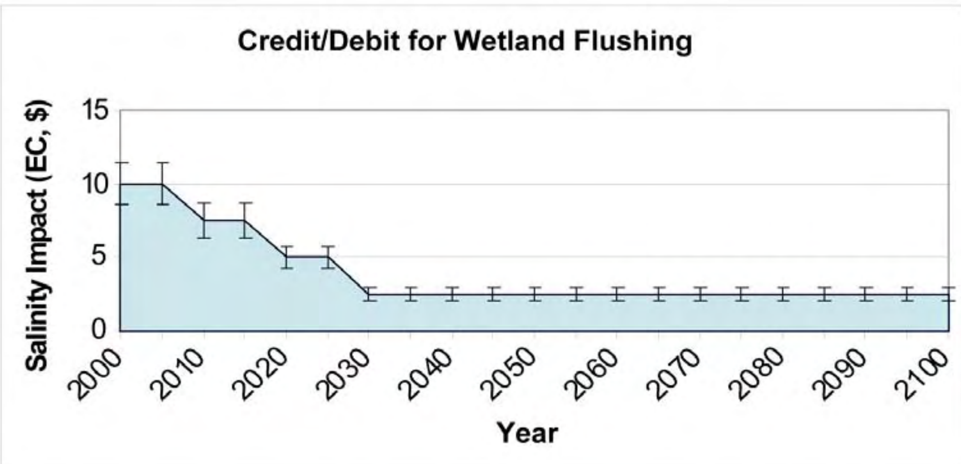
- that stage has been completed and commissioned, and
- the Commission has agreed to declare that stage of the work or measure *effective*.

Register entries will be reviewed annually until the *action* as a whole is complete, by comparing actual progress in annual reporting with planned progress, and adjusting the time-based *salinity impact* response curve accordingly. Otherwise, Register entries will be revised at five yearly intervals (see Protocols 5.7.1 and 5.7.2) taking into account the time-based response curve and any subsequent reviews.

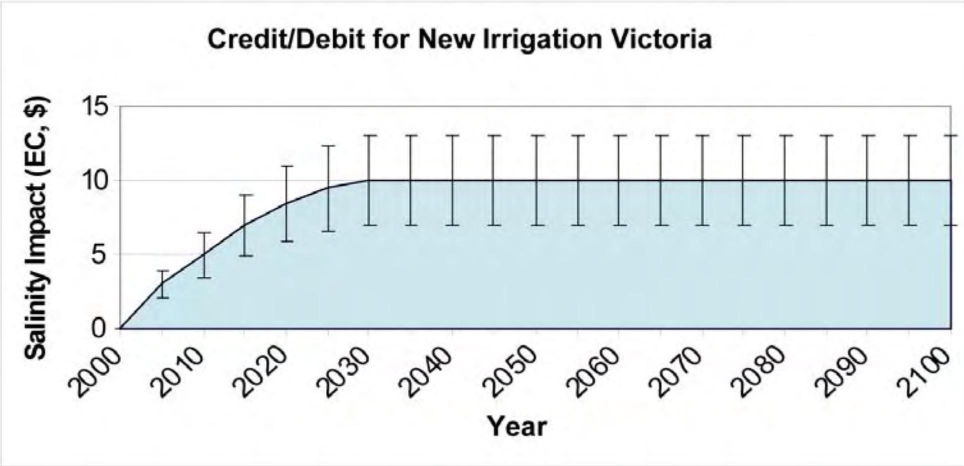
Examples of different types of actions and the corresponding likely entries in *Register A* are shown below.



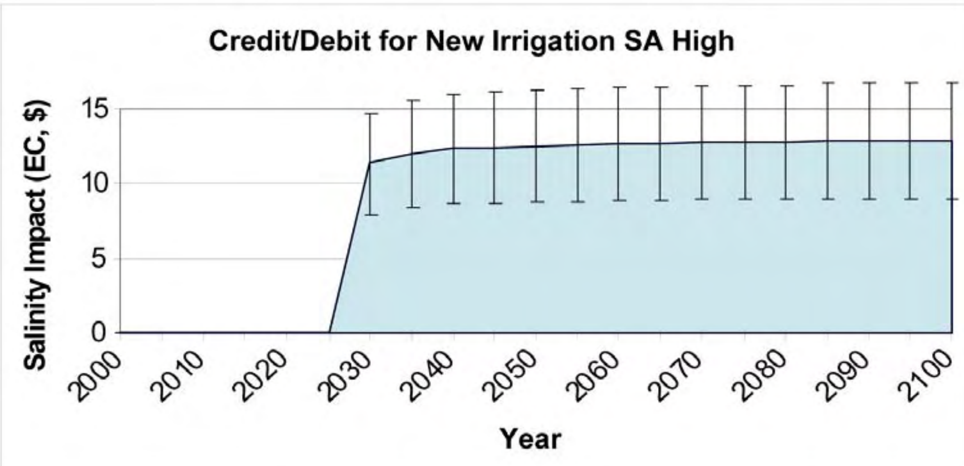
	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	10	10	10
Year 2005	10	10	10
Year 2010	10	10	10
Year 2015	10	10	10
Year 2020	10	10	10
Year 2025	10	10	10
Year 2030	10	10	10



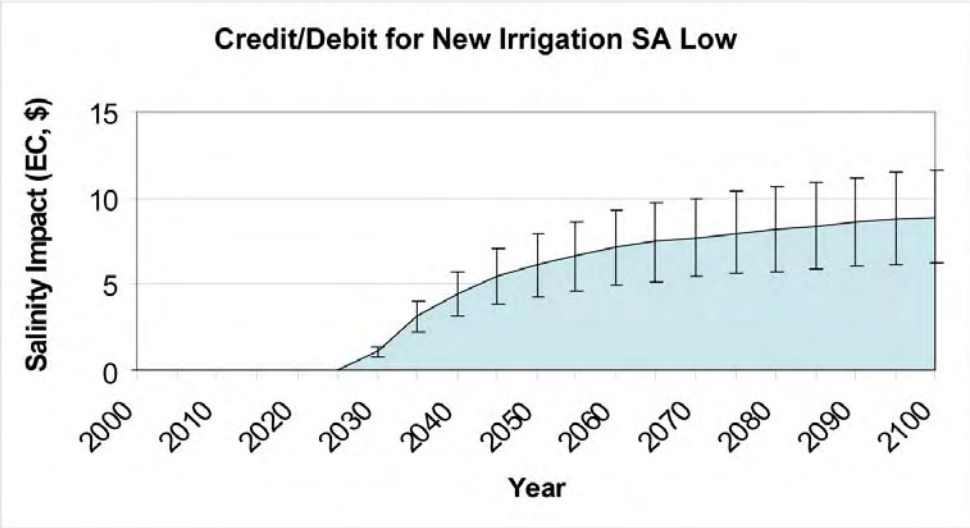
	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	9.2	6.8	5.2
Year 2005	8.3	5.7	4.5
Year 2010	6.7	4.6	3.9
Year 2015	5.8	3.9	3.4
Year 2020	4.2	3.2	3
Year 2025	3.3	2.9	2.7
Year 2030	2.5	2.5	2.5



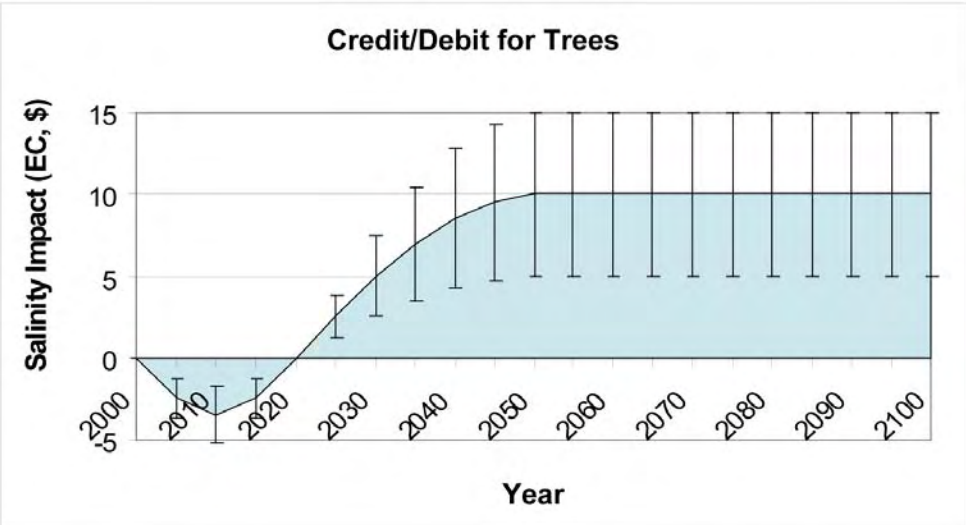
	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	2.7	6.1	7.5
Year 2005	5	7.6	8.5
Year 2010	6.8	8.6	9.1
Year 2015	8.3	9.3	9.5
Year 2020	9.3	9.7	9.8
Year 2025	9.8	9.9	10
Year 2030	10	10	10



	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	0	1.6	5.5
Year 2005	0	3.3	6.7
Year 2010	0	5.1	7.8
Year 2015	0	6.9	9
Year 2020	3.8	8.7	10.1
Year 2025	7.8	10.5	11.3
Year 2030	11.9	12.3	12.5



	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	0	0.2	1.8
Year 2005	0	0.6	2.4
Year 2010	0	1.2	3.1
Year 2015	0	2	3.7
Year 2020	0.4	2.9	4.4
Year 2025	1.4	3.8	5.2
Year 2030	2.9	4.8	5.9



	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	-2	-0.1	3.1
Year 2005	-2.8	0.9	4
Year 2010	-2	2.4	5.1
Year 2015	0	4.3	6.4
Year 2020	2.5	6.1	7.5
Year 2025	4.8	7.5	8.4
Year 2030	6.8	8.6	9.1

Appendix 3.6

ATTRIBUTION OF *DELAYED SALINITY IMPACTS*

Salinity debits

Salinity debits that have an impact after 1 January 2000 but which are the result of actions incurred before the baseline dates are known as '*delayed salinity impacts'* and are entered in Register B. They are based upon the latest information available in salinity audits, using the 50 year annual increment as described in Appendix 3.5.

An interim agreement has been made to use the seven-year incremental predictions to determine the relative shares of the delayed salinity impacts between the individual States and the joint program. The agreement assigns 41 EC of *salinity debits* to be distributed between the States and the *joint program*[4].

The current audit for 'no further intervention' predictions is the 1999 salinity audit (with amendments for Queensland in Aug 2001), which indicates a *salinity impact* at Morgan of 215 EC by year 2050.

For the years 2001 to 2007:

- 31 EC of the *salinity debits* associated with *delayed salinity impacts* are assigned to the *joint program*
- 10.1 EC of the *salinity debits* are assigned to the individual States in shares proportionate to 2001 assessment of each States contribution to the 'no further intervention' prediction (based on the revised 1999 Audit), with the exception of Queensland.

Accordingly the *salinity debits* entered in *Register B* due to *delayed salinity impacts* have been determined as follows:

State	by 2007	each year
Joint program	31 EC	4.43
NSW	2.4 EC	0.34
Vic	1.9 EC	0.27
SA	5.8 EC	0.83

These salinity debits may be offset by credits arising from the *joint works program* and the implementation of catchment programs of actions.

If during the course of reviews the predictions are amended, then the Commission may modify the future assignment of salinity debits. As a guiding principle, the remaining years are debited with proportionately less or greater debits assigned to the combined States and the *joint program* in order to bring the 'no further intervention' outcome in line with the latest prediction.

4 The agreement was made by the Commission in the context of a *joint program* for salt interception schemes.

Salinity credits

The Commonwealth's 25% share of salinity credits (15.25/61) is assigned to *Register B* in accordance with the following arrangement agreed at the Ministerial Council Meeting No 32 of 2 November 2002:

NSW	15%	2.1 EC
Victoria	5%	0.7 EC
South Australia	80%	12.6 EC
	100%	15.3 EC

This distribution will occur as each joint work is constructed and declared *effective,* as set out in Protocol 3.7.2.

This assignment arrangement is based upon the Commonwealth's agreement to resolve the difference between the States' future impacts taking into account the 1999 Salinity Audit predictions of the 'Legacy of History' (*delayed salinity impacts*) made at the time of agreement to the BSMS in June 2001. As in the case of *salinity debits,* the assignment to States may be modified in future as the result of 5 year rolling reviews.

Appendix 3.7

SAMPLE REGISTERS A & B

Basin Salinity Management Strategy (Murray-Darling Basin Agreement Schedule C)

Salinity Registers "A" and "B" (Transitional as at June 2003)

Final Version 2.0 for Independent Audit Group for Salinity Consideration - 12 March 2004

COMMISSION REGISTER A	Type	Date Effective	Provisional Salinity Effect	Salinity Effect (EC at Morgan) Current Year	2015	2050	2100	30 Year Average	Salinity Cost Effect (30 Year Average $'000) NSW	Vic	SA	Qld	Total	Salinity Credits/Debits (30 Year Average Equivalent EC) NSW	Vic	SA	Qld	Total	5 Year Rolling Review Latest Review	Review Deadline	Status
JOINT WORKS & MEASURES																					
Former Salinity & Drainage Works																					
Woolpunda Interception Scheme	Joint	Jan 1991		-40.8	-40.8	-40.8	-40.8	-40.8	$575	$575	$0	$0	-$3,066	7.2	7.2	0	0	14.4	2000	2005	-
Improved Buronga and Mildura/ Merbein I.S.	Joint	Jan 1991		-3.0	-3.0	-3.0	-3.0	-3.0	$57	$57	$0	$0	-$303	0.7	0.7	0	0	1.4	2000	2005	-
New Operating Rules for Barr Ck Pumps	Joint	Jul 1991		-6.0	-6.0	-6.0	-6.0	-6.0	$101	$101	$0	$0	-$540	1.3	1.3	0	0	2.5	2000	2005	in progress
Waikerie Interception Scheme	Joint	Dec 1992		-12.7	-12.7	-12.7	-12.7	-12.7	$193	$193	$0	$0	-$1,028	2.4	2.4	0	0	4.8	2000	2005	-
Mallee Cliffs Salt Interception Scheme	Joint	Jul 1994		-12.9	-12.9	-12.9	-12.9	-12.9	$242	$242	$0	$0	-$1,288	3.0	3.0	0	0	6.0	2000	2005	in progress
Increased Riparian Flow in the Lower Darling	Joint	Nov 1997		1.9	1.9	1.9	1.9	1.9	-$8	-$8	$0	$0	$45	-0.1	-0.1	0	0	-0.2	1997	Overdue	-
Changed Internal Operation of Menindee Lakes	Joint	Nov 1997		0.7	0.7	0.7	0.7	0.7	-$65	-$65	$0	$0	$348	-0.8	-0.8	0	0	-1.6	1997	Overdue	-
Waikerie Phase II A Scheme	Joint	Feb 2002		-6.1	-6.1	-6.1	-6.1	-6.1	$89	$89	$0	$0	-$472	1.1	1.1	0	0	2.2	-	-	-
Sub Total - Former Salinity & Drainage Works				-78.7	-78.7	-78.7	-78.7	-78.7	$1,093	$1,093	$0	$0	-$6,304	14.8	14.8	0.0	0.0	29.5			
Basin Salinity Management Strategy																					
Pyramid Creek	Joint	Not effective	-4.6																		
Bookpurnong	Shared	Not effective	-20.5																		
Sub Total Joint Works under BSMS																					
Joint Works Sub Total				-78.7	-78.7	-78.7	-78.7	-78.7	$1,093	$1,093	$0	$0	-$6,304	14.8	14.8	0.0	0.0	29.5			
STATE WORKS & MEASURES																					
New South Wales																					
Barwon Darling Licensing Policy	NSW	Aug 1991		0.8	0.8	0.8	0.8	0.8	-$40	-	-	-	$40	-0.5	-	-	-	-0.5	1991	Overdue	-
Boggabilla Weir	NSW	Dec 1991		0.2	0.2	0.2	0.2	0.2	-$6	-	-	-	$12	-0.1	-	-	-	-0.1	1991	Overdue	-
Pindari Dam Enlargement	NSW	Aug 1994		1.6	1.6	1.6	1.6	1.6	-$210	-	-	-	$210	-2.6	-	-	-	-2.6	1994	Overdue	-
NSW LWMP's	NSW	Feb 1998		5.0	5.0	5.0	5.0	5.0	-$438	-	-	-	$438	-5.5	-	-	-	-5.5	2000	2005	-
Permanent Inter State Water trade - Dilution Effect	NSW	Various		-0.2	-0.2	-0.2	-0.2	-0.2	$13	-	-	-	-$13	0.2	-	-	-	0.2	2000	2005	-
New irrigation development due to Water Trade	NSW	TBA		TBA	TBA	TBA	TBA	TBA	TBA	-	-	-	TBA	TBA	-	-	-	TBA	-	-	-
New South Wales Subtotal				7.4	7.4	7.4	7.4	7.4	-$681				$687	-8.5				-9.5			
Victoria																					
North-Central	Vic	Various		3.6	3.6	3.6	3.6	3.6	-	-$330	-	-	$330	-	-4.1	-	-	-4.1	2000	2005	-
Mallee	Vic	Various		TBA	TBA	TBA	TBA	7.1	-	-$557	-	-	$557	-	-7.0	-	-	-7.0	2000	2005	-
Goulburn-Broken	Vic	Various		4.9	4.9	4.9	4.9	4.9	-	-$411	-	-	$411	-	-5.1	-	-	-5.1	2000	2003	in progress
Barr Creek Catchment Plan	Vic	Mar 1991		-3.6	-3.6	-3.6	-3.6	-3.6	-	$323	-	-	-$323	-	4.0	-	-	4.0	2000	2005	-
Psyche Bend Lagoon	Vic	Feb 1996		-0.7	-0.7	-0.7	-0.7	-0.7	-	$60	-	-	-$120	-	0.7	-	-	0.7	2000	2005	-
Permanent Inter State Water trade - Dilution Effect	Vic	Various		-0.2	-0.2	-0.2	-0.2	-0.2	-	$16	-	-	-$16	-	0.2	-	-	0.2	2000	2005	-
Sunraysia drains drying up	Vic	Jun 2003	-2.15	TBA	TBA	TBA	TBA	TBA	-	TBA	-	-	TBA	-	TBA	-	-	TBA	-	-	-
Victoria Subtotal				4.1	4.1	4.1	4.1	11.2		-$899			$839		-11.2			-11.2			
South Australia																					
Irrigation Development due to Water Trade	SA	Jun 2004	23.1	TBA	TBA	TBA	TBA	TBA	-	-	TBA	-	TBA	-	-	TBA	-	TBA	2002	2004	in progress
Improved Irrigation Practice	SA	Jun 2004	-7.1	TBA	TBA	TBA	TBA	TBA	-	-	TBA	-	TBA	-	-	TBA	-	TBA	2002	2004	in progress
Irrigation and Drainage Infrastructure	SA	Jun 2004	-11.2	TBA	TBA	TBA	TBA	TBA	-	-	TBA	-	TBA	-	-	TBA	-	TBA	2002	2004	in progress
South Australia Subtotal								TBA			TBA		TBA			TBA		TBA			
Queensland																					
No works or measures to-date	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Queensland Subtotal																					
Balance - Register A														6.2	3.5	TBA	-	9.8			

COMMISSION REGISTER B	Type	Year of Predictions	Provisional Salinity Effect	Salinity Effect (EC at Morgan) Current Year	2015	2050	2100	30 Year Average	Salinity Cost Effect ($'000) NSW	Vic	SA	Qld	Total	Salinity Credits/Debits (Current Year - "Ticking clock")					Latest Review	Review Deadline	Status
New South Wales																					
Namoi	Delayed	1999		1.3	6.4	21.3	42.7	-	-	-	-	-	-	-1.3	-	-	-	-1.3	1999	2004	in progress
Macquarie	Delayed	1999		0.9	4.3	14.3	28.7	-	-	-	-	-	-	-0.9	-	-	-	-0.9	1999	2004	in progress
Gwyder	Delayed	1999		0.02	0.1	0.3	0.7	-	-	-	-	-	-	0.0	-	-	-	0.0	1999	2004	in progress
Border Rivers	Delayed	1999		0.02	0.1	0.3	0.7	-	-	-	-	-	-	0.0	-	-	-	0.0	1999	2004	in progress
Murrumbidgee	Delayed	1999		1.2	6.0	20.0	40.0	-	-	-	-	-	-	-1.2	-	-	-	-1.2	1999	2004	in progress
Bogan	Delayed	1999		0.6	3.2	10.7	21.3	-	-	-	-	-	-	-0.6	-	-	-	-0.6	1999	2004	in progress
Castlereagh	Delayed	1999		0.0	0.2	0.7	1.3	-	-	-	-	-	-	0.0	-	-	-	0.0	1999	2004	in progress
Victoria																					
Goulburn	Delayed	1999		0.2	0.8	2.7	5.3	-	-	-	-	-	-	-	-0.2	-	-	-0.2	1999	2004	-
Loddon	Delayed	1999		0.1	0.7	2.3	4.7	-	-	-	-	-	-	-	-0.1	-	-	-0.1	1999	2004	-
Vic Mallee	Delayed	1999		3.0	15.0	50	100	-	-	-	-	-	-	-	-3.0	-	-	-3.0	1999	2004	in progress
South Australia																					
SA Mallee	Delayed	1999		10.0	50.0	167	333	-	-	-	-	-	-	-	-	-10.0	-	-10.0	1999	2004	in progress
Queensland																					
Condamine Balone	Delayed	2000		0.10	0.5	1.7	3.3	-	-	-	-	-	-	-	-	-	-0.1	-0.1	2000	2005	-
Border Rivers	Delayed	1999		0.10	0.5	1.7	3.3	-	-	-	-	-	-	-	-	-	-0.1	-0.1	2000	2005	in progress
Irrigation development pre 1 January 2000	Delayed	TBA		TBA	TBA	TBA	TBA	-	-	-	-	-	-	-	-	-	TBA	TBA			-
Balance - Register B																			-17.6			
Balance - Registers A & B																			-7.8			

Registers Explainatory Notes
TBA - To be assessed
Victorian administrative areas revised June 2003
Credits shown as positive numbers, debits shown as negative numbers
Salinity Effect - Increase in average salinity at Morgan in EC
Salinity Cost Effect - Increase in average salinity costs in $'000's (March 1988 values)
Salinity Credits - Unit of account of Salinity and Drainage Strategy (= negative of salinity cost effect)
Equivalent EC - Salinity credits (in $) expressed in EC units using the ratio of total $ credits to total Salinity Effect for the initial joint works.
Register B - Contributions to Morgan salinity in 2015 (assuming no intervention) as predicted in the 1999 Salinity Audit (see Table 1 in Basin Salinity Management Strategy 2001-2015)
Register is Transitional from Salinity and Drainage Register (All items to be recalculated using MSMS Bigmod (to be finalised March 04) and new cost Functions (to be finalised by September 2004)

Appendix 3.8

SALINITY IMPACT AT MORGAN - READY RECKONER AND COST FUNCTIONS

Salinity cost functions

The Basin Salinity Management Strategy requires salinity credits and salinity debits resulting from accountable actions to be entered as appropriate in Register A and/or Register B (Schedule C, Clause 20). The terms *salinity debit* and *salinity credit* refer to changes in ‘average salinity costs’. Estimates of salinity impacts are normally made in EC units, and cost functions are required to convert EC units to costs before entries in the Registers are made.

Cost functions have been developed to reflect the estimated economic effect of rising salinity levels in the basin. High salinity levels have the potential to not only reduce agricultural yields but can also impose additional costs to urban and industrial water users. The factors being used to derive these cost functions are as follows:

Domestic Water Users

Studies have indicated that costs to household water users would increase as a result of high salinity levels and the subsequent increase in water hardness. These increased costs arise as a result of the greater need to repair and replace household fixtures due to corrosion, and the effects of hardness. Domestic costs include impacts to the following:

- plumbing fixtures and fittings;
- hot water systems;
- domestic water softeners.

Industrial Water Users

The impact of increasing salinity on industry is seen in the reduced reliability and lifespan of plant equipment, and additional processes and costs required to maintain product quality. Some specific problems experienced by industry are:

- Corrosion of pipes and fittings
- Reduced boiler life
- Additional blow down requirements in cooling towers and boilers
- Additional pre-treatment and chemical costs to ensure that the salinity and hardness of water are suitable for manufacturing processes.

Agricultural Water Users

Costs to agricultural users as a result of increasing salinity are primarily attributed to crop yield loss as a result of the following:

- Crop yield decreases as the soil-water salinity increases beyond a threshold value
- Impact on crop yields due to foliar damage resulting from over-head irrigation.

The major salinity cost functions for the River Murray have been documented and are available from the Commission. Further details regarding cost functions can be found in:

- Gutteridge Haskins and Davey Pty Ltd (1999). *Salinity Impact Study*. Report to Murray-Darling Basin Commission
- Allen Consulting Group (2004). Independent Review of Salinity Cost Functions for the River Murray. Report to Murray-Darling Basin Commission.

Ready reckoner

The MDBC MSM-BIGMOD has been used to establish the effect of salt inflows in various reaches of the river on the salinity at Morgan. The relative impacts are illustrated in Table 1 and Figures 1 to 4.

Figure 4 "Equivalent EC" is an appropriate tool for initial appraisals, while final assessments should be undertaken using models as described in Protocol 3.6.5.

Table 1
***Salinity impacts* at Morgan of 100 t/d**

Station	River Distance from Mouth of River Murray (km)	Salt Load (t/d) for 3 flow ranges			EC Impact @ Morgan				Cost Impact of Salinity ($'000/annum)			
		<10000 ML/d	10-20000 ML/d	>20000 ML/d	<10000 ML/d	10-20000 ML/d	>20000 ML/d	Total	<10000 ML/d	10-20000 ML/d	>20000 ML/d	Total
Corowa	2208	100	100	100	2.2	1.3	1.3	4.9	510	290	290	1100
Tocumwal	1886	100	100	100	3.6	2.7	0.58	6.9	700	620	150	1500
Torrumbarry	1678	100	100	100	5.8	0.89	0.61	7.3	1200	210	120	1500
Swan Hill	1409	100	100	100	11	1	0.69	12	2200	240	130	2600
Kyalite	-	100	100	100	12	0.47	0	13	2500	100	0	2600
Mildura	910	100	100	100	13	1.9	1.3	16	2500	400	250	3200
Weir 32	-	100	100	100	13	0.58	0.31	14	3400	88	58	3500
Wentworth	825	100	100	100	13	3.2	1.8	18	2100	730	330	3200
Lock 6	654	100	100	100	17	2.3	1.2	20	2800	450	170	3400
Lock 5	620	100	100	100	18	1.8	1.2	21	2300	230	120	2600
Lock 4	516	100	100	100	20	1.6	1.1	23	1900	170	110	2200
Lock 3	496	100	100	100	21	1.4	1.1	23	1600	110	76	1700
Lock 2	383	100	100	100	22	1.3	1.1	25	1300	100	76	1500
Morgan	315	100	100	100	22	3	1.5	26	1300	160	99	1600
Lock 1	274	100	100	100	0	0	0	0	680	58	49	790
Murray Bridge	150	100	100	100	0	0	0	0	130	9	19	160

Figure 1
Morgan *salinity impact* ready reckoner
Salinity impacts at Morgan for adding constant 100 tonnes/day at various locations along the River Murray and the Darling River - 1975 to 2000 Benchmark period

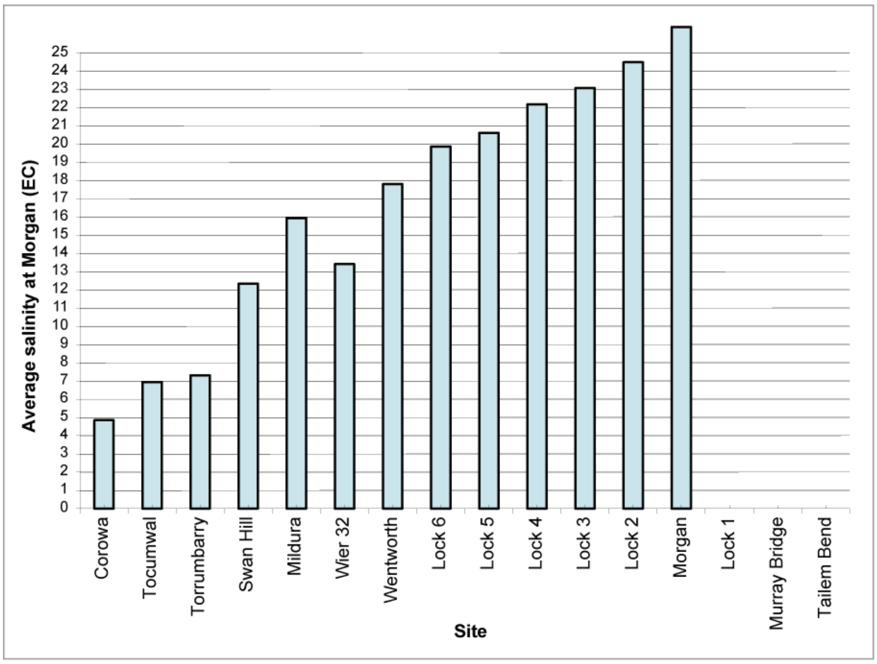


Figure 2
Economic impact ($/p.a)
Economic impact of Salt Entering various locations along the River Murray
Modelled results assuming inflow of constant 100 tonnes/day over 1975 to 2000 benchmark

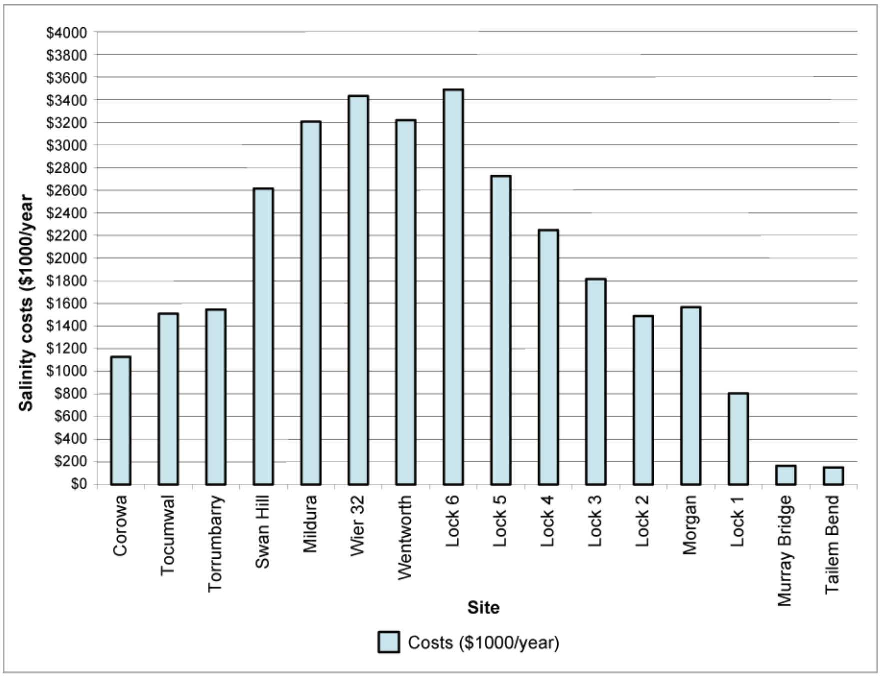


Figure 3
Economic impact ($/tonne)
Economic impact to downstream water users of Salt Entering the Murray River

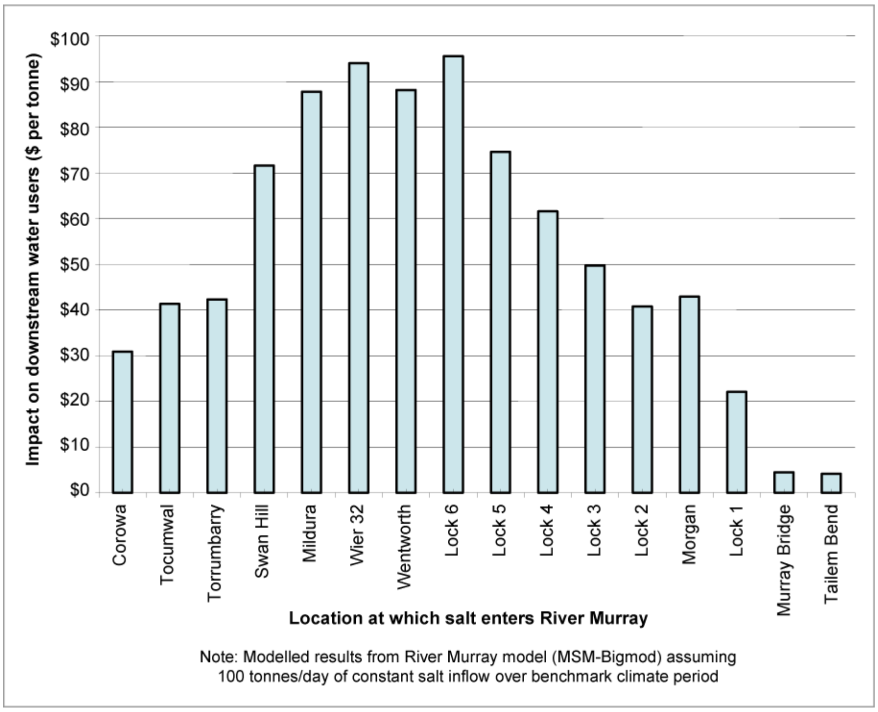
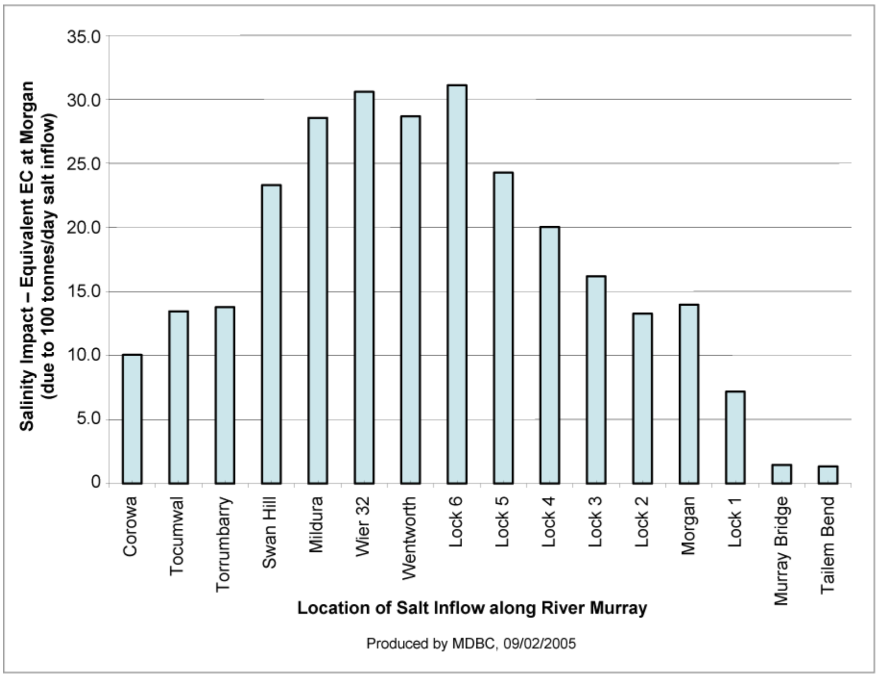


Figure 4
Salinity impact – Equivalent EC
River Murray Salinity Impacts "Ready Reckoner"Salinity Impact due to 100 tonnes/day salt inflow - Equivalent EC at Morgan



Appendix 3.9

Assessment Criteria used for reviewing hydrological models developed under the BSMS

	EVALUATION CRITERIA	STATUS				RECOMMENDED IMPROVEMENTS		
						2004	2007	2010-2015
1.0	***MODEL OVERVIEW***							
1.1	Is there a clear statement of model objectives in the report and are these objectives consistent with the model requirements of Clauses 5(2), 37 and 39 of Schedule C?	Missing	Deficient	Adequate	Very Good			
1.2	Is a salt and water balance reported?	Missing	Deficient	Adequate	Very Good			
1.3	Has the modelling effort been directed towards satisfying the stated objectives?	Missing	Deficient	Adequate	Very Good			
1.4	Have the limitations of the model been correctly identified and reported?	Missing	Deficient	Adequate	Very Good			
1.5	Has an appropriate set of future model improvements been identified and scheduled? Where appropriate, do the proposed model improvements take account of increased data availability in the near future?.	Missing	Deficient	Adequate	Very Good			
1.6	Has the model already undergone external review? If so, have the findings of these reviews been made available?	Missing	Deficient	Adequate	Very Good			
2.0	***DATA ANALYSIS***							
2.1	Has relevant data (surface water, groundwater, landuse, diversions, climate, etc.) been collected and analysed?	Missing	Deficient	Adequate	Very Good			
2.2	Is information on the spatial and temporal extent, and the quality of the available data, been provided?	Missing	Deficient	Adequate	Very Good			
2.3	Has the process of infilling data gaps and extending data beyond the period of record been highlighted and carried out appropriately?	Missing	Deficient	Adequate	Very Good			
2.4	Has the process of establishing Year 2000 conditions for various model inputs been competently undertaken and documented?	Missing	Deficient	Adequate	Very Good			
3.0	***MODEL STRUCTURE***							
3.1	Is there a clear description of the conceptual model and is it consistent with Schedule C's objectives and the required model complexity? Has a schematic diagram of the model been provided?	Missing	Deficient	Adequate	Very Good			
3.2	Are all the principal flow/salt inputs and outputs included and is the spatial extent appropriate?	Missing	Deficient	Adequate	Very Good			
3.3	Are all the relevant flow/salt routing processes included and documented?	Missing	Deficient	Adequate	Very Good			
3.4	Is the model flexible enough to be expanded or refined with the availability of more data in the future (i.e. 5-yr rolling review)?		No	Maybe	Yes			
3.5	Are the number and size of sub-catchments appropriate?	Missing	Deficient	Adequate	Very Good			
3.6	Is the software appropriate for the objectives of the study?		No	Maybe	Yes			
3.7	Is the software consistent with the conceptualisation?		No	Maybe	Yes			
3.8	Has the robustness of the model to fulfil Schedule C's requirements been established with regard to the model time-step, its structure and its internal flow/salt processes?	Missing	Deficient	Adequate	Very Good			

	EVALUATION CRITERIA	STATUS				RECOMMENDED IMPROVEMENTS		
						2004	2007	2010-2015
4.0	***CALIBRATION***							
4.1	Has sufficient effort been expended to obtain data for calibration?	Missing	Deficient	Adequate	Very Good			
4.2	Is the model sufficiently calibrated against spatial and temporal observations?	Missing	Deficient	Adequate	Very Good			
4.3	Are the calibrated values plausible?		No	Maybe	Yes			
4.4	Has the calibration process been sufficiently documented? Have an appropriate number and range of time-series plots and statistics of the observed and modelled data been provided ?	Missing	Deficient	Adequate	Very Good			
4.5	Has the robustness of the model to operate outside the calibration period been established and documented?	Missing	Deficient	Adequate	Very Good			
5.0	***VERIFICATION/TESTING***							
5.1	Where appropriate, have all reasonable avenues for verifying and testing the model been undertaken and documented? Alternatively, if verification or testing have not been undertaken, have the reasons been documented?	Missing	Deficient	Adequate	Very Good			
6.0	***PREDICTION***							
6.1	Have the year 2000 *baseline conditions* model been run for the period May 1975 to June 2000? Are the Year 2000 model assumptions appropriate and documented clearly?	Missing	Deficient	Adequate	Very Good			
6.2	Have key statistics been prepared from the *baseline conditions* predictions? Are the *baseline conditions* plausible?	Missing	Deficient	Adequate	Very Good			
6.3	Is the model capable of predicting the effect of all *accountable actions* in the modelled area?		No	Maybe	Yes			
6.4	Is the model capable of predicting any *delayed salinity impacts* from the modelled area?		No	Maybe	Yes			
7.0	***SENSITIVITY AND UNCERTAINTY ANALYSES***							
7.1	Have the potential uncertainties in the model inputs been identified?	Missing	Deficient	Adequate	Very Good			
7.2	Have the potential errors in the modelling processes been discussed?	Missing	Deficient	Adequate	Very Good			
7.3	Have the potential uncertainties in the model outputs been estimated, and in particular, the uncertainties in the key target values which the model may be used to predict?	Missing	Deficient	Adequate	Very Good			
8.0	***MONITORING***							
8.1	Has an assessment of the adequacy of the current monitoring network to support model development been made?	Missing	Deficient	Adequate	Very Good			
8.2	Are recommendations made to upgrade the monitoring network where it is inadequate?	Missing	Deficient	Adequate	Very Good			

Appendix 3.10

CRITERIA FOR ASSESSING THE IMPACTS OF IRRIGATION DEVELOPMENTS

	EVALUATION CRITERIA	*ASSESSMENT*	RECOMMENDED IMPROVEMENTS
1.0	**PROPOSAL OVERVIEW**		
1.1	Is the statement of objectives clear in the proposal and are the objectives consistent with the requirements of Schedule C?		
1.2	For what purposes and to what areas is the model stated as being applicable?		
1.3	Has appropriate effort been directed towards satisfying Initial appraisal requirements outlined in 3.6.3 of the protocols and Schedule C objectives?		
1.4	Is the level of detail provided commensurate with the extent of the potential salinity impact and associated uncertainty (Protocols 3.3 pt5)?		
1.5	Has the assessment already undergone external review? If so have the findings of these reviews been made available?		
1.6	Have the limitations of the assessment been correctly identified and reported in line with detailed assessment requirements (3.6.4)?		
1.7	Which version of SIMRAT was reviewed? Which version of MSM-BIGMOD was linked to SIMRAT? Is the BIGMOD version currently approved for the 1975-2000 simulation adjusted to 2000 conditions? Are the linkages between these two models up-to-date and consistent for the estimation of salinity impacts to downstream users and $$ benefits/disbenefits, and which report provides comprehensive documentation of this linkage?		
1.8	Which versions of the numerical groundwater flow models were used? Was the ready reckoner applied to the results from the numerical models?		

2.0	**DATA ANALYSIS**		
2.1	What objective evidence is provided (eg. assessment sheets) to comprehensively document the data available in terms of details of the proposed trade, the sites and the assumed/adopted parameters, any assumptions or default parameters, the water and salt balance and trade impacts, and reality checks on the model results? Does the objective evidence (Assessment Sheets) provide comprehensive (audit-trail) documentation? If not, what improvements are required?		
2.2	Has all data relevant to the actions (permanent and temporary (interstate and intrastate) trade, surface water, groundwater, landuse, diversions, climate, etc) been collected and analysed?		
2.3	Is information provided on the spatial and temporal extent, and the quality, extent and standard of the available data, commensurate with the potential impact. ?		
2.4	Has the process of infilling data gaps and extending data beyond the period of record been highlighted and carried out appropriately?		
2.5	Has relevant data (permanent and temporary interstate and intrastate trade), been collected and analysed? Has information on the spatial and temporal extent, and the quality of the available data, been provided?		
2.6	Have the data analysis aspects of the numerical groundwater model applications been reviewed for consistency with the MDBC Groundwater Flow Modelling Guidelines?		
3.0	***SALINITY IMPACT ASSESSMENT***		
3.1	Have the 1 January 1988 baseline and current conditions been run for the period May 1975 to June 2000 consistent with the requirement of the protocol? Are the assumptions appropriate and documented clearly?		
3.2	Has the salinity assessment been undertaken for future salinity impacts – 2015, 2050 and 2100? Are the estimates plausible?		
3.3	Does the assessment consider the impact in light of potential interactive effect of all other accountable actions in the study area? Record and comment key issues to be addressed if and when subsequent proposals are put forward		

3.4	Does the model output documentation clearly identify the purposes of the run and the unique model run identifier? Is there a logical and auditable link between the run identifier and the particular application (eg. licence/trade number)?		
4.0	***SENSITIVITY AND UNCERTAINTY ANALYSES***		
4.1	Have the potential errors in the proposal processes been discussed?		
4.2	Have the potential uncertainties in the proposal outputs been estimated, Are these estimates commensurate with the magnitude of the proposed impact.		
4.3	Has an appropriate set of future model improvements been identified and scheduled? Where appropriate, do the proposed model improvements take account of increased data availability in the future? What do the reports indicate regarding the likely sensitivity of the predictions to the proposed improvements?		
4.4	Has the SIMRAT model been used to test the sensitivity of results? Will the assumed boundary conditions or flow/salt processes greatly affect the prediction? For example: • Could the seller/buyer site be so close to the river that the boundary conditions and timelag processes are inappropriate? • Could the seller/buyer site so large that the actual location of the development is uncertain? • Could the information available regarding water use efficiency likely to affect the accuracy/reliability of the predictions What is the minimum requirement for adequate information be available for the spatial and temporal context for the assessment (seller/buyer details)		

5.0	***MONITORING***		
5.1	Does the Proposal provide sufficient detail to assess the adequacy of the current monitoring network to support ongoing assessment and reviews,? If not provide comment on what is needed		
5.2	Are recommendations made to upgrade the monitoring network where it is inadequate?		
6.0	***ADMINISTRATIVE AND LEGISLATIVE ARRANGMENTS***		
6.1	Are the administrative and reporting arrangements relevant to this proposal sufficient to allow for review, reporting and audit consistent with the intent of section 3.7 of the protocols		
7.0	**Other**		
	List any other criteria as appropriate		

Appendix 3.11

SIMRAT – DESCRIPTION AND ADMINISTRATIVE ARRANGEMENTS

Description

The Salinity IMpact Rapid Assessment Tool (SIMRAT) is a modelling tool that has been developed to assess the salinity impacts arising from the application of water on greenfield developments within the Pilot Interstate Water Trading area – the Mallee Zone of Victoria, New South Wales and South Australia. The model provides for the movement of water from the ground surface into recharge, and discharge from a nominated "discharge edge" into the River Murray. Relationships derived from MSM-BIGMOD modelling provide the means to translate salt inputs at particular points to salinity impacts at Morgan and the corresponding salinity cost effects.

SIMRAT's primary purpose is to provide estimates of increases or decreases in salt load to the River Murray arising from the trading of irrigation water. These estimates will allow the Commission to adjust the salinity registers established under Schedule C of the Murray Darling Basin Agreement. SIMRAT covers the extent of the Pilot Interstate Water Trading Project, from approximately Nyah to Goolwa. It encompasses a 15 km buffer either side of the River Murray, within which assessments can be made.

The SIMRAT model assesses unconfined aquifer discharge responses arising from changes in recharge occurring at some distance. The model combines this with groundwater salinities to calculate changes to salt inflows to the river. If a floodplain exists, SIMRAT allows for attenuation of the salt inflows.

- Once salt loads have been calculated, MSM-BIGMOD is used to convert salt inflows to EC changes and the salinity cost effects at Morgan. The impacts of water trades can then be assessed on a consistent basis.

SIMRAT may be used for other purposes such as assessing the impacts of irrigation and infrastructure rehabilitation, or improving irrigation efficiency. In these cases SIMRAT should be regarded as a specific purpose assessment model and the principles in Chart 2.2 apply.

How SIMRAT works

SIMRAT uses 5 steps to convert the application of traded water to a salinity impact at Morgan:

- **Step 1: Application to root zone drainage**
  The volume traded is assumed to all be contributing to a greenfield development that will operate at 85% water use efficiency. This leaves 15% not taken up by the plants. Of this amount, 1/3 (i.e. 5%) is allowed for losses such as surface runoff, evaporation and removal via subsurface drains. The assumption therefore is that 10% of the irrigation and effective rainfall will leave the root zone as Root Zone Drainage (RZD) and recharge the unconfined aquifer.

- SIMRAT will take the sum of the water traded and the effective rainfall to be the effective application to a greenfields development. If there is convincing evidence that these assumptions are incorrect for a particular transaction, then site-specific variations may be introduced into the SIMRAT model.

  - **Step 2: From root zone drainage to recharge**
    A lognormal algorithm is used to describe behaviour over time as irrigation development at an arrival site creates a 'wetting' scenario where the dry unsaturated profile is 'wet up' by the increased RZD. When calculating a salinity credit generated from the retirement of irrigation at a departure site, a 'drying' scenario is used to describe the draining of the wet profile. The recharge to the unconfined aquifer thus decreases over time as the wet profile gradually drains.

  - **Step 3: From recharge to impact at the discharge edge**
    Recharge to the unconfined aquifer calculated in step 2 causes a groundwater discharge response for a unit recharge based on distance from river and aquifer properties of transmissivity and specific yield. There is an assumption that all discharge occurs within a single cell, and that cell is the closest cell on the discharge edge to where the recharge occurs. The amount of salt induced from the recharge is relative to the salinity of the groundwater being driven into the river valley. Having determined groundwater salinities at the discharge edge, SIMRAT multiplies total flux responses by the salinity at the closest edge cell. This stage utilises the Unit Response Equation (URE) discussed below.

  - **Step 4: River connectivity and flood plain attenuation**
    In NSW and Victoria, the Parilla Sands aquifer is occasionally separated from the river by a clay layer. Where this is known to occur, SIMRAT applies a river connectivity factor to the outputs of stage 3 to compensate for this. Similarly, a floodplain attenuation factor can be applied to account for the amount of salt attenuated in the floodplain.

  - **Step 5: Conversion to assessment units**
    Outputs from stage 4 are converted to EC impacts at Morgan and $ costs to downstream users with factors derived from MSM-BIGMOD. If the results indicate that that the trade has given rise to a significant effect, then it can be reported to the Commission for possible entry into Register A.

SIMRAT Accreditation Status

The SIMRAT model is an approved model under Schedule C Clause 38(5) of the Murray-Darling Basin Agreement. In June 2004 the Commission approved the SIMRAT model as “fit for purpose” on the basis of recommendations from the Water Trade Salinity Impacts Evaluation Panel (WTSIEP) and Basin Salinity Management Strategy Implementation Working Group (BSMSIWG).

SIMRAT is approved for the assessment of the salinity impacts of new irrigation due to interstate water trade in the Mallee Zone. In particular, the use of the SIMRAT model output is approved as a basis for the adjustment of Register A where no other agreed method exists.

The key conditions applying to the use of SIMRAT are:

- Applications to new irrigation due to interstate water trade in the Mallee Zone
- SIMRAT may be used for the assessment of arrival site debits, and for departure site credits when the history of water use can be proved
- Assessments should be made using best available data for each specific trade, with jurisdictions ensuring best available data is made available for use in SIMRAT data inputs.

Administrative principles for SIMRAT

The use of SIMRAT to adjust Register A must be highly controlled, properly managed and accountable. The following principles apply:

- The Commission will coordinate the use of the model, and ensure that appropriate training and support is provided for model users;
- The model, its default layers and variables will be given controlled document status;
- The Commission will retain a copy of the model, and the default layers and variables including site specific information used for each assessment;
- Estimation of Register A debits will be undertaken by the States in collaboration with the Commission;
- The model will be run at least annually for the purpose of estimating Register A debits for the cumulative impacts of relevant trades in that year;
- The model, default layers and variables will be presented to the Independent Audit Group annually;
- The States will provide basic data needs,being the volume of trade, the spatial location of irrigation development, the relevant default layer metadata and variables including site specific data for each trade;

- The States will provide hydrogeological expertise to advise on the appropriate parameters and adjustments to model runs to ensure applicability or identify limitations of the URE for each trade;

- As with all accountable actions, initial estimates of the salinity impacts of new irrigation development will be based on a number of theoretical assumptions (eg location of irrigated area, root zone drainage rates). Monitoring of *accountable actions* (Protocol 5.4.2) should focus on testing key assumptions, with estimated impacts revised, as appropriate, through the Five Year Reviews (Protocol 5.7.5).

Support processes

The Commission will establish the following support processes:

1. Convening an inter-jurisdictional reference group to oversight the implementation and maintenance of SIMRAT. Terms of reference for the group will include: The review of data layers:
    - The review of assumptions and algorithmic (model) changes
    - Recommendations to BSMSIWG regarding changes to SIMRAT
    - Delivery of revised versions of SIMRAT and/or data layers to jurisdictions
    - Oversight and review of SIMRAT reporting protocols.

2. An interstate trade numbering system to internally track interstate trades and to ensure appropriate coupling of departure side and arrival side impacts.

Appendix 5.1

DETAILED REGIONAL REPORT—OUTLINE

Structure of a typical annual progress report from a State government, based on the 9 intervention themes of the BSMS:

1 Developing capacity to implement the strategy

If applicable, report on activities undertaken to support catchment communities in the implementation of the BSMS.

2 Identifying values and assets at risk

If applicable, report on the identification of important values and assets at risk from salinity, and the nature and timeframe of the risk.

3 Setting salinity targets

Progress towards finalising targets and monitoring regimes

3a Report on *end-of-valley targets*

Measured flow and EC at end-of-valley and intermediate sites

3b Report on within-valley targets

Initially this report should focus on the processes to develop these targets and a timetable of milestones.

4 Managing trade-offs with the available within-valley options

If applicable, report on progress towards establishing within-valley targets, assessment of the predicted impacts and proposed monitoring arrangements for tracking these targets.

5 Implementing salinity and catchment management plans

*If applicable, report on the status of development, accreditation and implementation of regional plans, and apredicti**on** of the impact of works, expressed in terms of EC at Morgan and the relevant end-of-valley site.*

5a Allocation and uptake of salinity disposal entitlements

Expressed in terms of EC at Morgan, clearly state the basis and assumptions for calculating the uptake.

6 Redesigning farming systems

If applicable, report on the type and extent of on-ground works or research projects undertaken.

7 Targeting reforestation and vegetation management

If applicable, report on the area and location of vegetation protected by physical works (such as fencing), the area and location of vegetation protected by covenants (or similar) and the area, location and species of revegetation.

8 Constructing salt interception works

If applicable, report on cost ofworks, completion date and expected salinity benefits.

9 Ensuring basin-wide accountability, monitoring, evaluating and reporting

If applicable, give adescription of the models used in assessing the impact of actions on within-valley, end-of-valley and basin targets; report on the monitoring regimes established, and provide asummary of the results of any evaluations undertaken this financial year that differ from the rolling 5-year audit.

Source: MDBC memorandum to States re annual reports, 24 July 2002.

Appendix 5.2

ATTRIBUTES OF 5-YEAR ROLLING REVIEWS

The attributes and parameters for the quantification of salinity impacts in the rolling audits need to allow for consistent basin-wide assessments without limiting the ability of the States to choose the analytical tools.

The assessments should be made for rational sub-units of each catchment and should refer to current conditions (refer to Baseline and Benchmarks), and for predictions for at least the years 2015, 2050 and 2100. The resulting report should include:

(a) the land area likely to be affected,

(b) the salt mobilised (tonnes per year per unit area or per length of river)

(c) the salt retained in the landscape and/or mobilised to the streams

(d) the stream salinity changes, (EC at target sites)

(e) the ecological thresholds (including endangered species protection),

(f) the implications for key values and assets including cultural heritage aspects

(g) the economic impacts.

The updated audit will be retained in a salinity reporting database which could be based upon land management units, groundwater flow systems or other appropriate geographic units defined by the catchment managers. It could incorporate biophysical parameters such as:

(a) rate of rise or depth to groundwater, groundwater salinity, equilibrium times, predictions of time to reach the surface

(b) areas at risk of waterlogging or salinisation (km 2)

(c) salt wash-off or base flow contributions to streams, (t/km 2, or T/km)

(d) implications for stream salinity and salt loads (EC %iles, and T/year)

(e) agricultural productivity at risk, in both dryland and irrigated regions (Ha , $$)

(f) public and private infrastructure (classes, $$)

(g) terrestrial and aquatic biodiversity (classes, Ha & reaches)

(h) cultural heritage (classes and significance attributes)

Appendices

Appendix 1.1

Basin Salinity Management Strategy (Implementation) Working Group

Terms of Reference (2 February 2005)

Preamble

The *Basin Salinity Management Strategy* (BSMS) provides a guideline for communities and governments to work together to control salinity and protect key natural resource values in the Murray-Darling Basin, and is consistent with the principles of the *Integrated Catchment Management Policy Statement* (ICM). It establishes targets for river salinity of each tributary valley and the Murray-Darling system, reflecting the shared responsibility for actions between valley communities and between States. The BSMS establishes a 15-year strategy within an accountable framework to achieve these targets.

The Strategy **objectives** are to:

- 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
- control the rise in salt loads in all tributary rivers of the Basin and, through that control, protect their water resources and aquatic ecosystems at agreed levels
- control land degradation and protect important terrestrial ecosystems, productive farm land, cultural heritage, and built infrastructure at agreed levels Basin-wide
- maximise net benefits from salinity control across the Basin.

Under the BSMS, the partner Governments are committing to the following nine elements of strategic action, to be implemented over the next 15 years:

- developing capacity to implement the Strategy
- identifying values and assets at risk
- setting salinity targets
- managing trade-offs with the available within-valley options
- implementing salinity and catchment management plans
- redesigning farming systems
- targeting reforestation and vegetation management
- constructing salt interception works

- ensuring Basin-wide accountability: monitoring, evaluating, and reporting.

As part of this action the Commission will manage a comprehensive knowledge generation program, coordinate and enhance further research and development (R&D) on farming and forestry systems, construct and operate salt interception schemes, further develop the vegetation bank concept and establish Basin-wide monitoring, evaluation and reporting arrangements.

The BSMS Implementation Working Group (BSMSIWG) will oversee the monitoring, evaluation and reporting components, essential to ensure accountability under Strategy implementation. The working group will provide the necessary quality assurance and auditing, and will liaise closely with the High-Level inter-jurisdictional Working Group (HiLWG) on salt interception schemes.

General

- Advise on coordinated implementation of all aspects of the Basin Salinity Management Strategy.

- Manage the reporting and accountability arrangements for implementation of the Strategy.

- Advise on revisions to Schedule C of the Murray Darling Basin Agreement to implement the Strategy.

- Advise on the preparation of reports and audits to the Council.

- As an early priority, develop reporting and accountability protocols for consideration and endorsement of the Commission.

End-of-Valley Targets

- In close collaboration with State Agencies, develop and implement reporting arrangements and protocols for assessing progress towards the Basin end-of-valley salinity, salt load and flow targets.
- Advise on the finalisation and modification of end-of-valley targets.
- Establish the modelling framework upon which assessments will be made and advise on the accreditation of models, valley by valley.
- Establish protocols and arrangements for recording the effect of actions (works and measures) in making progress towards each target.

Basin Salinity Target at Morgan

- Establish a reporting arrangement for assessing the cumulative effect of actions contributing to each of the end-of-valley targets towards meeting the Basin salinity target at Morgan.

Joint Works and Measures for Salinity Mitigation

- Recommend standard methods, procedures and protocols for assessment of proposals/works or measures with salinity implications.

Salinity registers

- Establish reporting and accountability arrangements for salinity credits and salinity debits in accordance with Schedule C to the Agreement.
- Advise on the integration of the existing Salinity Drainage Strategy Register into the new Council Registers, and on the operation of the A and B Registers themselves.
- Establish protocols for identifying the value of *salinity credits* and *salinity debits* associated with the cumulative impact of actions within each valley.
- Establish auditing arrangements for items on the Registers.

Modus Operandi

Membership skills

Membership of the Basin Salinity Management Implementation Working Group will consist of senior staff from Contracting Governments having technical or policy development responsibility for salinity management. States may choose two members if this is necessary to cover the representational needs and skills required. Additional expertise can be co-opted as necessary to meet the terms of reference, (including access to short-term consultancy contracts).

Short-term focus

The Basin Salinity Management Strategy Working Group will initially focus on the design, development and trialing of the BSMS reporting arrangements leading to the adoption of assessment and accountability protocols by the Commission. Initially, this will require an intensive effort, involving more frequent meetings, commitments of State resources and the supervision of technical studies.

Strategy operation

In the longer term, as the Strategy becomes operational, the Working Group will advise on coordinated implementation of all aspects of the Strategy, to the Commission. There will be access to Commission technical support and external contract or consultancy skills.

Independent audits

The Basin Salinity Management Strategy will be subject to independent audits which shall be managed elsewhere in the Commission arrangements but will have access to all the data, model results, workings and deliberations of the Working Group.

Executive support

The Commission Office will be responsible for convening the Working Group meetings and providing the executive support including the management of any technical investigations necessary in developing the protocols and interim reporting.

Membership

The members of the group as at December 2005 are:

South Australia
Cole, Phil
Group Manager, Salinity, Strategic Policy Division
DWLBC
Email: cole.phil@saugov.sa.gov.au

Kirk, Judith
Senior Policy Officer Salinity
Department of Water, Land and Biodiversity Conservation
Email: kirk.judith@saugov.sa.gov.au

Victoria
Critchell, Stuart
DSE
Email: Stuart.Critchell@dse.vic.gov.au

Hood, Adam
Landscape Scientist, Land and Catchments, DSE
Email: Adam.Hood@dse.vic.gov.au

New South Wales
Black, Dugald
Manager, Resource Processes
DIPNR
Email: dugald.black@dipnr.nsw.gov.au

Pendlebury, Paul
Manager, Surface and Groundwater Processes
Email: ppendlebury@dipnr.nsw.gov.au

Queensland
Power, Ed
Manager, Catchment and Regional Planning
DNRM
Email: Ed.Power@nrm.qld.gov.au

Australian Government
Smalley, Simon
General Manager, Water Reform
DAFF
Email: simon.smalley@daff.gov.au

Gary Davis (interim)
DAFF

Australian Capital Territory
Chapman, Stewart
ACT MDBC Coordinator
Office of Sustainability
Canberra
Email: stewart.chapman@act.gov.au

Kym Nixon
Office of Sustainability, Canberra
Email: kym.nixon@act.gov.au

Community Advisory Committee
Broster, Leon
Email: lbroster@internode.on.net

Hayden, Rodney
Email: rodhay@iinet.net.au

MDBC
Keyworth, Scott, Chairman
Director, Strategy Implementation
Email: scott.keyworth@mdbc.gov.au

Kendall, Matt, Executive Officer
Salinity Manager, Strategy Implementation
Email: matt.kendall@mdbc.gov.au

Appendix 2.1

APPROVED END-OF-VALLEY SALINITY TARGETS

Valley	Baseline Conditions (1 Jan 2000) Salinity (EC µS/cm)		Salt Load (t/yr)	End-of-Valley Targets (as percentage of Baseline) Salinity (EC µS/cm)		Salt Load (t/yr)	End-of-Valley Targets (as absolute value) Salinity (EC µS/cm)		Salt Load (t/yr)	Valley Reporting Site	AWRC Site Number	Map EoV Site ID
	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean			
All PARTNER GOVERNMENTS												
Murray-Darling Basin	570	920 (95%ile)	1,600,000	110%	87% (95%ile	110%	627	**800^** (95%ile)	1,760,000	Murray R @ Morgan (Salinity) Murray R at Lock 1 (Flow)	426554 426902	96
SOUTH AUSTRALIA												
SA Border	*380*	*470*	*1,300,000*	-	*88%*	-	-	*412*	-	*Flow to SA*	*426200*	*92*
Lock 6 to Berri	450	600	1,500,000	-	91%	-	-	543	-	Murray R @ Lock 4 (Flow) Berri Pumping Station (Salinity)	426514 426537	94
Below Morgan	600	820	1,600,000	-	94%	-	-	770	-	Murray R @ Murray Bridge	426522	98
NEW SOUTH WALES												
Murrumbidgee	150	230	160,000	108%	112%	106%	162	258	169,600	Murrumbidgee R d/s Balranald Weir	410130	58
Lachlan	430	660	250,000	107%	105%	103%	460	693	257,500	Lachlan R @ Forbes (Cottons Weir)	412004	55
Bogan	440	490	27,000	132%	93%	129%	581	456	34,830	Bogan R @ Gongolgon	421023	78
Macquarie	480	610	23,000	105%	122%	112%	504	744	25,760	Macquarie R @ Carinda (Bells Bridge)	421012	77
Castlereagh	350	390	9,000	105%	-	99%	368	-	8,910	Castlereagh R @ Gungalman Bridge	420020	76
Namoi	440	650	110,000	108%	110%	116%	475	715	127,600	Namoi R @ Goangra	419026	75
Gwydir	400	540	7,000	103%	101%	100%	412	545	7,000	Mehi R @ Bronte	418058	74
NSW Border Rivers	250	330	50,000	100%	100%	100%	250	330	50,000	Macintyre R @ Mungindi	416001	70
Barwon-Darling	*330*	*440*	*440,000*	*118%*	*103%*	*131%*	*389*	*453*	*576,400*	*Darling R @t Wilcannia Main Channel*	*425008*	*90*
NSW Upper Murray	*54*	*59*	*150,000*	-	-	-	-	-	-	*Murray R @ Heywoods*	*409016*	*10*
NSW Riverine Plains	*310*	*390*	*1,100,000*	-	-	-	-	-	-	*Murray R @t Redcliffs*	*414204*	*60*
NSW Mallee Zone	*380*	*470*	*1,300,000*	-	-	-	-	-	-	*Flow to SA*	*426200*	*92*
VICTORIA												
Wimmera	1,380	1,720	31,000	100%	100%	100%	1,380	1,720	31,000	Wimmera R @ Horsham Weir	415200	34
Avoca	2,060	5,290	37,000	102%	-	-	2,096	-	-	Avoca R @ Quambatook	408203	32
Loddon	750	1,090	88,000	95%	-	-	711	-	-	Loddon R @ Laanecoorie	407203	24
Campaspe	530	670	54,000	78%	-	-	412	-	-	Campaspe R @ Campaspe Weir	406218	22
Goulburn	100	152	166,000	99%	-	-	99	-	-	Goulburn R @ Goulburn Weir	405259	18
Broken	100	130	15,000	141%	-	-	141	-	-	Broken Ck @ Casey's Weir	404217	16
Ovens	72	100	54,000	100%	100%	101%	72	100	54,540	Ovens R @ Peechelba-East	403241	14
Kiewa	47	55	19,000	100%	100%	100%	47	55	19,000	Kiewa R @ Bandiana	402205	12
Vic Upper Murray	*54*	*59*	*150,000*	-	-	-	-	-	-	*Murray R @ Heywoods*	*409016*	*10*
Vic Riverine Plains	*270*	*380*	*630,000*	-	-	-	-	-	-	*Murray R @ Swan Hill*	*409204*	*30*
Vic Mallee Zone	*380*	*470*	*1,300,000*	-	-	-	*+15EEC*	-	-	*Flow to SA*	*426200*	*92*
QUEENSLAND												
Qld Border Rivers	250	330	50,000	100%	100%	100%	250	330	50,000	Barwon R @ Mungindi#	416001#	70
Moonie	140	150	8,700	100%	100%	100%	140	150	8,700	Moonie R @ Fenton	417204A	71
Condamine-Balonne	170	210	4,200	100%	100%	100%	170	210	4,200	Ballandool R @ Hebel-Bollon Rd	422207A	83
	170	210	5,000	100%	100%	100%	170	210	5,000	Bohkara R @ Hebel	422209A	82
	150	280	6,500	100%	100%	100%	150	280	6,500	Braire Ck @ Woolerbilla-Hebel Rd	422211A	84
	170	210	29,000	100%	100%	100%	170	210	29,000	Culgoa R @ Brenda #	422015 #	85
	160	210	10,000	100%	100%	100%	160	210	10,000	Narran R @ New Angeldool #	422030#	81
Paroo	90	100	24,000	100%	100%	100%	90	100	24,000	Paroo R @ Caiwarro	424201A	88
Warrego	101	110	4,800	100%	100%	100%	101	110	4,800	Warrego R @ Barringun No.2 #	423004 #	86
	100	130	5,500	100%	100%	100%	100	130	5,500	Cuttaburra Ck @ Turra #	423005 #	87
AUSTRALIAN CAPITAL TERRITORY												
ACT	tba	tba	tba	tba	tba	tba	tba	tba	tba	Murrumbidgee R at Hall's Crossing	410777	52

Notes
^ 95th percentile target
# - These sites are operated by New South Wales on behalf of Queensland.

NOTES

New South Wales Targets as advised in letter from Peter Sutherland to Don Blackmore dated 17 February 2004.

Queensland Targets as advised in letter from Terry Hogan to Don Blackmore dated 3 March 2004.

South Australian targets as advised in SA River Murray Salinity Strategy (August 2001) (P.Cole pers comm 10/5/04)

Victorian targets as advised in letter from Sue Jaquinot to Wendy Craik received 10 August 2005

ACT has advised that its target is interim and when finalised will be based on net salt balance for the ACT (P.Donnelly per comm 21/4/04)

Appendix 2.2

HYDRAULIC CONDITIONS FOR AN IDEAL GAUGE SITE FOR DETERMINING STREAM FLOW

1. The general course of the stream is straight for about 100 m upstream and downstream of the gauge site.
2. The total flow is confined to one channel at all stages, and no flow bypasses the site as subsurface flow.
3. The stream bed is not subject to scour and fill and is free from aquatic growth.
4. Banks are permanent, high enough to contain floods, and free of brush.
5. Unchanging natural controls are present in the form of bedrock outcrop or other stable riffle for low flows and a channel constriction for high flows or a falls or cascade that are submerged at all times.
6. A pool is present upstream from the control site at extremely low stages to ensure recording at low flow.
7. The gauging site is far enough upstream from a confluence with another stream or from tidal effect to avoid any variable influence at the site.
8. A satisfactory reach for measuring discharge at all stages is available within reasonable proximity of the gauge site.
9. The site is readily accessible for installation and operation.
10. The site is not susceptible to man-made disturbances, nearby tributaries or point discharges.

The above conditions for river flow are seldom fully realised in natural streams, particularly the low gradient streams of the central to western Murray-Darling Basin that have highly variable flows and very large floodplains.

Acknowledgement: Taken from Rantz, S.E. et al. (1982). Measurement and computation of stream flow: Volume 1: Measurement of stage and discharge. US Geological Survey Water Supply Paper 2175, US Government Printing Office.

Appendix 2.3

RECOMMENDED MINIMUM STANDARDS AND PROTOCOLS TO BE ADOPTED FOR END-OF-VALLEY SALINITY MONITORING GAUGING STATIONS

Level information shall be collected to better than ± 10mm.

EC readings shall be collected to better than ± 10% of reading.

EC reading shall be obtained at each visit via calibrated portable sensors or grab sample analysed by traceably calibrated instrument for the purpose of verifying recorded data.

Recorded EC data is presented as EC compensated to 25°C (ensure portable field unit is compensated or calculate compensated reading).

Portable EC sensors (such as Horiba or WTW) shall be calibrated over the full range at least once every two years and a two-point reference check spanning the expected EC range conducted before use.

All level and EC sensors shall be calibrated over their full range at least once every two years. Pressure sensors shall be calibrated using a traceable pressure calibrator.

All equipment calibrations shall be documented and traceable to a national standard. This includes, but is not limited to:

- EC sensors
- level sensors
- portable water quality instruments
- reference instruments
- current meters
- survey equipment.

Gauge boards shall be maintained at ±3mm for the 80 percentile of flows.

Inspection of gauge plate levels shall be undertaken annually and after each high flow event.

Data shall be downloaded at least weekly via telemetry where available.

EC sensors shall be cleaned at each station visit.

95% data capture shall be maintained for each parameter at each site.

Operational telemetry shall be installed at each site (if possible) to assist in data capture rates.

EC and temperature shall be recorded at each site.

A minimum of 6 gaugings shall be taken per annum (this number will be highly variable as some sites will require more).

Quality coded rating tables shall be developed to cover the full range of recorded flows.

Verified data shall be delivered quarterly to MDBC in a yet to be advised web-based format. The minimum data requirement is time series level, flow and EC. Delivered data shall be no more than 6 months old.

Each site shall be visited at least once every 8 weeks.

EC readings delivered shall be temperature corrected to 25°C.

All provided data shall be appropriately quality coded (any changes to suppliers' quality coding system shall be advised to MDBC).

EC profiling shall be taken at each EC recording cross section at low medium and high flows.

EC profiling shall be undertaken along a stream before the selection of any new sites to determine the most appropriate cross-section for EC measurement.

Flow measurement shall be undertaken in accordance with the appropriate sections of AS3778.

Quarterly performance report shall be provided with each data delivery showing:

- number of gaugings taken
- loss of record
- percentage of data provided in each quality code band
- instrument calibration status
- rating table status
- list of tasks undertaken in past quarter
- results of EC profiling taken at each site.

Source: Hydrographic Review – End of Valley Monitoring Network. Ecowise Environmental Pty Ltd, August 2002.

Appendix 2.4

Basin Salinity Management Strategy – End of Valley Summary Report Card - *Example*

Valley	2015 Target[1] (% of 2000 Benchmark Conditions)			Valley Reporting Site	Assessed Baseline Conditions – 1/1/2000	"Do Nothing" Legacy of History Impact – 2015 Effect	Agreed 2015 Target	Progress Given Actions To-Date				Current year Effect at Morgan (Equivalent EC)	
								Current Year	2015 Outlook	2050 Outlook	2100 Outlook	Morgan "A" Items	Morgan "B" Items
	Salinity		Salt load	*(Shared resource sites shown in italics)*	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	End of Valley: Flow, Salinity, Salt Load	Morgan: Flow, Salinity, Salt Load	Morgan: Flow, Salinity, Salt Load
South Australia	Median	95%ile	Average										
Lock 6 to Morgan	**tba**	**tba**	**110%**	*Murray at Morgan*									
Below Morgan	**tba**	**tba**	**tba**	Murray at Murray Bridge									
NSW	Median	80%ile	Average										
Murrumbidgee	**108%**	**112%**	**107%**	Murrumbidgee at Balranald									
Lachlan	**108%**	**106%**	**103%**	Lachlan at Forbes									
Bogan	**137%**	**93%**	**133%**	Bogan at Gongolgon									
Macquarie	**108%**	**126%**	**114%**	Macquarie at Carinda									
Castlereagh	**105%**	**99%**	**100%**	Castlereagh at EoV									
Namoi	**108%**	**110%**	**116%**	Namoi at Goangra									
Gwydir	**103%**	**101%**	**100%**	Gwydir at Collarenebri									
NSW Border Rivers	**100%**	**100%**	**100%**	*Barwon at Mungindi*									
NSW Upper Murray	**tba**	**tba**	**tba**	*Murray at Heywoods*									
Barwon-Darling				*Darling at Wilcannia*									
NSW Riverine Plains				*Murray at Redcliffs*									
NSW Mallee Zone				*Murray at Lock 6*									
Victoria	Median	80%ile	Average										
Wimmera	**tba**	**tba**	**tba**	Wimmera at Horsham Weir									
Avoca	**102%**	**102%**	**102%**	Avoca at Quambatook									
Loddon	**103%**	**101%**	**101%**	Loddon at Laanecoorie									
Campaspe	**101%**	**101%**	**101%**	Campaspe at Pumps									
Goulburn	**100%**	**100%**	**100%**	Goulburn at Goulburn Weir									
Broken	**136%**	**136%**	**136%**	Broken at Casey's Weir									
Ovens	**100%**	**tba**	**101%**	Ovens at Peechelba East									
Kiewa	**100%**	**tba**	**100%**	Kiewa at Bandiana									
Vic Upper Murray	**tba**	**tba**	**tba**	*Murray at Heywoods*									
Vic Riverine Plains				*Murray at Swan Hill*									
Vic Mallee Zone				*Murray at Lock 6*									
Queensland	Median	80%ile	Average										
Qld Border Rivers:	**tba**	**tba**	**tba**	*Barwon at Mungindi*									
Moonie	**tba**	**tba**	**tba**	Moonie at Fenton									
Condamine Balonne	**tba**	**tba**	**tba**	Culgoa at Hastings									
Warrego	**tba**	**tba**	**tba**	Warrego at Cunnamulla									
Paroo	**tba**	**tba**	**tba**	Paroo at Caiwarro									
ACT	Median	80%ile	Average										
ACT				*Murrumbidgee at Hall's Crossing*									

Appendix 2.5

MODEL PURPOSES AND CLASSIFICATION GUIDE

PURPOSE OF MODEL	DESCRIPTION	Specific model characteristics required
1. Enhance Understanding • flow and salinity characteristics • flow and salinity processes • the influence of catchment characteristics and climate on flows and salinities *(Refer Clauses 4, 6, 8, 16–25, 27–32 & 35–37 of Schedule C of the M-DB Agreement).*	To enhance the understanding of the flow and salinity characteristics and processes within the surface water systems of a valley. Models allow gaps in flow and salinity records to be filled in, and data records extended. By testing hypotheses of the flow/salinity transport processes, it is possible to determine the dominant physical processes. When the dominant processes have been identified, the manner in which the system will respond to changes imposed on it can be more accurately predicted.	• process-based models are preferred • replication of recorded historical behaviour of flow and salinity establishes confidence in model predictions • complex hydrological data associated with models must be presented in easy-to-understand formats • ability to test 'what if' scenarios.
2. *Estimate Flow and Salinity Values* • to prepare baseline conditions at the end-of-valley target site • estimate absolute values of flow and salinity at other locations, under other catchment conditions and under other climatic conditions. *(Refer Clauses 5–8, 26, 29–32 & 35–37 of Schedule C of the M-DB Agreement).*	The States and the MDBC must model the daily salinity, salt load and flow at each end-of-valley target site under the baseline conditions over the *benchmark period*. The median and 80 percentile salinities, as well as the average salt load need to be determined at the target site. (For the MDBC, the target site is Morgan and the 95 percentile salinity is required in lieu of the 80 percentile). To assist in fulfilling the requirements of Schedule C, predictions of flow and salinity at locations other than the target site, and under conditions other than *baseline*, will often be required.	• ability to represent not only the mean flows and salinities but also the variations likely to be experienced over the climatic conditions represented by the *benchmark period* • capability to simulate baseline conditions (i.e. Year 2000) • simulation of accurate flow and salinity estimates at the target site • estimates at other locations may also be needed • ability to test how various works and measures would meet agreed targets

PURPOSE OF MODEL	DESCRIPTION	Specific model characteristics required
3. Estimate Changes in Flow and Salinity Values • to assess the impacts of *actions* including the no-intervention scenario • to provide for the establishment and updating of *Registers A* and *B*. *(Refer Clauses 6, 10, 11, 15, 16, 29–32 & 35–37 of Schedule C of the M-DB Agreement).*	Each State must develop models capable of predicting the flow and salinity effects of all *accountable actions* and any delayed salinity impacts. In addition, the Commission's model must also be capable of predicting the salinity impacts at Morgan. The Commission will also establish and maintain *RegistersA* and *B* based on the results of its model and the various valley models operated by the States. Whilst there may be considerable uncertainty with the model predictions of absolute salinities, a higher accuracy usually results when the models predict the relative salinities (eg. the change in salinity resulting from *accountable actions* or delayed salinity impacts).	• ability to simulate the relevant salt generation and salt transport processes relating to *accountable actions* and the no-intervention scenario. • where not all of these processes are simulated internally, the model must be capable of interfacing with other land-use, groundwater or catchment models that can simulate these processes. • ability to generate salinities with sufficient accuracy and rigour to engender confidence in *Registers A* and *B* that are established and maintained using the model results
4. Integrate With Upstream and Downstream Models in the Basin • to allow flows and salinities generated by upstream models to be included • to simulate the flow and salinity contributions to downstream valleys. *(Refer Clauses 7, 10, 11, 15, 16, 29–32 & 35–37 of Schedule C of the M-DB Agreement).*	It would be impractical to establish a single model for the whole basin that could incorporate all the tributary systems and all the salt generation and transport processes. A variety of models have been developed in different geographical areas and for different salinity management purposes. Where processes and management strategies span model boundaries, integration of models is essential if a basin-wide understanding and management of salinity is to be achieved.	• as well as predicting flow and salinity at the end-of-valley target site (which is rarely located at a valley outlet), models must be capable of predicting the flow and salinity at the valley outlet (or at the boundary with the next most downstream model) • similarly the model must have the ability to integrate flows and salinities from upstream models.

Notes: The table indicates the typical characteristics of each class of models, and the appropriate uses of the model. Use as a guide only.

CLASSIFICATION GUIDE

MODEL CLASS	TYPICAL MODEL CHARACTERISTICS AND DATA ENVIRONMENT			USE OF MODEL FOR SCHEDULE C PURPOSES			
	Availability of Flow and Salinity Data. Understanding of Salt Processes	**Flow and Salt Inputs from Upstream Models**	**Uncertainty in Model Results**	**Enhance Understanding of Data and Processes 1**	***Baseline Conditions* and Target Compliance 2**	**Maintaining *Registers* and Assessing the Impacts of Actions 3**	**Integration with Other Models 4**
CLASS 1	Data rich with typically at least 20 years**5** of flow and salinity records and a range of climatic variability typical of the *benchmark period*. Valley processes well understood. Model is process-based and verified against observed data.	Majority of modelled flow and salt inputs are from Class 1 models	Uncertainty in key model outputs quantified and found to be acceptable.	Reproduces all flow/salt characteristics and processes competently. Valuable aid to enhance understanding.	High confidence established in the means and statistical variability of the baseline conditions generated by the model.	Model can be confidently used to maintain *registers* and to predict the impacts of *actions* in the valley.	The high confidence in the model outputs at the outlet will reduce uncertainty in the downstream model's predictions.
CLASS 2	Extensive flow data and sufficient salinity data to define salinity characteristics at key valley locations for about 5 to 15 years**5** with a limited range of climatic conditions. Flow processes are well understood, but not all salinity processes. Some salinity components of model are empirical or based on processes from other valley models with limited verification to observed data.	Majority of modelled flow and salt inputs are from Class 2 models	Uncertainty not quantified. Sensitivity of key model parameters investigated. Qualitative description of potential sources of model uncertainty provided.	Simulates most characteristics and processes. Valuable aid to enhance understanding subject to known limitations of model. Use to enhance understanding and identify further data collection and model development.	High confidence established in the means and lesser confidence in the statistical variability of the *baseline conditions*. Percentile salinity values are published and used tentatively for the BSMS subject to on-going review every few years as more data becomes available.	Model likely to predict salinity changes more accurately than absolute values. Where entries need to be made on the *registers* or average EC changes need to be simulated, model results can be used with some confidence. Revision may be necessary every 3-5 years as more data becomes available.	The medium confidence in the model outputs at the outlet may reduce or increase uncertainty in the downstream model's predictions.

MODEL CLASS	TYPICAL MODEL CHARACTERISTICS AND DATA ENVIRONMENT			USE OF MODEL FOR SCHEDULE C PURPOSES			
	Availability of Flow and Salinity Data. Understanding of Salt Processes	**Flow and Salt Inputs from Upstream Models**	**Uncertainty in Model Results**	**Enhance Understanding of Data and Processes 1**	***Baseline Conditions* and Target Compliance 2**	**Maintaining *Registers* and Assessing the Impacts of Actions 3**	**Integration with Other Models 4**
CLASS 3	Data very limited, particularly salinity, with typically less than 5 years[5] of record. Climatic conditions over the recorded data period are not representative of variability in the *benchmark period*. Valley processes poorly understood. Salinity components of model are assumed/empirical or based on processes from other valley models.	Majority of modelled flow and salt inputs are from Class 3 models	Not quantified. Only a qualitative description of potential sources of uncertainty can be provided.	Low confidence in many of the key flow/salt characteristics and processes simulated by the model. Use cautiously to enhance understanding and identify further data collection and model development.	Little confidence in the statistical variability of the *baseline conditions*. Only possible to publish a typical range of salinity values not percentile values. Some confidence that the mean salt load is of the right order.	Model likely to predict salinity changes more accurately than absolute values. Where entries need to be made on the *registers* or average EC changes need to be simulated, model results tentatively used subject to on-going review every 1–2 years as more data becomes available.	The low confidence in the model outputs at the outlet will increase uncertainty in the downstream model's predictions.

Appendix 3.1

The Benchmark Period

Definition

As used in the BSMS, the 'Benchmark period' defines a climatic sequence that is used consistently in models to predict the effects of various combinations of actions at specified times. The period initially selected was from 1 May 1975 to 30 April 2000. Schedule C, Clause 2 authorises the Commission from time to time to determine a modified period.

The benchmark period will be reviewed from time, in the light of the best available data, in order to keep it as hydrologically representative as possible. The present intention is to review it in conjunction with the review of the operation of Schedule C itself, to be undertaken in 2007 and every 7 years thereafter.

Background

The climate of the Murray-Darling Basin, as for most of Australia, is highly variable. In fact on a global scale, Australia (together with South Africa) experiences higher runoff variability than any other continental area (McMahon et al. 1992). These variations in rainfall and evaporation have a significant influence on the dynamics of river flow and salinity (see Figure 3.1).

In order to assess the current and future salinity and flow behaviour of the landscapes and rivers within the Murray-Darling Basin, it is necessary to consider an appropriate range of climatic events (wet, dry and average years). To do this the Murray-Darling Basin Ministerial Council has agreed to standardise the climate sequences used for input into these assessments through the use of a *benchmark period*.

The *benchmark period* is the 25-year period from 1 May 1975 to 30 April 2000. This period was chosen because it adequately covers the typical range of climate variability that can be expected both now and in the future, and for which there are both stream flow and salinity records for the major rivers in the basin.

To illustrate the range of wet, dry and average years during the *benchmark period* the historical rainfall and evaporation from Hume Reservoir is shown in Figure 3.1. The response of the landscape and rivers of the Murray-Darling Basin to the *benchmark period* climatic events can be seen in the graphs of flow and salinity for the River Murray at Morgan.

It is recognised that more extreme climate events than those recorded during the *benchmark period* may be observed in the future. While it would be preferable to use 100 or more years to define the *benchmark period*, the available salinity data (and flow data to a lesser extent) within the Murray-Darling Basin is limited. Thus the 25 years with relatively good records has been selected as an appropriate compromise. The *benchmark period* may be reviewed or extended in future if deemed appropriate by the Commission.

In addition it is recognised that other factors such as climate change may affect climate variability in future. While climate change and other factors are not currently accounted for in the use of the benchmark period, these issues may require further consideration in the longer-term assessment of catchment and river response to future climate variability.

Through the use of the *benchmark period*, flow and salinity models (refer Appendix 3.3) can be established to estimate the range of salinity and flow response due to catchment and river scenarios including the baseline conditions (see Appendix 3.2) and future scenarios (‘no further intervention’, or the implementation of a program of actions) for various years including 2015, 2050 and 2100.

Use of the *benchmark period*

The use of the *benchmark period* is tied directly to the definition of the basin salinity target (Schedule C, Clause 7). This is because:

- The biggest influence on the variability of flows, salinities and salt loads in the rivers of the Murray-Darling Basin is climate variability (i.e. periods of floods, droughts, intermediate conditions, and their sequencing).

- Due to climate variability effects, data on flows, salinities and salt loads recorded over periods such as one year will not be directly useful in determining whether a target expressed in terms of a percentage probability of non-exceedance over the long term is being met or not. This applies equally to the basin salinity target and to end-of-valley targets. The minimum period of record that is likely to be directly useful for this purpose is about 20 years.

- As we cannot afford to wait for 20 years to ascertain whether we have achieved (or preserved) a target or not, we use a combination of modelling and monitoring to enable progress to be checked much earlier and at more frequent intervals.

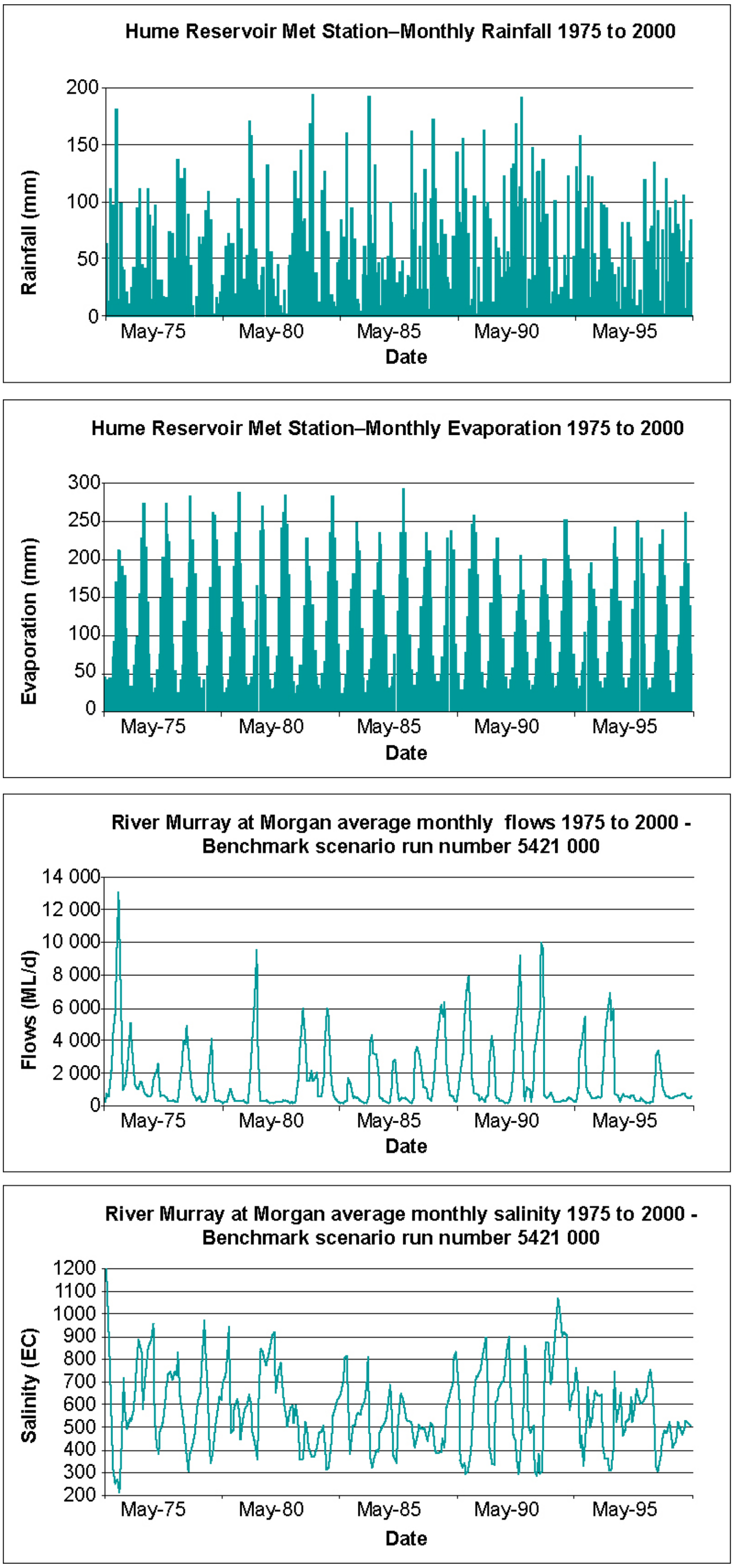
- Therefore, Clause 7(2) refers to the use of models, and the observed data collected over time can be used to progressively refine these models.

- The *benchmark period* is important because, by using data from this period as input to all the models used across the basin, we can evaluate all actions and whether we have achieved targets or not, on a consistent basis as far as climate variability effects are concerned.

- This eliminates the biggest influence on variability of flows, salinities and salt loads, which would otherwise completely confuse all our assessments and make comparisons meaningless.

- If the *benchmark period* changes then our assessment of whether we are achieving targets or not may also change, and the targets themselves may change as well.

Figure 3.1
BSMS "*benchmark period*" - 1 May 1975 to 30 April 2000 (example only of climate and hydrological sequence)



Appendix 3.2

Defining the *Baseline Conditions*

Context

Schedule C, Clause 5 establishes the process for determining the baseline conditions contributing to the movement of salt through land and water upstream of all end-of-valley target sites and the Basin Salinity Target site at Morgan, but does not refer to the *baseline conditions* defined in Clause 2 of Schedule F of the Agreement (Cap on Diversions).

Each State Contracting Government must, by 31 March 2004, prepare and give to the Commission estimated *baseline conditions* relating to the salinity, salt load and flow regime at each site at which it proposes to measure that government's achievement of an *end-of-valley target* (if adopted) for the portion of the Murray-Darling Basin within that State, as at 1 January 2000.

The Commission must, by 31 March 2003, prepare estimated *baseline conditions* relating to the salinity, salt load and flow regime at the Basin Salinity Target site at Morgan, as at 1 January 2000.

Background

The accountability arrangements of the Basin Salinity Management Strategy (BSMS) rely on the definition and adoption of agreed *baseline conditions* across the Murray-Darling Basin.

An accurate definition of the *baseline conditions* is critical as end-of-valley salinity and salt load targets (Schedule C, Appendix 1) are expressed as a percentage of the *baseline conditions* and the delayed salinity impacts for which all partner governments are jointly accountable are calculated as the salinity impact which occurs after the baseline conditions date of 1 January 2000.

In the case of the Basin Salinity Target site at Morgan and most of the Tributary Valleys for which there is an *end-of-valley target* site, flow and salinity models (see Appendix 3.3) are being used to assist in defining the *baseline condition*s and also to provide a basis for analysing the impacts of actions.

For the purposes of the BSMS the *baseline conditions* are defined as the agreed suite of conditions in place within the catchments and rivers on 1 January 2000 for:

- land use (level of development of the landscape)
- water use (level of diversions from the rivers)
- land and water management policies and practices (including the Murray-Darling Basin Cap agreements and any subsequent flow management agreements)
- river operating regimes
- salt interception schemes
- run-off generation and salt mobilisation processes
- groundwater status and condition.

The salinity, salt load and flow regime and the conditions within the catchments and rivers should be recorded as thoroughly as practicable within the documentation supporting the hydrologic modelling studies. The relationship between the above conditions and the salinity, salt load and flow regime at the basin salinity target site is established by modelling, using the benchmark period climatic sequence (see Table 1).

The process for the establishment of the *baseline conditions* is summarised in Figure 1. Although the Commission has agreed that the *baseline conditions* for the River Murray tributaries will not be finalised until March 2004, an interim set of *baseline conditions* for the River Murray at Morgan has been defined (Table 1 and Figure 2). Table 1 also shows the historical flow, salinity and salt loads for Morgan and the various *end-of-valley target* sites.

Figure 1
Process for approving the BSMS *baseline conditions*

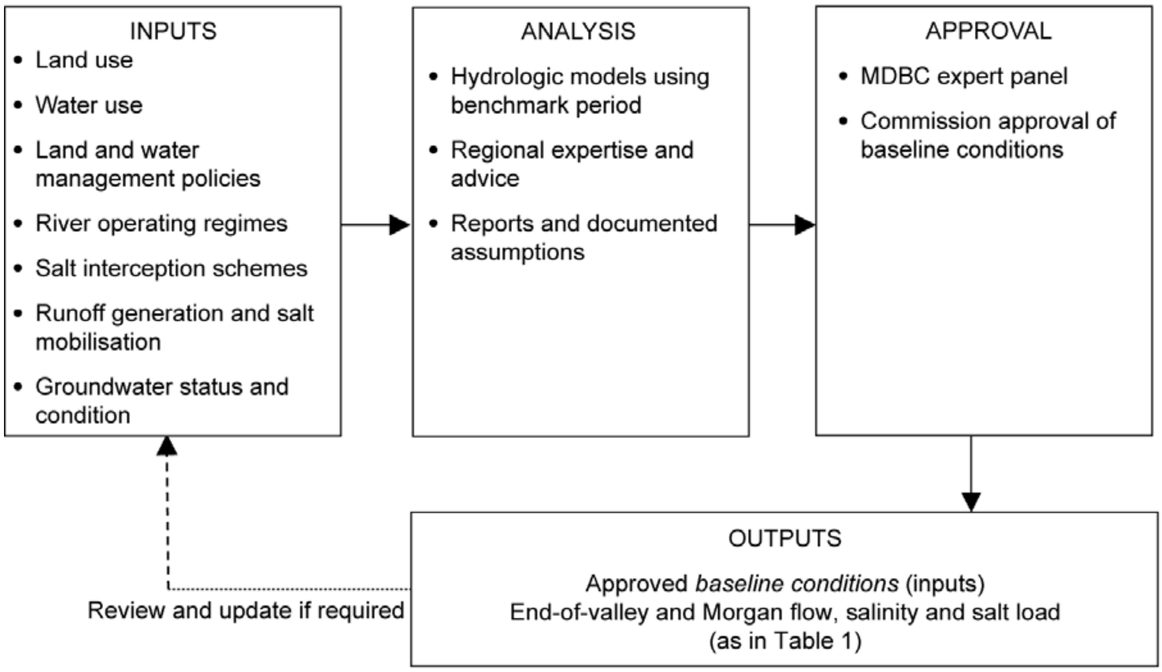


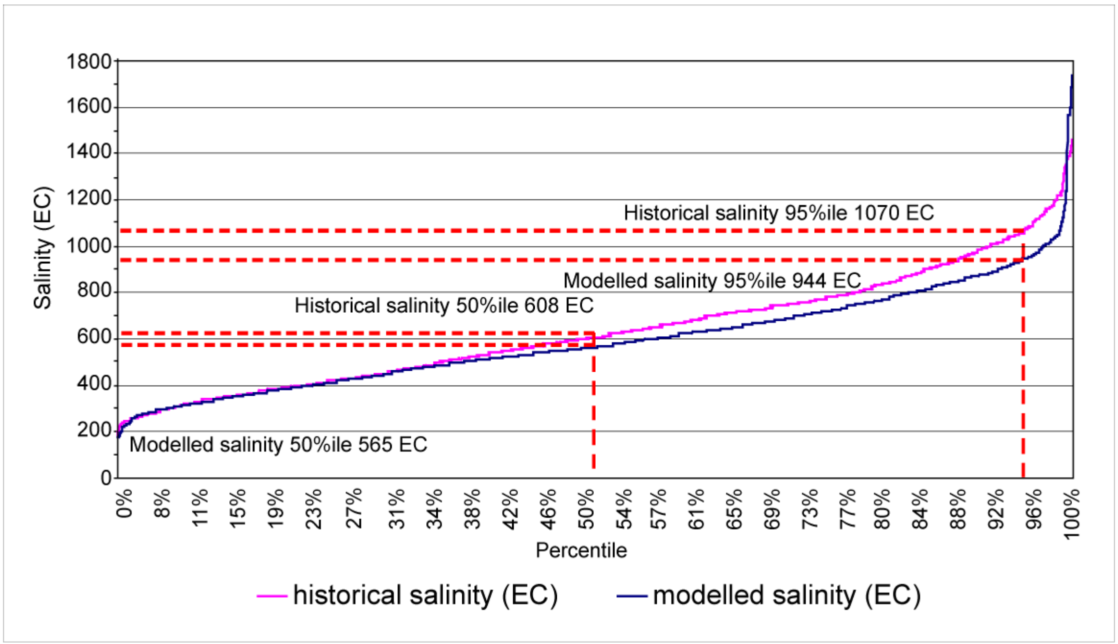
Table 1
Approved baseline conditions for salinity at end-of-valley and basin target sites

Valley	Baseline Conditions (1 Jan 2000)			End-of-Valley Targets (as percentage of Baseline)			End-of-Valley Targets (as absolute value)			Valley Reporting Site	AWRC Site Number	Map EoV Site ID
	Salinity (EC µS/cm)		Salt Load (t/yr)	Salinity (EC µS/cm)		Salt Load (t/yr)	Salinity (EC µS/cm)		Salt Load (t/yr)			
	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean	Median (50%ile)	Peak (80%ile)	Mean			
All PARTNER GOVERNMENTS												
Murray-Darling Basin	570	920 (95%ile)	1,600,000	110%	87% (95%ile	110%	627	**800^** (95%ile)	1,760,000	Murray R @ Morgan (Salinity) Murray R at Lock 1 (Flow)	426554 426902	96
SOUTH AUSTRALIA												
SA Border	380	470	1,300,000	-	88%	-	-	412	-	*Flow to SA*	*426200*	*92*
Lock 6 to Berri	450	600	1,500,000	-	91%	-	-	543	-	Murray R @ Lock 4 (Flow) Berri Pumping Station (Salinity)	426514 426537	94
Below Morgan	600	820	1,600,000	-	94%	-	-	770	-	Murray R @ Murray Bridge	426522	98
NEW SOUTH WALES												
Murrumbidgee	150	230	160,000	108%	112%	106%	162	258	169,600	Murrumbidgee R d/s Balranald Weir	410130	58
Lachlan	430	660	250,000	107%	105%	103%	460	693	257,500	Lachlan R @ Forbes (Cottons Weir)	412004	55
Bogan	440	490	27,000	132%	93%	129%	581	456	34,830	Bogan R @ Gongolgon	421023	78
Macquarie	480	610	23,000	105%	122%	112%	504	744	25,760	Macquarie R @ Carinda (Bells Bridge)	421012	77
Castlereagh	350	390	9,000	105%	-	99%	368	-	8,910	Castlereagh R @ Gungalman Bridge	420020	76
Namoi	440	650	110,000	108%	110%	116%	475	715	127,600	Namoi R @ Goangra	419026	75
Gwydir	400	540	7,000	103%	101%	100%	412	545	7,000	Mehi R @ Bronte	418058	74
NSW Border Rivers	250	330	50,000	100%	100%	100%	250	330	50,000	Macintyre R @ Mungindi	416001	70
Barwon-Darling	*330*	*440*	*440,000*	*118%*	*103%*	*131%*	*389*	*453*	*576,400*	*Darling R @t Wilcannia Main Channel*	*425008*	*90*
NSW Upper Murray	*54*	*59*	*150,000*	-	-	-	-	-	-	*Murray R @ Heywoods*	*409016*	*10*
NSW Riverine Plains	*310*	*390*	*1,100,000*	-	-	-	-	-	-	*Murray R @t Redcliffs*	*414204*	*60*
NSW Mallee Zone	*380*	*470*	*1,300,000*	-	-	-	-	-	-	*Flow to SA*	*426200*	*92*
VICTORIA												
Wimmera	1,380	1,720	31,000	100%	100%	100%	1,380	1,720	31,000	Wimmera R @ Horsham Weir	415200	34
Avoca	2,060	5,290	37,000	102%	-	-	2,096	-	-	Avoca R @ Quambatook	408203	32
Loddon	750	1,090	88,000	95%	-	-	711	-	-	Loddon R @ Laanecoorie	407203	24
Campaspe	530	670	54,000	78%	-	-	412	-	-	Campaspe R @ Campaspe Weir	406218	22
Goulburn	100	152	166,000	99%	-	-	99	-	-	Goulburn R @ Goulburn Weir	405259	18
Broken	100	130	15,000	141%	-	-	141	-	-	Broken Ck @ Casey's Weir	404217	16
Ovens	72	100	54,000	100%	100%	101%	72	100	54,540	Ovens R @ Peechelba-East	403241	14
Kiewa	47	55	19,000	100%	100%	100%	47	55	19,000	Kiewa R @ Bandiana	402205	12
Vic Upper Murray	*54*	*59*	*150,000*	-	-	-	-	-	-	*Murray R @ Heywoods*	*409016*	*10*
Vic Riverine Plains	*270*	*380*	*630,000*	-	-	-	-	-	-	*Murray R @ Swan Hill*	*409204*	*30*
Vic Mallee Zone	*380*	*470*	*1,300,000*	-	-	-	*+15EEC*	-	-	*Flow to SA*	*426200*	*92*
QUEENSLAND												
Qld Border Rivers	250	330	50,000	100%	100%	100%	250	330	50,000	Barwon R @ Mungindi#	416001#	70
Moonie	140	150	8,700	100%	100%	100%	140	150	8,700	Moonie R @ Fenton	417204A	71
Condamine-Balonne	170	210	4,200	100%	100%	100%	170	210	4,200	Ballandool R @ Hebel-Bollon Rd	422207A	83
	170	210	5,000	100%	100%	100%	170	210	5,000	Bohkara R @ Hebel	422209A	82
	150	280	6,500	100%	100%	100%	150	280	6,500	Braire Ck @ Woolerbilla-Hebel Rd	422211A	84
	170	210	29,000	100%	100%	100%	170	210	29,000	Culgoa R @ Brenda #	422015 #	85
	160	210	10,000	100%	100%	100%	160	210	10,000	Narran R @ New Angeldool #	422030#	81
Paroo	90	100	24,000	100%	100%	100%	90	100	24,000	Paroo R @ Caiwarro	424201A	88
Warrego	101	110	4,800	100%	100%	100%	101	110	4,800	Warrego R @ Barringun No.2 #	423004 #	86
	100	130	5,500	100%	100%	100%	100	130	5,500	Cuttaburra Ck @ Turra #	423005 #	87
AUSTRALIAN CAPITAL TERRITORY												
ACT	tba	tba	tba	tba	tba	tba	tba	tba	tba	Murrumbidgee R at Hall's Crossing	410777	52

Notes
^ 95th percentile target
# - These sites are operated by New South Wales on behalf of Queensland.

Figure 2
Interim *baseline conditions* for the River Murray at Morgan (based on the MSM-BIGMOD). Historical salinity is also shown.

Modelled and historical salinity at Morgan from 1 May 1975 to 30 April 2000—Modelled data from MSM-BIGMOD run number 5684000



Appendix 3.3

Flow and Salinity Models

Context

The framework for the development of models for the River Murray and its tributaries is given in Schedule C, clauses 36 and 37.

Commission models

Using the benchmark period, the Commission is required to develop one or more models to simulate the salinity, salt load and flow regime, each on a daily basis, and the economic effects on water users of the simulated salinity, salt load and flow regime in the Upper River Murray and the River Murray in South Australia.

These models must be capable of predicting any salinity impacts of *joint works and measures* and *state actions* as well as any delayed salinity impacts, at Morgan and such other relevant locations as the Commission may determine. The Commission may alter these models from time to time.

State models

State Contracting Governments are required to develop one or more models to simulate, under baseline conditions, the daily salinity, salt load and flow regime, over the *benchmark period*, at each site at which compliance with an end-of-valley target is to be measured.

A model developed by a State Contracting Government must be capable of predicting the effect of all accountable actions undertaken in the State, and of any delayed salinity impacts, on the salinity, salt load and flow regime at each site at which compliance with an end-of-valley target is to be measured in each of 2015, 2050, 2100, and in such other years as the Commission may determine. A State Contracting Government may alter the model from time to time.

Background

As specified in Schedule C, the Commission and its partner governments are developing a suite of hydrologic models for the River Murray and its tributary rivers which will assist in the establishment of the *baseline conditions* and the analysis of salinity intervention actions against a no-further-intervention scenario. The specific objectives for the models include the following tasks:

- the establishment of the agreed *baseline conditions* by
    - supplementing or infilling missing historic flow and salinity data using appropriate flow/salinity relationships
    - interpolating flow and salinity data to key locations where data has not been measured

  - providing for the removal of trends from the historic data which are determinable through the application of relevant data (a prime example is the adjustment of stream flows to account for observed water consumption trends)

  - identifying the elements of the landscape which have been the source of water and/or salt

  - identifying the elements of the landscape which have been sinks for water and/or salt

  - providing a basis for the consideration of uncertainty within the salinity reporting arrangements by allowing for sensitivity analyses for such issues as climate variability, climate change, uncertainty in no-intervention predictions, uncertainty in the credibility of available calibration data

- the predictions for ‘no-further-intervention scenarios’ for 2015, 2050 and 2100

- the finalisation of end-of-valley salinity and salt load targets by providing a baseline and identifying the quantum of no further interventions and the impact of a suite of intervention actions (interim targets have been set without hydrologic computer models in some tributaries

- the assessment of salinity management interventions by providing the opportunity to link landscape salt mobilisation models to the stream models (see Figures 3 and 4)
- the operation of the A&B registers which are based upon the Commission’s hydrologic model MSM-BIGMOD (see Figure 2)

- the support of the rolling 5-year review and audit of salinity management programs at a valley scale through assessing the theoretical contributions of a *programof actions* towards meeting the agreed salinity targets

- the implementation and review of the Strategy by providing a stable link between landscape salt mobilisation, impacts on stream salt loads and salinity, assessment of impacts on values and assets, in particular the in-stream assets such as irrigation supply and wetlands, and the costs of salinity to irrigation and urban users

- the assessment of progress in meeting end-of-valley salinity and salt load targets and in meeting the Basin Salinity Target at Morgan (see Figure 3).

Examples of what the models will be used for are highlighted in Figures 2, 3 and 4. The examples highlight the linkages of the different scale models, the catchment salt mobilisation or within-valley processes linked to the River Murray tributaries and eventually to the River Murray at Morgan.

Figure 1
The Murray-Darling Basin—The River Murray

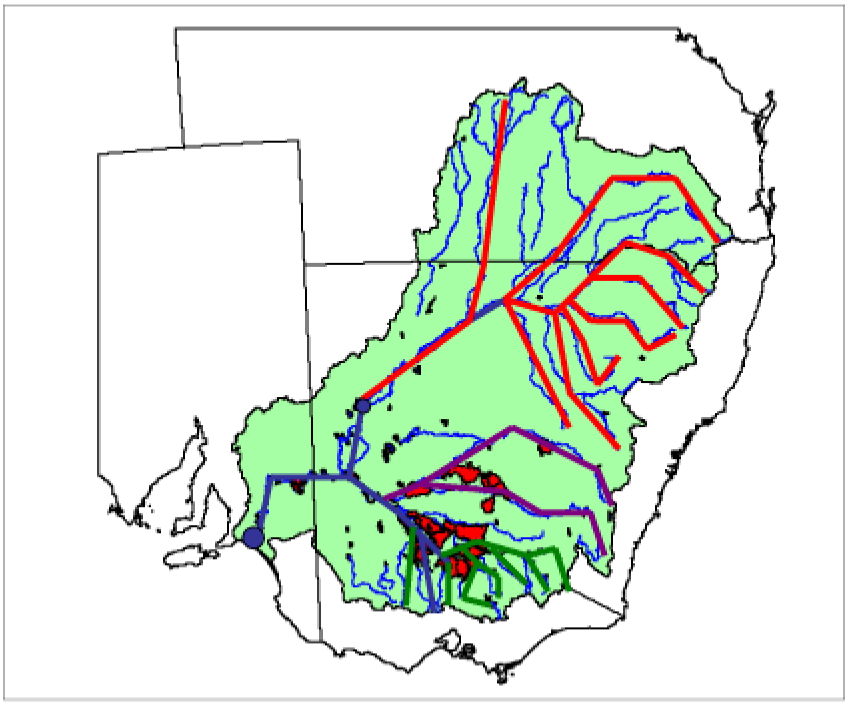
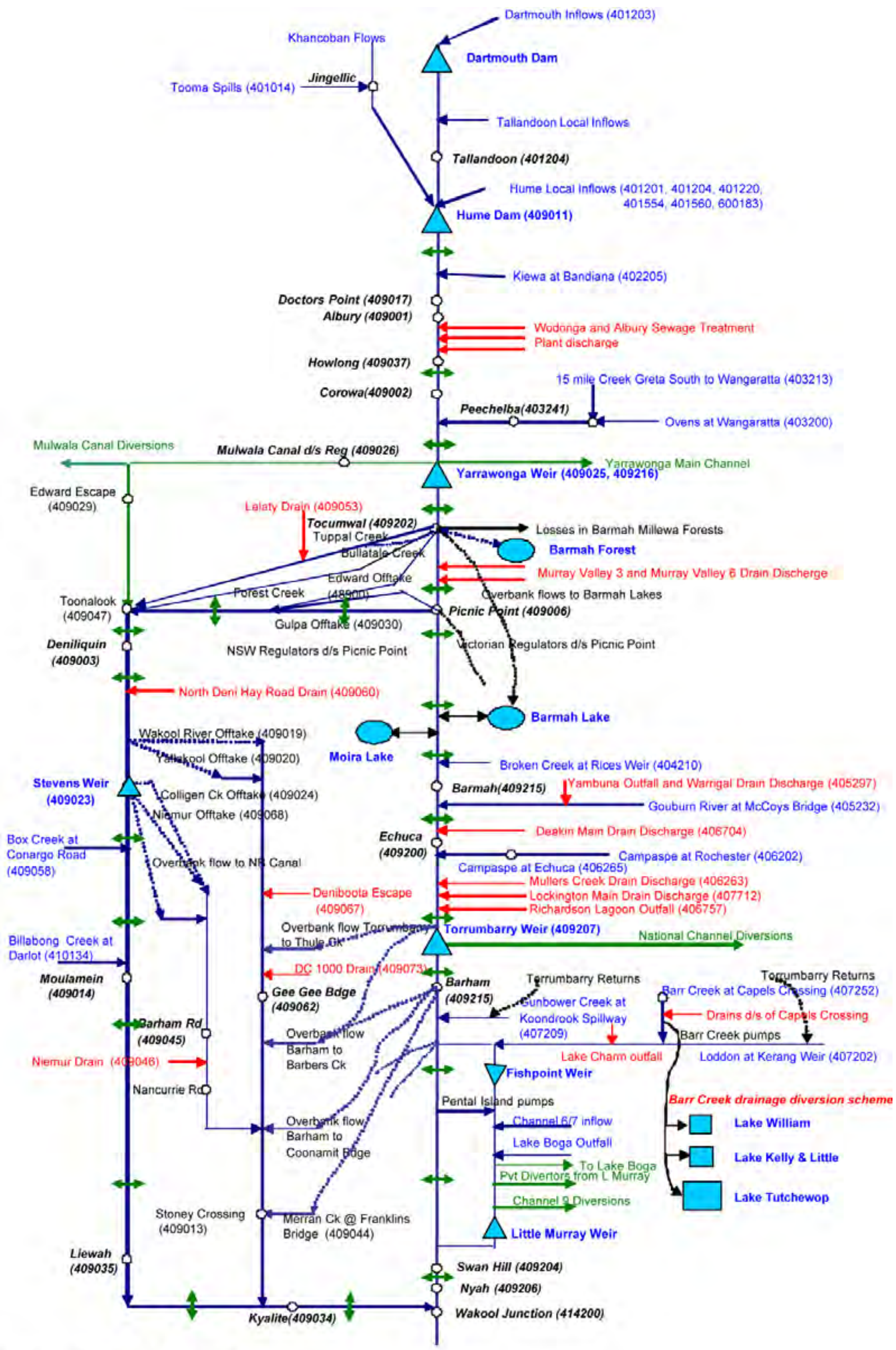
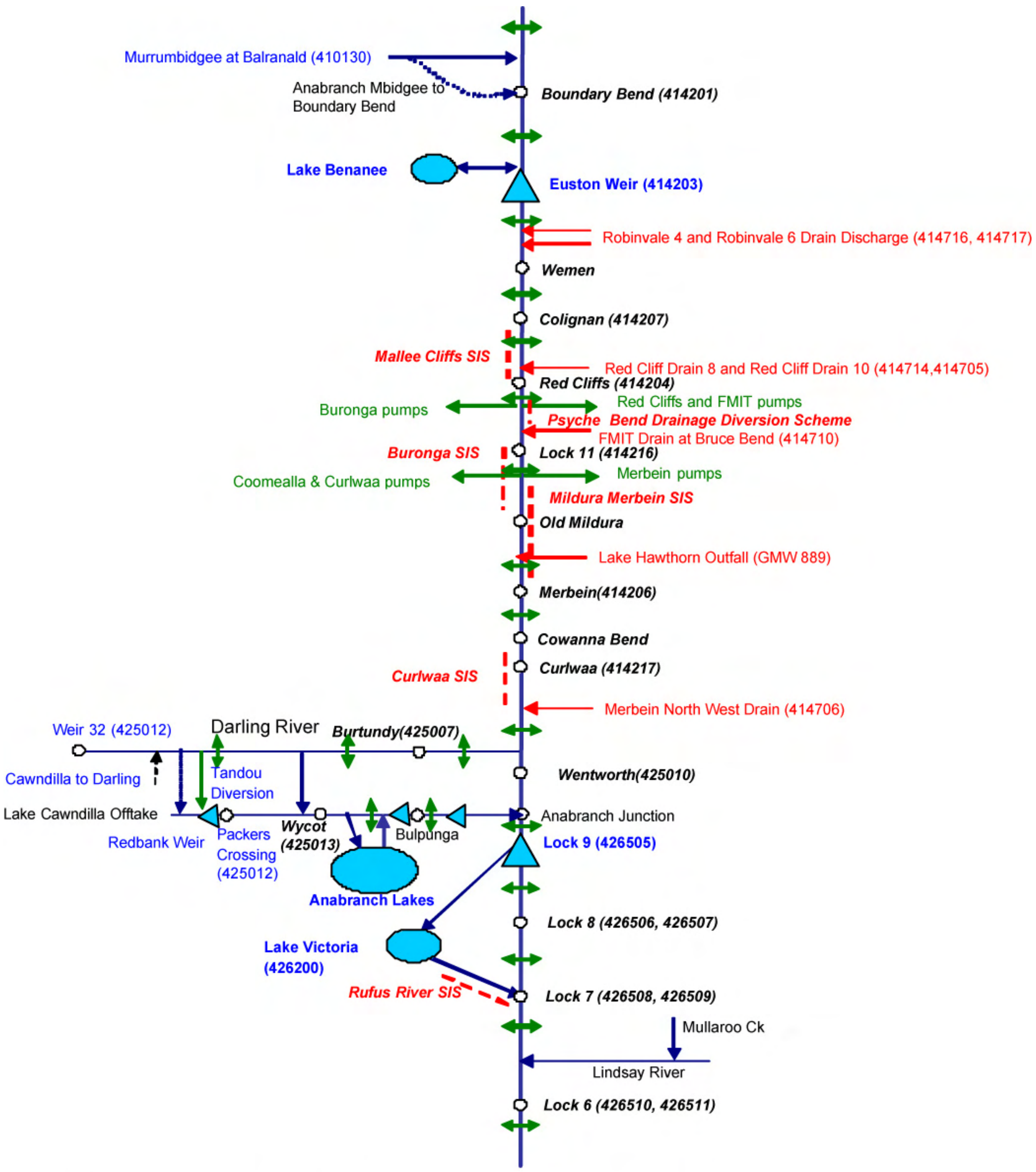


Figure 2
Shows a schematic diagram of how the MDBC suite of models for the River Murray (now superseded by MSM-BIGMOD) were used to provide assessments of the salinity impacts at various points along the river under the Salinity & Drainage Strategy. The impacts were put onto an accountability register.

Schematic Representation of System Modelled by BIGMOD Model



Schematic Representation of System Modelled by BIGMOD Model (continued)



Schematic Representation of System Modelled by BIGMOD Model (continued)

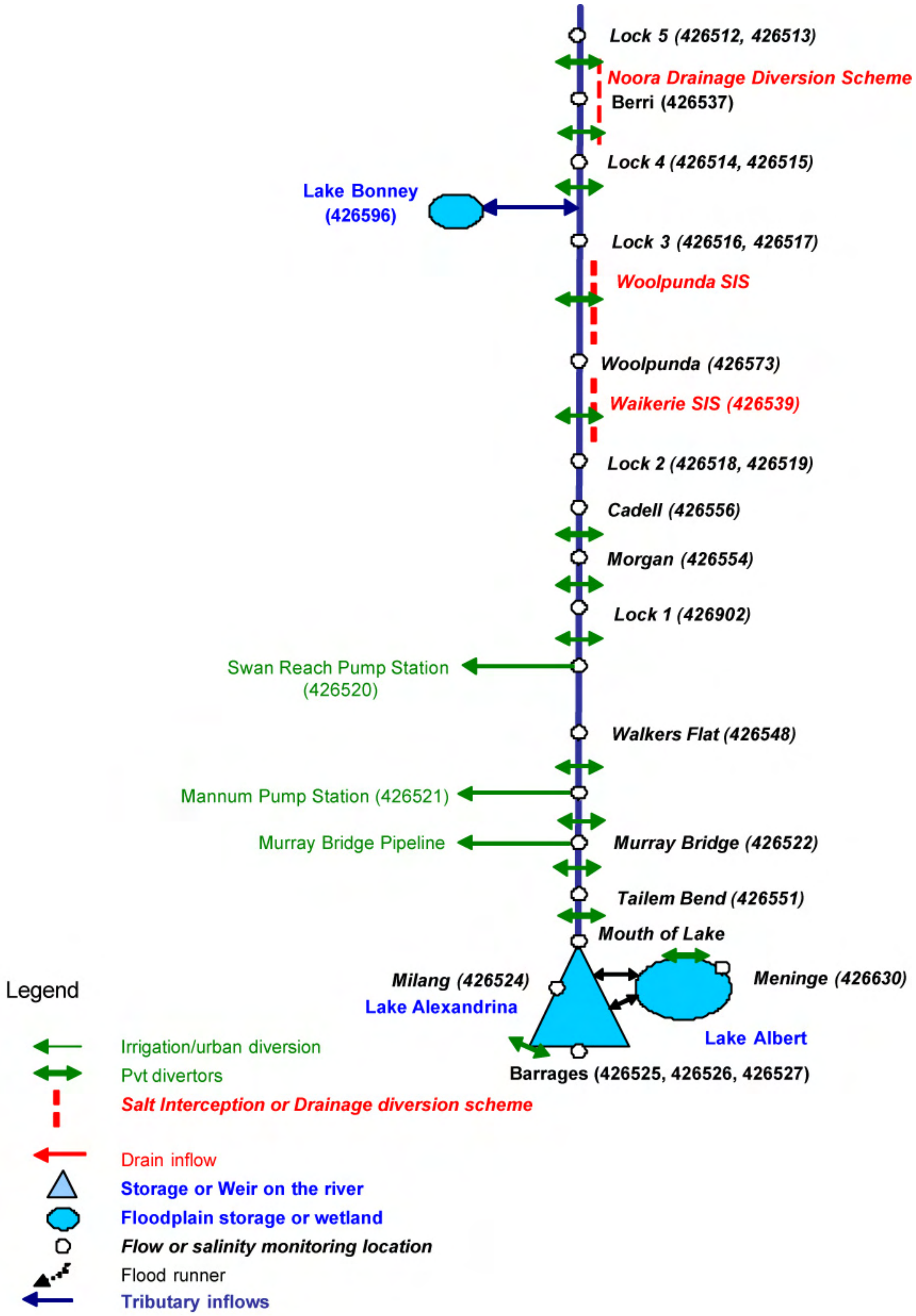
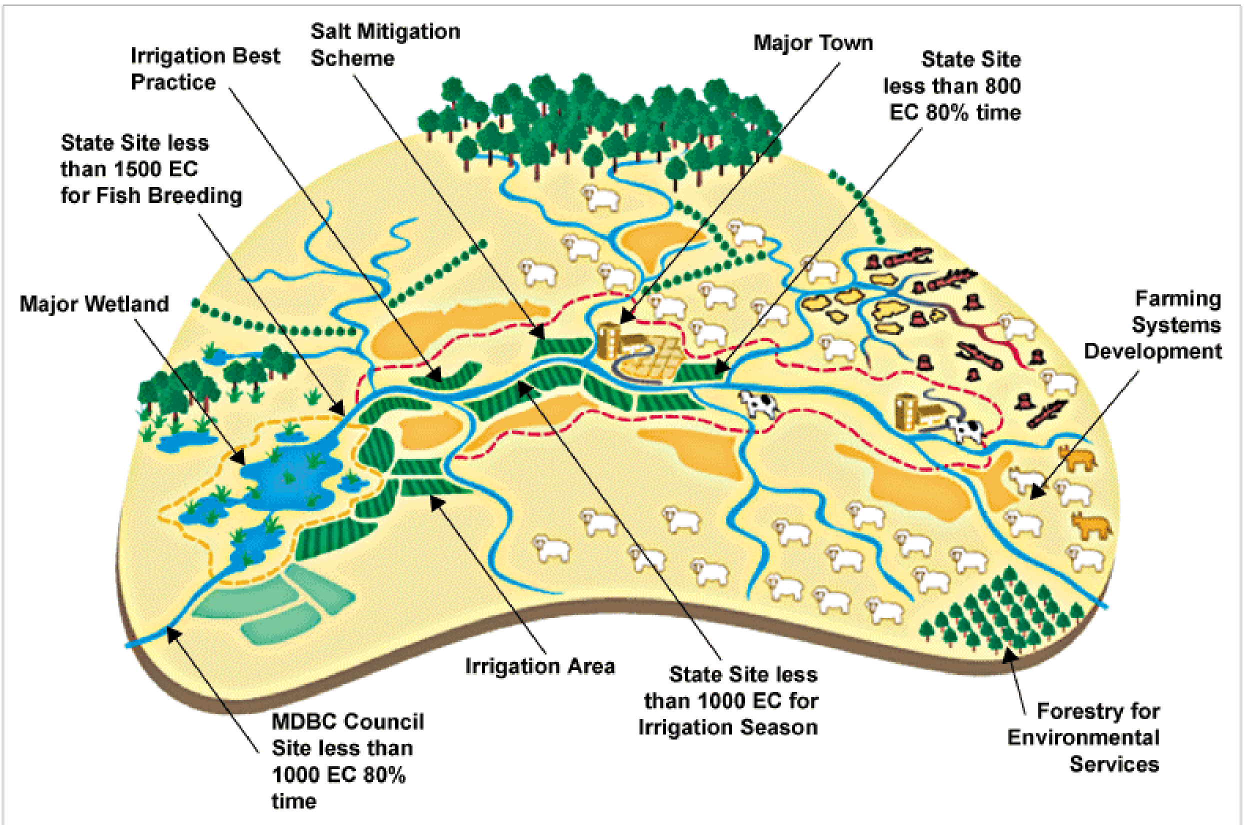


Figure 3
Basin scale hydrologic models. Shows the State tributary models linking into the River Murray model MSM-BIGMOD. This integrated modelling approach allows the salinity impacts of any intervention within the Basin to be assessed at end-of-valley and further downstream in the River Murray at Morgan.

Figure 4
Catchment scale processes: salt mobilisation into rivers and eventually to the end-of-valley target site. The impacts of these are modelled through the various tributary models that link to the River Murray model and eventually to Morgan (see Figure 3).



Hydrologic Models – key features

The key features of the suite of models currently used are given below:

The Commission Office Model – MSM-BIGMOD

The MSM-BIGMOD modelling suite has been developed for simulating flow and salinity in the Murray Lower Darling river system. In this suite MSM and BIGMOD models are run sequentially to simulate water management decisions such as operation of storages, water accounting, resource assessment and irrigation demand computations on a monthly time-step by the MSM model while flow and salinity routing from downstream of Hume Dam to Murray Mouth is carried out by the BIGMOD model on a daily time-step. The flow modelling is carried out for the 1891 to 2000 period while salinities are modelled for the BSMS *benchmark period* of 1975–2000.

The model has been calibrated and verified with the flow and salinity data from 1971 to 2003 and has been set up for *baseline conditions* of the BSMS. Within this modelling suite, computations for the economic impacts of salinity on irrigation and on domestic and industrial water users, and statistics for a whole range of environmental indicators, water demands, flow and salinity are computed at a number of locations including basin salinity target site and interpretation sites.

The NSW Hydrologic Models IQQM

The NSW IQQM models are daily salt and water balance models covering the benchmark period 1975 to 2000. There are models for the Macquarie, Gwydir, Namoi, Border Rivers, Barwon-Darling, Lachlan and Murrumbidgee systems. The water balance part of the model is based on the suite of models used in the 2001–2003 NSW Water Sharing Plan (WSP) process. This suite of WSP models was built, calibrated and validated to represent the major water flow related processes of resource assessment and allocation, reservoir operation, channel constraints, crop water requirement, irrigation water ordering and diversion, and environmental flow rules and delivery.

The salt balance part of the models was added to the WSP models. This involved the incorporation of flow load relationships for the systems unregulated tributary inflows. The salinity sub-models were validated against all available salinity data in the *benchmark period*. These typically comprised about 10 years of periodic grab sample data and a few years of continuous data. The end of system outputs from the Barwon-Darling and Murrumbidgee systems become inputs to the MSM-BIGMOD model previously described.

The Victorian models REALM

The Victorian REALM models are daily salt and water balance models covering the BSMS benchmark period of 1975 to 2000. There are models for the Upper Loddon, Wandella Creek, Kerang Lakes, Campaspe and Goulburn-Broken River systems (Figure 2). They were developed using historical demand data to provide salinity for the *benchmark period*. The demands and model configurations are at 1988 and 2000 levels of development allowing for direct comparison between pre and post implementation of schemes listed on the MDBC Salinity and Drainage Strategy (S&DS) Register.

The Queensland Hydrologic Models IQQM

The Queensland IQQM models are daily salt and water balance models covering the benchmark period 1975 to 2000. There are models for the Condamine-Balonne, Border Rivers, Warrego, Paroo and Moonie systems. The water balance part of the model is based on the suite of models used in the Queensland Water Resource Planning (WRP) process. This suite of WRP models was built, calibrated and validated to represent the major water flow related processes of resource assessment and allocation, reservoir operation, channel constraints, crop water requirement, irrigation water diversion, overland flow and flood harvesting, and environmental flow rules and delivery.

The salt balance part of the models has been added to the WRP models. This involved the incorporation of flow load relationships for the systems unregulated tributary inflows. The salinity sub-models were validated against all available salinity data in the *benchmark period*. These typically comprised about 15 - 20 years of periodic grab sample data and a few years of continuous data. The end of system outputs from the Queensland streams become inputs into the NSW Barwon-Darling system IQQM models, which in turn become inputs to the MSM-BIGMOD model previously described.

The models listed below were approved by the Commission in June 2004.

Geographic Area	Flow and Salinity Process Models
Murrumbidgee	Murrumbidgee Integrated Quantity/Quality Model (IQQM)
Lachlan	Lachlan IQQM
Macquarie	Macquarie IQQM
Namoi	Namoi IQQM
Gwydir	Gwydir IQQM
Barwon Darling	Barwon Darling IQQM
Border Rivers	Border Rivers IQQM
Moonie	Moonie IQQM
Paroo	Paroo IQQM
Condamine-Balonne	Condamine-Balonne IQQM
Goulburn-Broken	Goulburn-Broken REsource Allocation Model (REALM)
Campaspe	Campaspe REALM
Upper Loddon	Upper Loddon REALM
Wandella Creek	Wandella Creek REALM
Kerang Lakes	Kerang Lakes REALM
Upper River Murray and River Murray in South Australia	Monthly Simulation Model – Bigmod (MSM Bigmod) Pilot Interstate Water Trading Zone
Salinity Impacts Rapid Assessment Tool (SIMRAT)	

Appendix 3.4

ASSESSING FUTURE SALINITY AND SALT LOADS, AND *END-OF-VALLEY TARGETS*

The Basin Salinity Management Strategy requires the consideration of future salinity impacts in the short, medium and long term. When assessing future salinities, estimates should normally be produced for the years 2015, 2050 and 2100.

As outlined in Appendix 3.2, both salinities and flows within the Murray-Darling Basin are highly variable and the use of the benchmark period climatic sequence (1 May 1975 – 30 April 2000) is essential to account for a range of responses in wet, dry and average years.

The assessment of future salinity and salt loads should maintain a focus on the median and peak (80 or 95 percentile non-exceedance) salinity levels, while for salt loads a focus should be maintained on the average salt load.

The steps for assessing future salinity and salt loads are as follows:

- predict the salinity trend at the proposed target site for the 'no further intervention' scenario. The 'no further intervention' scenario assumes that the current land and water management regime will continue indefinitely into the future, and provides the basis for predicting future delayed salinity impacts ('legacy of history' impacts). The trend prediction should be based on the results from the latest salinity audit for the valley, which will be progressively updated under the five-year rolling audit program. Where the trends are evaluated at the proposed target site in the latest salinity audit, it is expected that the results from the audit would be used directly, otherwise some further analysis will be required

- from these results evaluate 'no further intervention' daily salinities and salt loads at key dates (for example, 2015, 2050, 2100) using models established for climate variability over the *benchmark period*. Other decision support tools and expert opinion may also be used, such that the statistics of the resultant daily time series (mean, median, percentiles) at each key date match the statistics from the trend predictions. Extract any additional statistics needed from the results that are not available from the trend predictions

- for each of the key dates, define a set of 'pre-action conditions' that reflect the *salinity impacts* of approved actions since the baseline date that have been declared effective, or are in progress

- develop a range of management scenarios that will consider local priorities, assets and values to be protected, private and public costs and benefits, and the projected effect on the *basinsalinity target*. Scenarios may include a number of possible interventions including changes in land management, engineering works, changes in flow management and modified agricultural practices

- estimate the daily salinities and salt loads at key dates (for example, 2015, 2050, 2100) using the *benchmark period* climatic sequence for the alternative management scenarios, the 'pre-action conditions', and the same models, other decision support tools, and expert opinion as employed for the 'pre-action conditions'. This will generate a set of 'post-action conditions' for each management scenario. Evaluate the required statistics of the resultant time series (mean, median, percentiles) at key dates and use these to derive trend predictions for each scenario

- further analyses may involve community consultation, and investigations of biophysical, economic, social and other environmental impacts consistent with the local Catchment Management Strategy or its equivalent
- for each management scenario estimate the end-of-valley salinity levels as a percentage of the 'no intervention' value at the assessment date. Compare the analyses of each scenario and identify the scenario that gives the optimal outcome (that is, the scenario that meets the target at the least overall cost to society, taking into account economic, social and environmental criteria). The selected salinity levels become the end-of-valley target and the management scenario associated with it become the basis for a program of actions for the valley (see Protocol 2.4.8).

Figure 1
Schematic diagram for no further intervention scenario for 2015, 2050 and 2100 – Flow, salinity and salt load

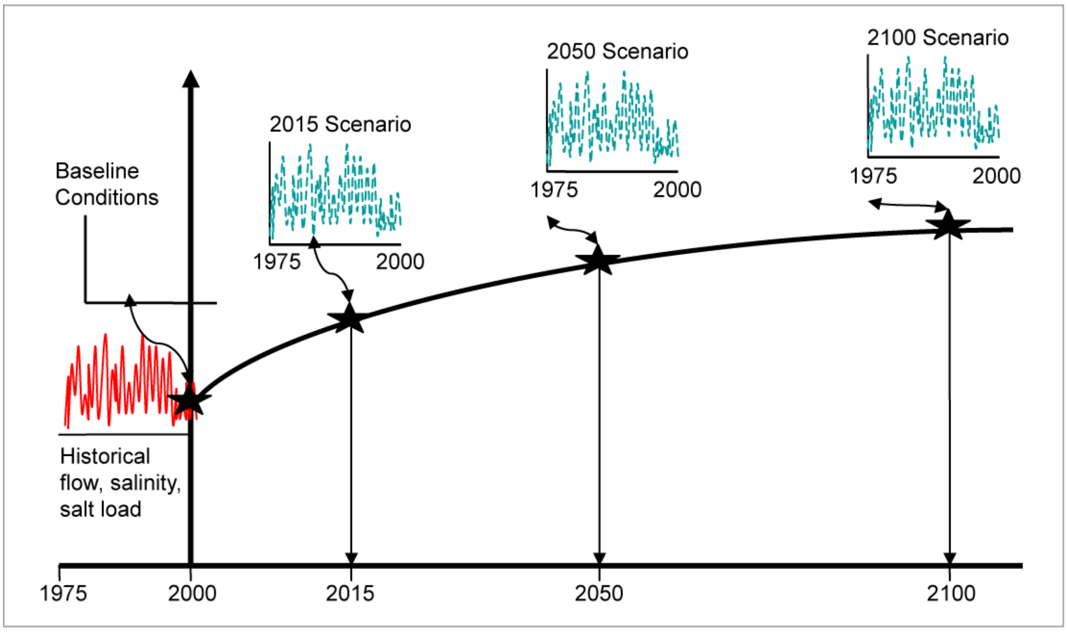


Figure 2
Setting Salinity Targets Using a Benchmark Period

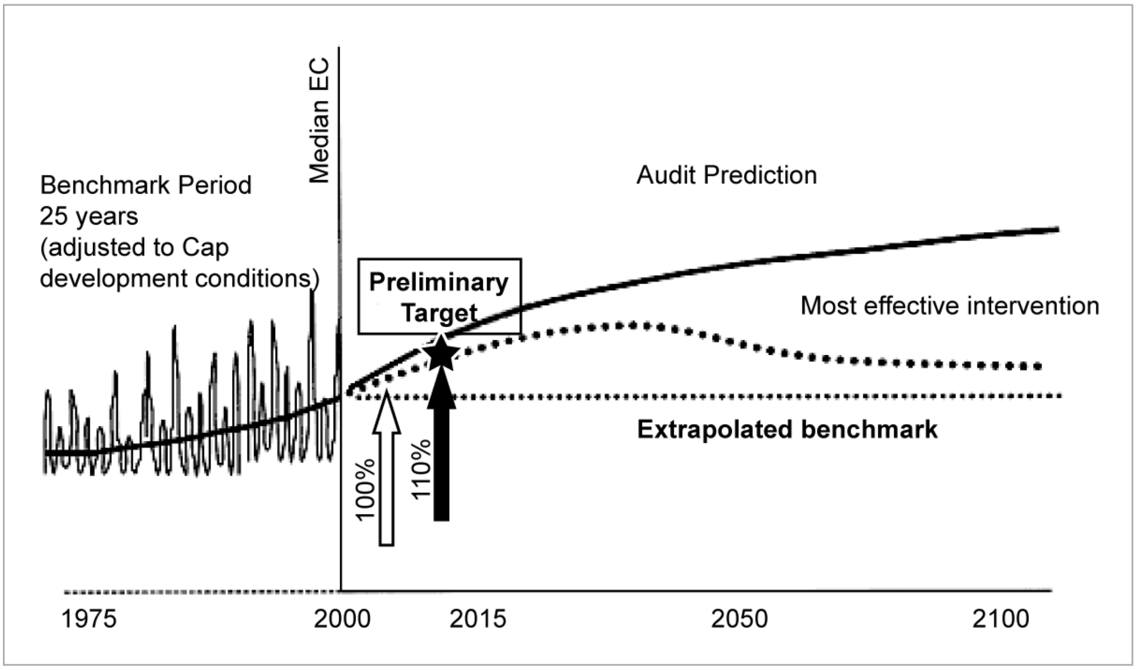
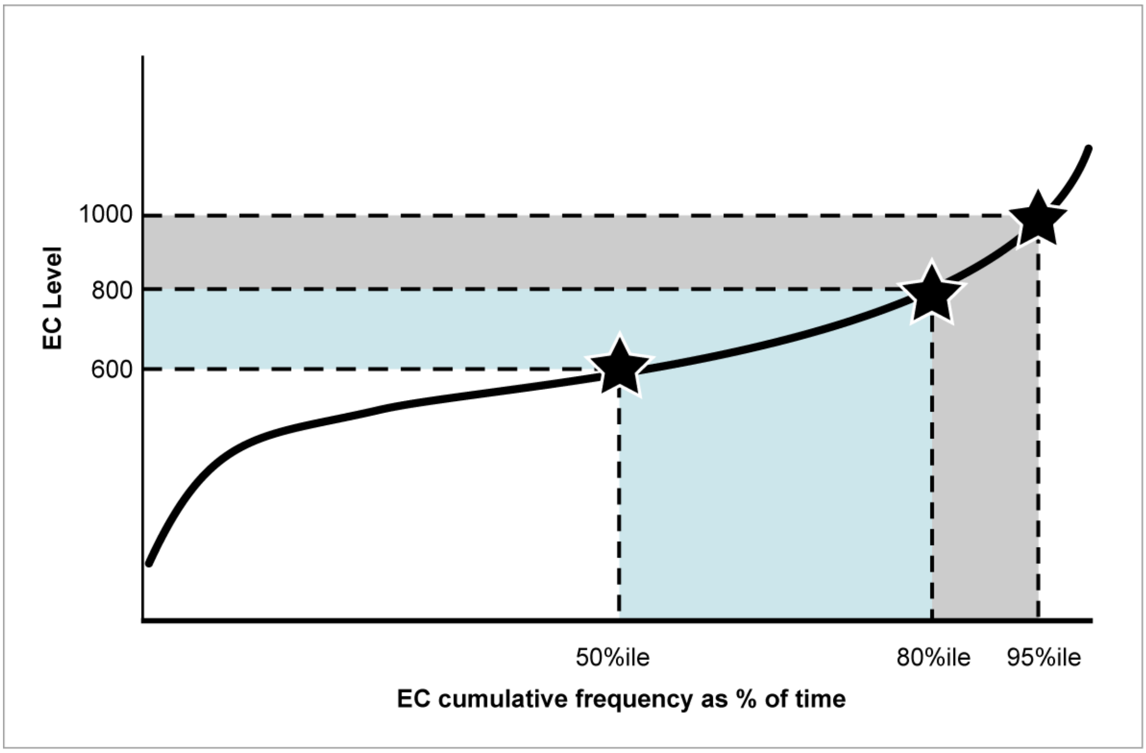


Figure 3
Typical salinity variability graph



Appendix 3.5

CALCULATING AND ATTRIBUTING *SALINITY CREDITS* AND *SALINITY DEBITS*

Estimated salinity credits and salinity debits are entered in the Registers in different ways depending on their origin. If the entry is initiated by an accountable action (that is, a proposal having a significant effect) it will require an entry in Register A. If the entry is a delayed salinity impact or an *action* designed to offset a *delayed salinity impact* it will require an entry in Register B.

Entries in *Register A* (*salinity credits* and *salinity debits*) are based upon the average impact over the 30 year period from the time that the initiating action is expected to take effect. The entry is reviewed every 5 years and the average over the next 30 years is reassessed. This may result in a changed entry for the same *action*.

Entries of *salinity credits* in *Register B* are also based on a 30 year average as for *Register A*, and are reviewed every 5 years in the same way.

Entries of *salinity debits* in *Register B* (*delayed salinity impacts*) are those which occur after 1 January 2000, but are attributable to an action taken or a decision made before 1 January 1988 (1 January 2000 in the case of Queensland) and that are considered by the Commission to have a significant effect. Debit entries are made annually in equal increments, based on the most recent 50 year projection.

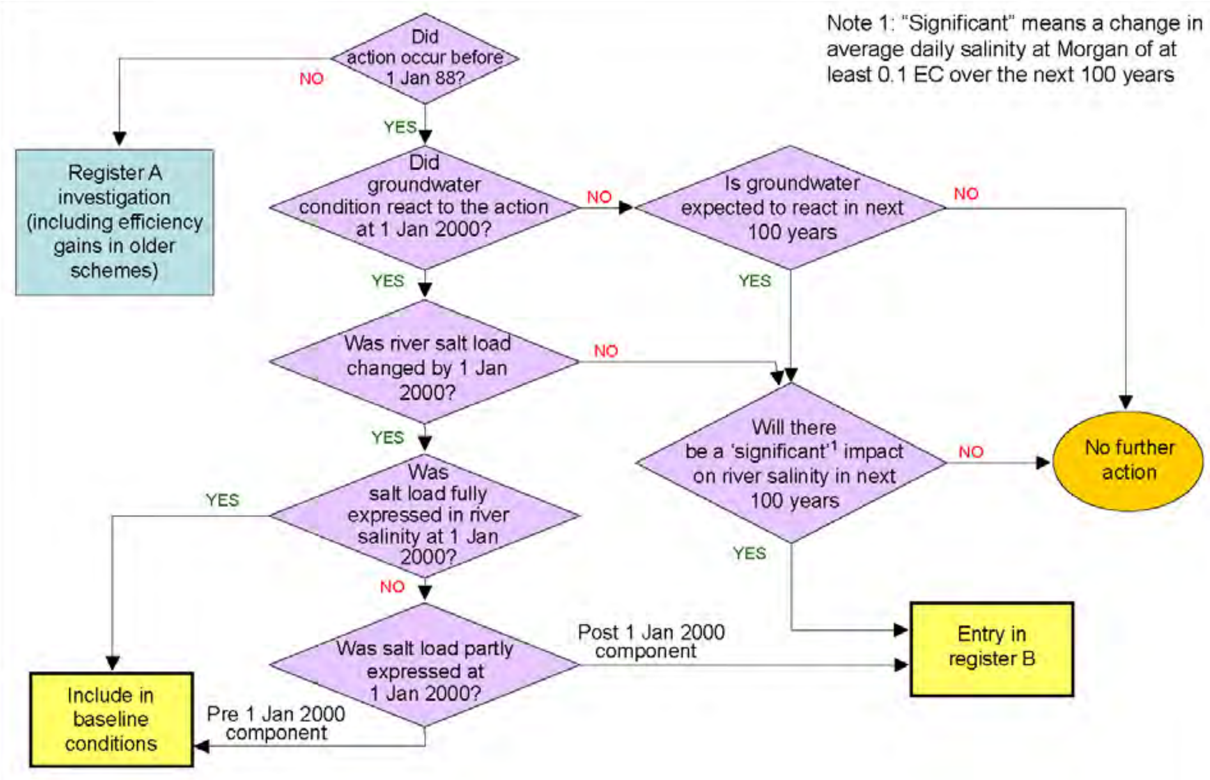
A review at any time (at least every 5 years) may modify the 50 year projection for *delayed salinity impacts*. When this occurs the annual increments for *salinity debits* in *Register B* will be adjusted to match the new projection, including adjustments to retrospective entries.

Register B debit entries are computed on a linear 50 year basis (instead of a 30 year rolling average) because:

- *delayed salinity impacts* typically take many decades to take effect, and their salinity response curve is not linear in the first 30 years. In such cases a 30 year average can give a misleadingly high debit result which may distort investment towards short term outcomes.
- a key premise of the BSMS is that capital works projects (such as salt interception schemes) may be employed to “buy time” until longer term measures (such as revegetation) take effect. The 50 year approach reflects this philosophy, and encourages actions that focus on long term improvement in salinity levels.

The following decision tree (Figure 1) illustrates the logic behind entries in the *B Register*.

Figure 1
Basin Salinity Management Strategy—Decision tree for entries in *Register B*

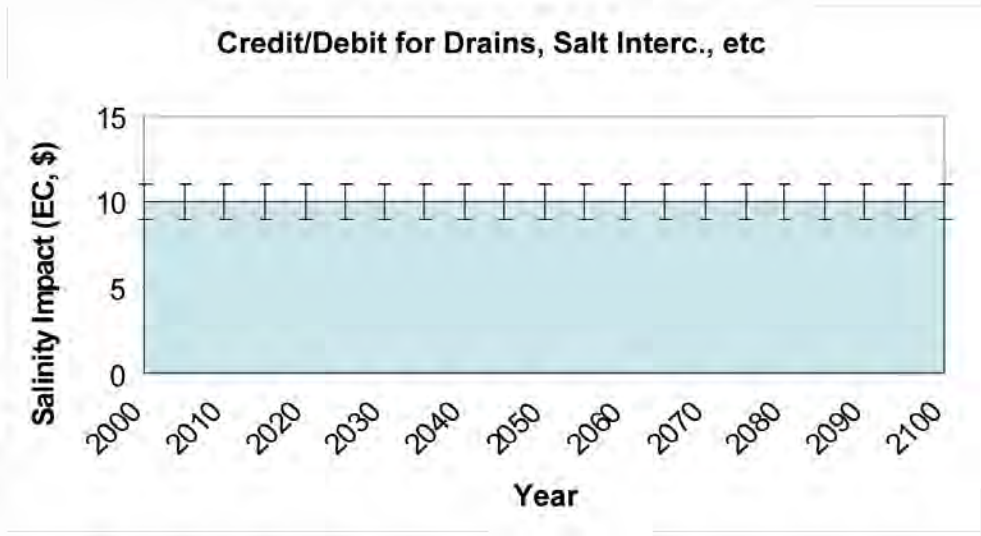


When a proposed *action* is anticipated to generate *salinity credits*, and to be implemented progressively over several years (such as a staged development, or a program of actions), the assessment should include a time-based *salinity impact* response curve over 100 years from the date that the action is expected to take effect. The provisional entry in the Register will be the average *salinity impact* over the next 30 years for the whole action, and the actual entries of *salinity credits* for each stage can be made as soon as:

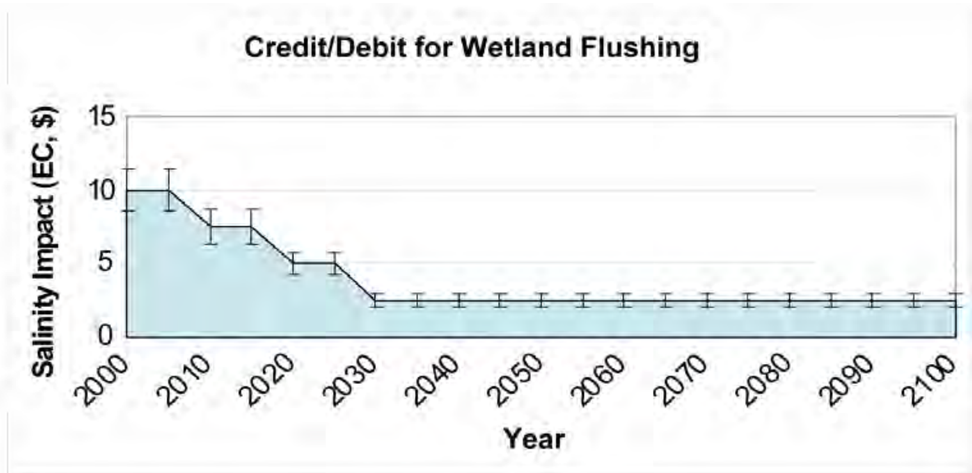
- that stage has been completed and commissioned, and
- the Commission has agreed to declare that stage of the work or measure *effective*.

Register entries will be reviewed annually until the *action* as a whole is complete, by comparing actual progress in annual reporting with planned progress, and adjusting the time-based *salinity impact* response curve accordingly. Otherwise, Register entries will be revised at five yearly intervals (see Protocols 5.7.1 and 5.7.2) taking into account the time-based response curve and any subsequent reviews.

Examples of different types of actions and the corresponding likely entries in *Register A* are shown below.

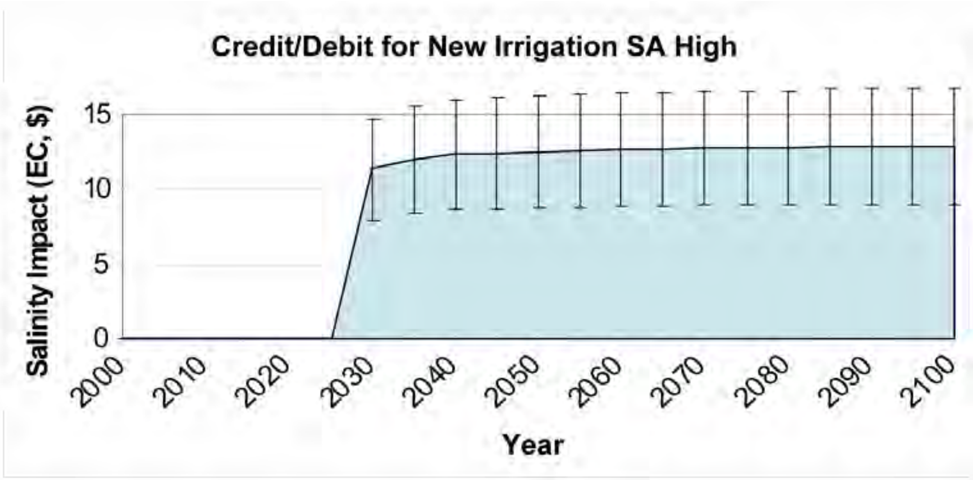


	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	10	10	10
Year 2005	10	10	10
Year 2010	10	10	10
Year 2015	10	10	10
Year 2020	10	10	10
Year 2025	10	10	10
Year 2030	10	10	10

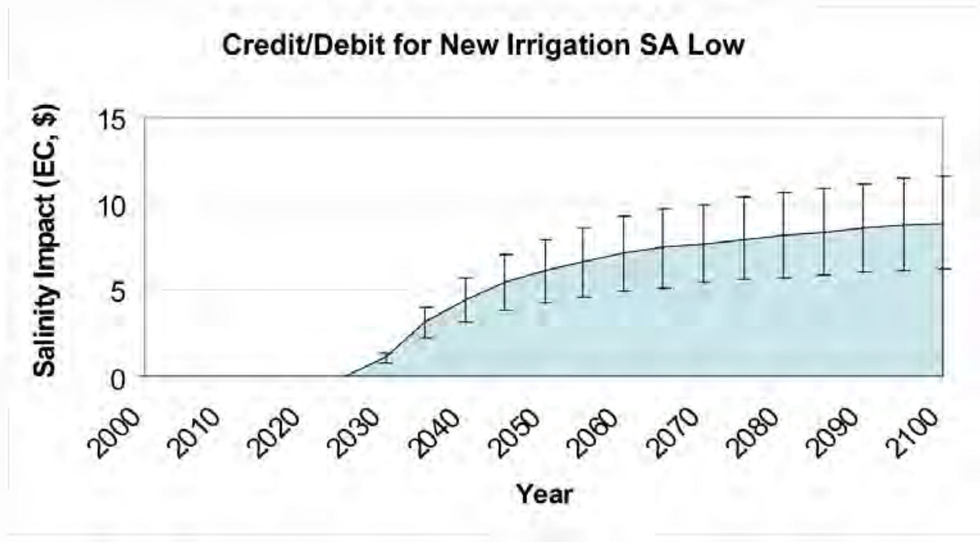


	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	9.2	6.8	5.2
Year 2005	8.3	5.7	4.5
Year 2010	6.7	4.6	3.9
Year 2015	5.8	3.9	3.4
Year 2020	4.2	3.2	3
Year 2025	3.3	2.9	2.7
Year 2030	2.5	2.5	2.5

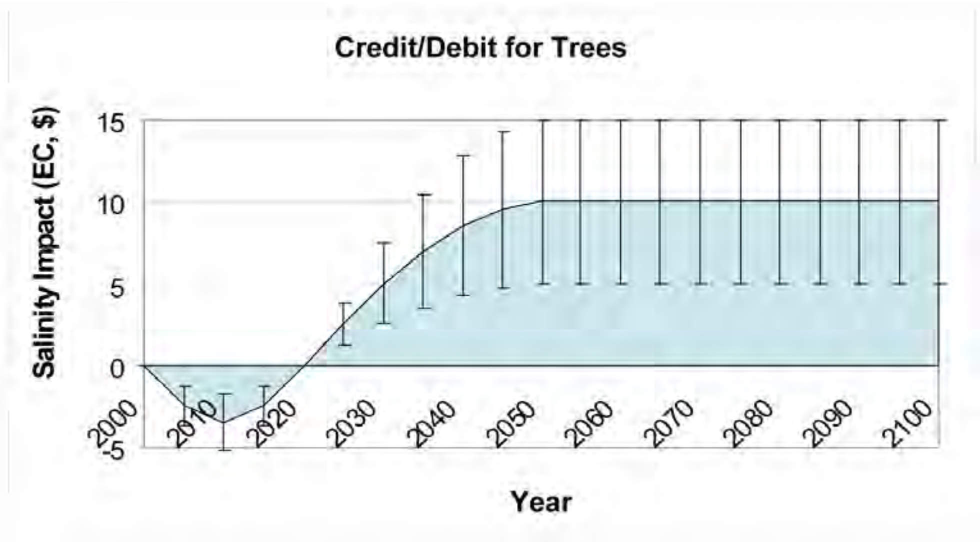
	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	2.7	6.1	7.5
Year 2005	5	7.6	8.5
Year 2010	6.8	8.6	9.1
Year 2015	8.3	9.3	9.5
Year 2020	9.3	9.7	9.8
Year 2025	9.8	9.9	10
Year 2030	10	10	10



	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	0	1.6	5.5
Year 2005	0	3.3	6.7
Year 2010	0	5.1	7.8
Year 2015	0	6.9	9
Year 2020	3.8	8.7	10.1
Year 2025	7.8	10.5	11.3
Year 2030	11.9	12.3	12.5



	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	0	0.2	1.8
Year 2005	0	0.6	2.4
Year 2010	0	1.2	3.1
Year 2015	0	2	3.7
Year 2020	0.4	2.9	4.4
Year 2025	1.4	3.8	5.2
Year 2030	2.9	4.8	5.9



	Average over Years -		
Register entry	**0-10**	**0-30**	**0-50**
Year 2000	-2	-0.1	3.1
Year 2005	-2.8	0.9	4
Year 2010	-2	2.4	5.1
Year 2015	0	4.3	6.4
Year 2020	2.5	6.1	7.5
Year 2025	4.8	7.5	8.4
Year 2030	6.8	8.6	9.1

Appendix 3.6

ATTRIBUTION OF *DELAYED SALINITY IMPACTS*

Salinity debits

Salinity debits that have an impact after 1 January 2000 but which are the result of actions incurred before the baseline dates are known as '*delayed salinity impacts'* and are entered in Register B. They are based upon the latest information available in salinity audits, using the 50 year annual increment as described in Appendix 3.5.

An interim agreement has been made to use the seven-year incremental predictions to determine the relative shares of the delayed salinity impacts between the individual States and the joint program. The agreement assigns 41 EC of *salinity debits* to be distributed between the States and the *joint program*[4].

The current audit for 'no further intervention' predictions is the 1999 salinity audit (with amendments for Queensland in Aug 2001), which indicates a *salinity impact* at Morgan of 215 EC by year 2050.

For the years 2001 to 2007:

- 31 EC of the *salinity debits* associated with *delayed salinity impacts* are assigned to the *joint program*
- 10.1 EC of the *salinity debits* are assigned to the individual States in shares proportionate to 2001 assessment of each States contribution to the 'no further intervention' prediction (based on the revised 1999 Audit), with the exception of Queensland.

Accordingly the *salinity debits* entered in *Register B* due to *delayed salinity impacts* have been determined as follows:

State	by 2007	each year
Joint program	31 EC	4.43
NSW	2.4 EC	0.34
Vic	1.9 EC	0.27
SA	5.8 EC	0.83

These salinity debits may be offset by credits arising from the *joint works program* and the implementation of catchment programs of actions.

If during the course of reviews the predictions are amended, then the Commission may modify the future assignment of salinity debits. As a guiding principle, the remaining years are debited with proportionately less or greater debits assigned to the combined States and the *joint program* in order to bring the 'no further intervention' outcome in line with the latest prediction.

4 The agreement was made by the Commission in the context of a *joint program* for salt interception schemes.

Salinity credits

The Commonwealth's 25% share of salinity credits (15.25/61) is assigned to *Register B* in accordance with the following arrangement agreed at the Ministerial Council Meeting No 32 of 2 November 2002:

NSW	15%	2.1 EC
Victoria	5%	0.7 EC
South Australia	80%	12.6 EC
	100%	15.3 EC

This distribution will occur as each joint work is constructed and declared *effective,* as set out in Protocol 3.7.2.

This assignment arrangement is based upon the Commonwealth's agreement to resolve the difference between the States' future impacts taking into account the 1999 Salinity Audit predictions of the 'Legacy of History' (*delayed salinity impacts*) made at the time of agreement to the BSMS in June 2001. As in the case of *salinity debits,* the assignment to States may be modified in future as the result of 5 year rolling reviews.

Appendix 3.7

SAMPLE REGISTERS A & B

Basin Salinity Management Strategy (Murray-Darling Basin Agreement Schedule C)

Salinity Registers "A" and "B" (Transitional as at June 2003)

Final Version 2.0 for Independent Audit Group for Salinity Consideration - 12 March 2004

COMMISSION REGISTER A	Type	Date Effective	Provisional Salinity Effect	Salinity Effect (EC at Morgan)					Salinity Cost Effect (30 Year Average $'000)					Salinity Credits/Debits (30 Year Average Equivalent EC)					5 Year Rolling Review		
				Current Year	2015	2050	2100	30 Year Average	NSW	Vic	SA	Qld	Total	NSW	Vic	SA	Qld	Total	Latest Review	Review Deadline	Status
JOINT WORKS & MEASURES																					
Former Salinity & Drainage Works																					
Woolpunda Interception Scheme	Joint	Jan 1991		-40.8	-40.8	-40.8	-40.8	-40.8	$575	$575	$0	$0	-$3,066	7.2	7.2	0	0	14.4	2000	2005	-
Improved Buronga and Mildura/ Merbein I.S.	Joint	Jan 1991		-3.0	-3.0	-3.0	-3.0	-3.0	$57	$57	$0	$0	-$303	0.7	0.7	0	0	1.4	2000	2005	-
New Operating Rules for Barr Ck Pumps	Joint	Jul 1991		-6.0	-6.0	-6.0	-6.0	-6.0	$101	$101	$0	$0	-$540	1.3	1.3	0	0	2.5	2000	2005	in progress
Waikerie Interception Scheme	Joint	Dec 1992		-12.7	-12.7	-12.7	-12.7	-12.7	$193	$193	$0	$0	-$1,028	2.4	2.4	0	0	4.8	2000	2005	-
Mallee Cliffs Salt Interception Scheme	Joint	Jul 1994		-12.9	-12.9	-12.9	-12.9	-12.9	$242	$242	$0	$0	-$1,288	3.0	3.0	0	0	6.0	2000	2005	in progress
Increased Riparian Flow in the Lower Darling	Joint	Nov 1997		1.9	1.9	1.9	1.9	1.9	-$8	-$8	$0	$0	$45	-0.1	-0.1	0	0	-0.2	1997	Overdue	-
Changed Internal Operation of Menindee Lakes	Joint	Nov 1997		0.7	0.7	0.7	0.7	0.7	-$65	-$65	$0	$0	$348	-0.8	-0.8	0	0	-1.5	1997	Overdue	-
Waikerie Phase II A Scheme	Joint	Feb 2002		-6.1	-6.1	-6.1	-6.1	-6.1	$89	$89	$0	$0	-$472	1.1	1.1	0	0	2.2	-	-	-
Sub Total - Former Salinity & Drainage Works				-78.7	-78.7	-78.7	-78.7	-78.7	$1,093	$1,093	$0	$0	-$6,304	14.8	14.8	0.0	0.0	29.5			
Basin Salinity Management Strategy																					
Pyramid Creek	Joint	Not effective	-4.6																		
Bookpurnong	Shared	Not effective	-20.5																		
Sub Total Joint Works under BSMS																					
Joint Works Sub Total				-78.7	-78.7	-78.7	-78.7	-78.7	$1,093	$1,093	$0	$0	-$6,304	14.8	14.8	0.0	0.0	29.5			
STATE WORKS & MEASURES																					
New South Wales																					
Barwon Darling Licensing Policy	NSW	Aug 1991		0.8	0.8	0.8	0.8	0.8	-$40	-	-	-	$40	-0.5	-	-	-	-0.5	1991	Overdue	-
Boggabilla Weir	NSW	Dec 1991		0.2	0.2	0.2	0.2	0.2	-$6	-	-	-	$12	-0.1	-	-	-	-0.1	1991	Overdue	-
Pindari Dam Enlargement	NSW	Aug 1994		1.6	1.6	1.6	1.6	1.6	-$210	-	-	-	$210	-2.5	-	-	-	-2.6	1994	Overdue	-
NSW LWMP's	NSW	Feb 1996		5.0	5.0	5.0	5.0	5.0	-$438	-	-	-	$438	-5.5	-	-	-	-5.5	2000	2005	-
Permanent Inter State Water trade - Dilution Effect	NSW	Various		-0.2	-0.2	-0.2	-0.2	-0.2	$13	-	-	-	-$13	0.2	-	-	-	0.2	2000	2005	-
New Irrigation development due to Water Trade	NSW	TBA		TBA	TBA	TBA	TBA	TBA	TBA	-	-	-	TBA	TBA	-	-	-	TBA	-	-	-
New South Wales Subtotal				7.4	7.4	7.4	7.4	7.4	-$681				$687	-8.5				-8.5			
Victoria																					
North-Central	Vic	Various		3.6	3.6	3.6	3.6	3.6	-	-$330	-	-	$330	-	-4.1	-	-	-4.1	2000	2005	-
Mallee	Vic	Various		TBA	TBA	TBA	TBA	7.1	-	-$557	-	-	$557	-	-7.0	-	-	-7.0	2000	2005	-
Goulburn-Broken	Vic	Various		4.9	4.9	4.9	4.9	4.9	-	-$411	-	-	$411	-	-5.1	-	-	-5.1	2000	2003	in progress
Barr Creek Catchment Plan	Vic	Mar 1991		-3.6	-3.6	-3.6	-3.6	-3.6	-	$323	-	-	-$323	-	4.0	-	-	4.0	2000	2005	-
Psyche Bend Lagoon	Vic	Feb 1996		-0.7	-0.7	-0.7	-0.7	-0.7	-	$60	-	-	-$120	-	0.7	-	-	0.7	2000	2005	-
Permanent Inter State Water trade - Dilution Effect	Vic	Various		-0.2	-0.2	-0.2	-0.2	-0.2	-	$16	-	-	-$16	-	0.2	-	-	0.2	2000	2005	
Sunraysia drains drying up	Vic	Jun 2003	-2.15	TBA	TBA	TBA	TBA	TBA	-	TBA	-	-	TBA	-	TBA	-	-	TBA	-	-	
Victoria Subtotal				4.1	4.1	4.1	4.1	11.2		-$899			$839		-11.2			-11.2			
South Australia																					
Irrigation Development due to Water Trade	SA	Jun 2004	23.1	TBA	TBA	TBA	TBA	TBA	-	-	TBA	-	TBA	-	-	TBA	-	TBA	2002	2004	in progress
Improved Irrigation Practice	SA	Jun 2004	-7.1	TBA	TBA	TBA	TBA	TBA	-	-	TBA	-	TBA	-	-	TBA	-	TBA	2002	2004	in progress
Irrigation and Drainage Infrastructure	SA	Jun 2004	-11.2	TBA	TBA	TBA	TBA	TBA	-	-	TBA	-	TBA	-	-	TBA	-	TBA	2002	2004	in progress
South Australia Subtotal								TBA			TBA		TBA			TBA		TBA			
Queensland																					
No works or measures to-date	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Queensland Subtotal																					
Balance - Register A														**6.2**	**3.5**	**TBA**	**-**	**9.8**			

COMMISSION REGISTER B	Type	Year of Predictions	Provisional Salinity Effect	Salinity Effect (EC at Morgan)					Salinity Cost Effect ($'000)					Salinity Credits/Debits (Current Year - "Ticking clock")					Latest Review	Review Deadline	Status
				Current Year	2015	2050	2100	30 Year Average	NSW	Vic	SA	Qld	Total								
New South Wales																					
Namoi	Delayed	1999		1.3	6.4	21.3	42.7	-	-	-	-	-	-	-1.3	-	-	-	-1.3	1999	2004	in progress
Macquarie	Delayed	1999		0.9	4.3	14.3	28.7	-	-	-	-	-	-	-0.9	-	-	-	-0.9	1999	2004	in progress
Gwyder	Delayed	1999		0.02	0.1	0.3	0.7	-	-	-	-	-	-	0.0	-	-	-	0.0	1999	2004	in progress
Border Rivers	Delayed	1999		0.02	0.1	0.3	0.7	-	-	-	-	-	-	0.0	-	-	-	0.0	1999	2004	in progress
Murrumbidgee	Delayed	1999		1.2	6.0	20.0	40.0	-	-	-	-	-	-	-1.2	-	-	-	-1.2	1999	2004	in progress
Bogan	Delayed	1999		0.6	3.2	10.7	21.3	-	-	-	-	-	-	-0.6	-	-	-	-0.6	1999	2004	in progress
Castlereagh	Delayed	1999		0.0	0.2	0.7	1.3	-	-	-	-	-	-	0.0	-	-	-	0.0	1999	2004	in progress
Victoria																					
Goulburn	Delayed	1999		0.2	0.8	2.7	5.3	-	-	-	-	-	-	-	-0.2	-	-	-0.2	1999	2004	-
Loddon	Delayed	1999		0.1	0.7	2.3	4.7	-	-	-	-	-	-	-	-0.1	-	-	-0.1	1999	2004	-
Vic Mallee	Delayed	1999		3.0	15.0	50	100	-	-	-	-	-	-	-	-3.0	-	-	-3.0	1999	2004	in progress
South Australia																					
SA Mallee	Delayed	1999		10.0	50.0	167	333	-	-	-	-	-	-	-	-	-10.0	-	-10.0	1999	2004	in progress
Queensland																					
Condamine Balonne	Delayed	2000		0.10	0.5	1.7	3.3	-	-	-	-	-	-	-	-	-	-0.1	-0.1	2000	2005	-
Border Rivers	Delayed	1999		0.10	0.5	1.7	3.3	-	-	-	-	-	-	-	-	-	-0.1	-0.1	2000	2005	in progress
Irrigation development pre 1 January 2000	Delayed	TBA		TBA	TBA	TBA	TBA	-	-	-	-	-	-	-	-	-	TBA	TBA			-
Balance - Register B																		**-17.6**			
Balance - Registers A & B																		**-7.8**			

Registers Explainatory Notes
TBA - To be assesred
Victorian administrative areas revised June 2003
Credits shown as positive numbers, debits shown as negative numbers
Salinity Effect - Increase in average salinity at Morgan in EC
Salinity Cost Effect - Increase in average salinity costs in $'000's (March 1988 values)
Salinity Credits - Unit of account of Salinity and Drainage Strategy (= negative of salinity cost effect)
Equivalent EC - Salinity credits (in $) expressed in EC units using the ratio of total $ credits to total Salinity Effect for the initial joint works.
Register B - Contributions to Morgan salinity in 2015 (assuming no intervention) as predicted in the 1999 Salinity Audit (see Table 1 in Basin Salinity Management Strategy 2001-2015)
Register is Transitional from Salinity and Drainage Register (All items to be recalculated using MSMS Bigmod (to be finalised March 04) and new cost Functions (to be finalised by September 2004)

Appendix 3.8

SALINITY IMPACT AT MORGAN - READY RECKONER AND COST FUNCTIONS

Salinity cost functions

The Basin Salinity Management Strategy requires salinity credits and salinity debits resulting from accountable actions to be entered as appropriate in Register A and/or Register B (Schedule C, Clause 20). The terms *salinity debit* and *salinity credit* refer to changes in 'average salinity costs'. Estimates of salinity impacts are normally made in EC units, and cost functions are required to convert EC units to costs before entries in the Registers are made.

Cost functions have been developed to reflect the estimated economic effect of rising salinity levels in the basin. High salinity levels have the potential to not only reduce agricultural yields but can also impose additional costs to urban and industrial water users. The factors being used to derive these cost functions are as follows:

Domestic Water Users

Studies have indicated that costs to household water users would increase as a result of high salinity levels and the subsequent increase in water hardness. These increased costs arise as a result of the greater need to repair and replace household fixtures due to corrosion, and the effects of hardness. Domestic costs include impacts to the following:

- plumbing fixtures and fittings;
- hot water systems;
- domestic water softeners.

Industrial Water Users

The impact of increasing salinity on industry is seen in the reduced reliability and lifespan of plant equipment, and additional processes and costs required to maintain product quality. Some specific problems experienced by industry are:

- Corrosion of pipes and fittings
- Reduced boiler life
- Additional blow down requirements in cooling towers and boilers
- Additional pre-treatment and chemical costs to ensure that the salinity and hardness of water are suitable for manufacturing processes.

Agricultural Water Users

Costs to agricultural users as a result of increasing salinity are primarily attributed to crop yield loss as a result of the following:

- Crop yield decreases as the soil-water salinity increases beyond a threshold value
- Impact on crop yields due to foliar damage resulting from over-head irrigation.

The major salinity cost functions for the River Murray have been documented and are available from the Commission. Further details regarding cost functions can be found in:

- Gutteridge Haskins and Davey Pty Ltd (1999). *Salinity Impact Study*. Report to Murray-Darling Basin Commission
- Allen Consulting Group (2004). Independent Review of Salinity Cost Functions for the River Murray. Report to Murray-Darling Basin Commission.

Ready reckoner

The MDBC MSM-BIGMOD has been used to establish the effect of salt inflows in various reaches of the river on the salinity at Morgan. The relative impacts are illustrated in Table 1 and Figures 1 to 4.

Figure 4 "Equivalent EC" is an appropriate tool for initial appraisals, while final assessments should be undertaken using models as described in Protocol 3.6.5.

Table 1
Salinity impacts at Morgan of 100 t/d

Station	River Distance from Mouth of River Murray (km)	Salt Load (t/d) for 3 flow ranges			EC Impact @ Morgan				Cost Impact of Salinity ($'000/annum)			
		<10000 ML/d	10-20000 ML/d	>20000 ML/d	<10000 ML/d	10-20000 ML/d	>20000 ML/d	Total	<10000 ML/d	10-20000 ML/d	>20000 ML/d	Total
Corowa	2208	100	100	100	2.2	1.3	1.3	4.9	510	290	290	1100
Tocumwal	1886	100	100	100	3.6	2.7	0.58	6.9	700	620	150	1500
Torrumbarry	1678	100	100	100	5.8	0.89	0.61	7.3	1200	210	120	1500
Swan Hill	1409	100	100	100	11	1	0.69	12	2200	240	130	2600
Kyalite	-	100	100	100	12	0.47	0	13	2500	100	0	2600
Mildura	910	100	100	100	13	1.9	1.3	16	2500	400	250	3200
Weir 32	-	100	100	100	13	0.58	0.31	14	3400	88	58	3500
Wentworth	825	100	100	100	13	3.2	1.8	18	2100	730	330	3200
Lock 6	654	100	100	100	17	2.3	1.2	20	2800	450	170	3400
Lock 5	620	100	100	100	18	1.8	1.2	21	2300	230	120	2600
Lock 4	516	100	100	100	20	1.6	1.1	23	1900	170	110	2200
Lock 3	496	100	100	100	21	1.4	1.1	23	1600	110	76	1700
Lock 2	383	100	100	100	22	1.3	1.1	25	1300	100	76	1500
Morgan	315	100	100	100	22	3	1.5	26	1300	160	99	1600
Lock 1	274	100	100	100	0	0	0	0	680	58	49	790
Murray Bridge	150	100	100	100	0	0	0	0	130	9	19	160

Figure 1
Morgan *salinity impact* ready reckoner
Salinity impacts at Morgan for adding constant 100 tonnes/day at various locations along the River Murray and the Darling River - 1975 to 2000 Benchmark period

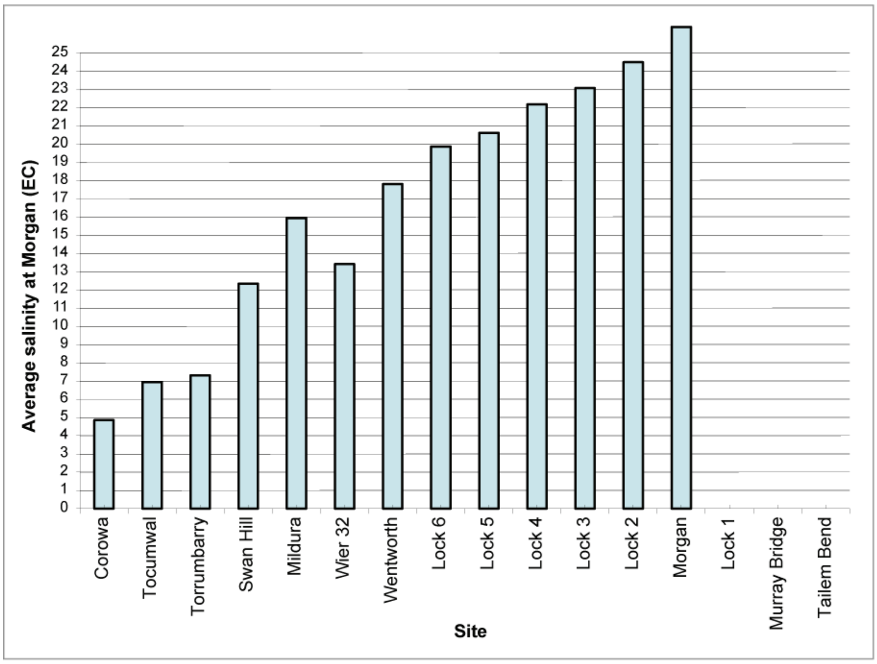


Figure 2
Economic impact ($/p.a)
Economic impact of Salt Entering various locations along the River Murray
Modelled results assuming inflow of constant 100 tonnes/day over 1975 to 2000 benchmark

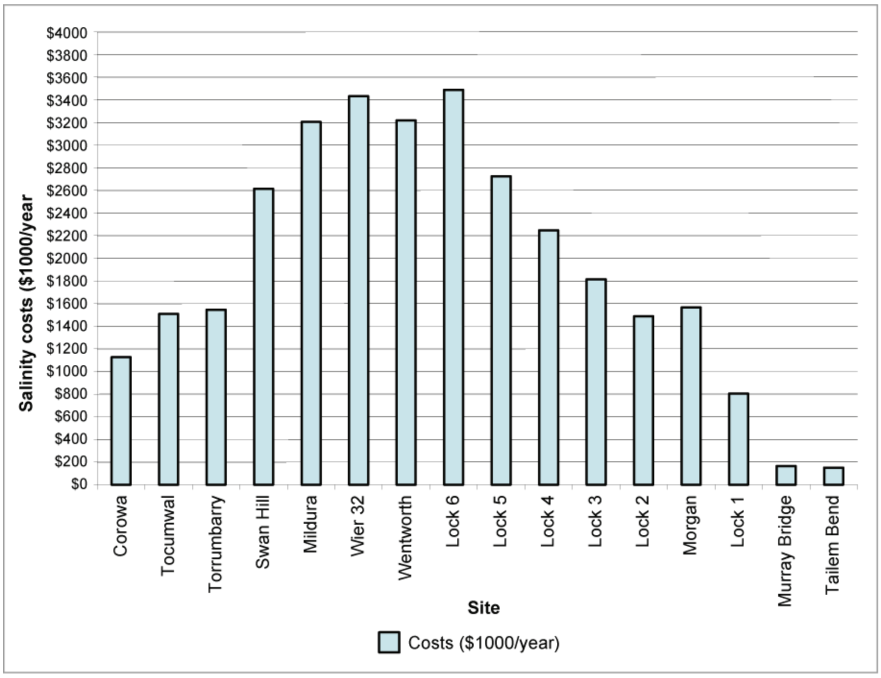


Figure 3
Economic impact ($/tonne)
Economic impact to downstream water users of Salt Entering the Murray River

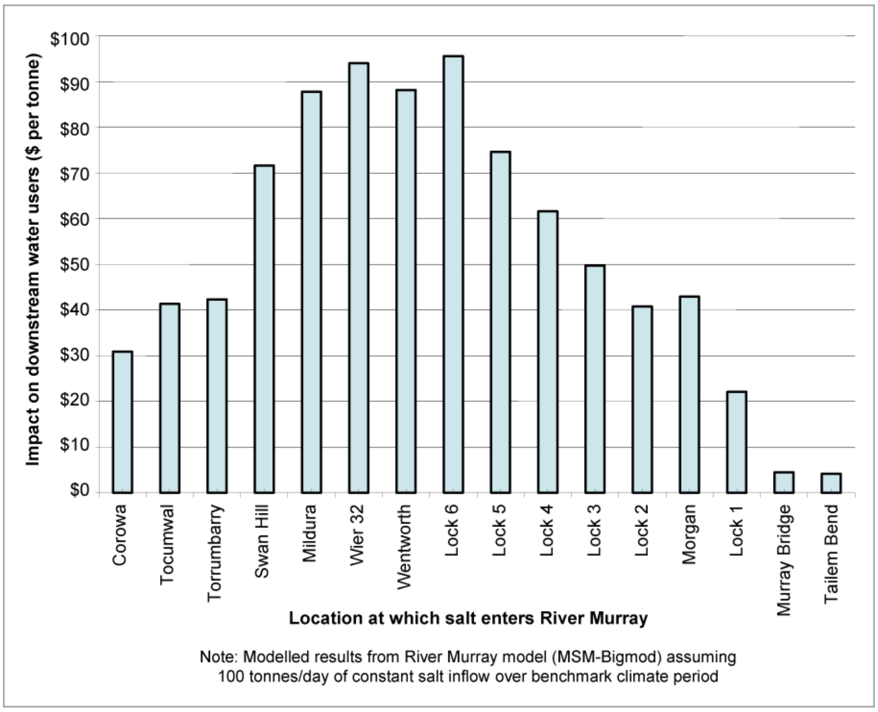
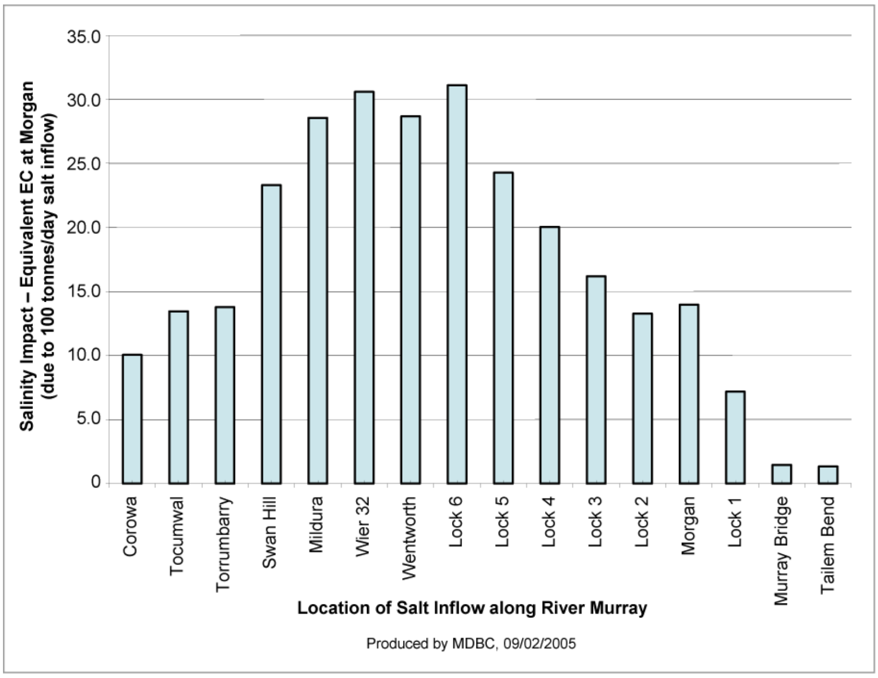


Figure 4
Salinity impact – Equivalent EC
River Murray Salinity Impacts "Ready Reckoner"Salinity Impact due to 100 tonnes/day salt inflow - Equivalent EC at Morgan



Appendix 3.9

Assessment Criteria used for reviewing hydrological models developed under the BSMS

	EVALUATION CRITERIA	STATUS				RECOMMENDED IMPROVEMENTS		
						2004	2007	2010-2015
1.0	***MODEL OVERVIEW***							
1.1	Is there a clear statement of model objectives in the report and are these objectives consistent with the model requirements of Clauses 5(2), 37 and 39 of Schedule C?	Missing	Deficient	Adequate	Very Good			
1.2	Is a salt and water balance reported?	Missing	Deficient	Adequate	Very Good			
1.3	Has the modelling effort been directed towards satisfying the stated objectives?	Missing	Deficient	Adequate	Very Good			
1.4	Have the limitations of the model been correctly identified and reported?	Missing	Deficient	Adequate	Very Good			
1.5	Has an appropriate set of future model improvements been identified and scheduled? Where appropriate, do the proposed model improvements take account of increased data availability in the near future?.	Missing	Deficient	Adequate	Very Good			
1.6	Has the model already undergone external review? If so, have the findings of these reviews been made available?	Missing	Deficient	Adequate	Very Good			
2.0	***DATA ANALYSIS***							
2.1	Has relevant data (surface water, groundwater, landuse, diversions, climate, etc.) been collected and analysed?	Missing	Deficient	Adequate	Very Good			
2.2	Is information on the spatial and temporal extent, and the quality of the available data, been provided?	Missing	Deficient	Adequate	Very Good			
2.3	Has the process of infilling data gaps and extending data beyond the period of record been highlighted and carried out appropriately?	Missing	Deficient	Adequate	Very Good			
2.4	Has the process of establishing Year 2000 conditions for various model inputs been competently undertaken and documented?	Missing	Deficient	Adequate	Very Good			
3.0	***MODEL STRUCTURE***							
3.1	Is there a clear description of the conceptual model and is it consistent with Schedule C's objectives and the required model complexity? Has a schematic diagram of the model been provided?	Missing	Deficient	Adequate	Very Good			
3.2	Are all the principal flow/salt inputs and outputs included and is the spatial extent appropriate?	Missing	Deficient	Adequate	Very Good			
3.3	Are all the relevant flow/salt routing processes included and documented?	Missing	Deficient	Adequate	Very Good			
3.4	Is the model flexible enough to be expanded or refined with the availability of more data in the future (i.e. 5-yr rolling review)?		No	Maybe	Yes			
3.5	Are the number and size of sub-catchments appropriate?	Missing	Deficient	Adequate	Very Good			
3.6	Is the software appropriate for the objectives of the study?		No	Maybe	Yes			
3.7	Is the software consistent with the conceptualisation?		No	Maybe	Yes			
3.8	Has the robustness of the model to fulfil Schedule C's requirements been established with regard to the model time-step, its structure and its internal flow/salt processes?	Missing	Deficient	Adequate	Very Good			

	EVALUATION CRITERIA	STATUS				RECOMMENDED IMPROVEMENTS		
						2004	2007	2010-2015
4.0	***CALIBRATION***							
4.1	Has sufficient effort been expended to obtain data for calibration?	Missing	Deficient	Adequate	Very Good			
4.2	Is the model sufficiently calibrated against spatial and temporal observations?	Missing	Deficient	Adequate	Very Good			
4.3	Are the calibrated values plausible?		No	Maybe	Yes			
4.4	Has the calibration process been sufficiently documented? Have an appropriate number and range of time-series plots and statistics of the observed and modelled data been provided ?	Missing	Deficient	Adequate	Very Good			
4.5	Has the robustness of the model to operate outside the calibration period been established and documented?	Missing	Deficient	Adequate	Very Good			
5.0	***VERIFICATION/TESTING***							
5.1	Where appropriate, have all reasonable avenues for verifying and testing the model been undertaken and documented? Alternatively, if verification or testing have not been undertaken, have the reasons been documented?	Missing	Deficient	Adequate	Very Good			
6.0	***PREDICTION***							
6.1	Have the year 2000 *baseline conditions* model been run for the period May 1975 to June 2000? Are the Year 2000 model assumptions appropriate and documented clearly?	Missing	Deficient	Adequate	Very Good			
6.2	Have key statistics been prepared from the *baseline conditions* predictions? Are the *baseline conditions* plausible?	Missing	Deficient	Adequate	Very Good			
6.3	Is the model capable of predicting the effect of all *accountable actions* in the modelled area?		No	Maybe	Yes			
6.4	Is the model capable of predicting any *delayed salinity impacts* from the modelled area?		No	Maybe	Yes			
7.0	***SENSITIVITY AND UNCERTAINTY ANALYSES***							
7.1	Have the potential uncertainties in the model inputs been identified?	Missing	Deficient	Adequate	Very Good			
7.2	Have the potential errors in the modelling processes been discussed?	Missing	Deficient	Adequate	Very Good			
7.3	Have the potential uncertainties in the model outputs been estimated, and in particular, the uncertainties in the key target values which the model may be used to predict?	Missing	Deficient	Adequate	Very Good			
8.0	***MONITORING***							
8.1	Has an assessment of the adequacy of the current monitoring network to support model development been made?	Missing	Deficient	Adequate	Very Good			
8.2	Are recommendations made to upgrade the monitoring network where it is inadequate?	Missing	Deficient	Adequate	Very Good			

Appendix 3.10

CRITERIA FOR ASSESSING THE IMPACTS OF IRRIGATION DEVELOPMENTS

	EVALUATION CRITERIA	*ASSESSMENT*	RECOMMENDED IMPROVEMENTS
1.0	**PROPOSAL OVERVIEW**		
1.1	Is the statement of objectives clear in the proposal and are the objectives consistent with the requirements of Schedule C?		
1.2	For what purposes and to what areas is the model stated as being applicable?		
1.3	Has appropriate effort been directed towards satisfying Initial appraisal requirements outlined in 3.6.3 of the protocols and Schedule C objectives?		
1.4	Is the level of detail provided commensurate with the extent of the potential salinity impact and associated uncertainty (Protocols 3.3 pt5)?		
1.5	Has the assessment already undergone external review? If so have the findings of these reviews been made available?		
1.6	Have the limitations of the assessment been correctly identified and reported in line with detailed assessment requirements (3.6.4)?		
1.7	Which version of SIMRAT was reviewed? Which version of MSM-BIGMOD was linked to SIMRAT? Is the BIGMOD version currently approved for the 1975-2000 simulation adjusted to 2000 conditions? Are the linkages between these two models up-to-date and consistent for the estimation of salinity impacts to downstream users and $$ benefits/disbenefits, and which report provides comprehensive documentation of this linkage?		
1.8	Which versions of the numerical groundwater flow models were used? Was the ready reckoner applied to the results from the numerical models?		

2.0	**DATA ANALYSIS**		
2.1	What objective evidence is provided (eg. assessment sheets) to comprehensively document the data available in terms of details of the proposed trade, the sites and the assumed/adopted parameters, any assumptions or default parameters, the water and salt balance and trade impacts, and reality checks on the model results? Does the objective evidence (Assessment Sheets) provide comprehensive (audit-trail) documentation? If not, what improvements are required?		
2.2	Has all data relevant to the actions (permanent and temporary (interstate and intrastate) trade, surface water, groundwater, landuse, diversions, climate, etc) been collected and analysed?		
2.3	Is information provided on the spatial and temporal extent, and the quality, extent and standard of the available data, commensurate with the potential impact. ?		
2.4	Has the process of infilling data gaps and extending data beyond the period of record been highlighted and carried out appropriately?		
2.5	Has relevant data (permanent and temporary interstate and intrastate trade), been collected and analysed? Has information on the spatial and temporal extent, and the quality of the available data, been provided?		
2.6	Have the data analysis aspects of the numerical groundwater model applications been reviewed for consistency with the MDBC Groundwater Flow Modelling Guidelines?		
3.0	***SALINITY IMPACT ASSESSMENT***		
3.1	Have the 1 January 1988 baseline and current conditions been run for the period May 1975 to June 2000 consistent with the requirement of the protocol? Are the assumptions appropriate and documented clearly?		
3.2	Has the salinity assessment been undertaken for future salinity impacts – 2015, 2050 and 2100? Are the estimates plausible?		
3.3	Does the assessment consider the impact in light of potential interactive effect of all other accountable actions in the study area? Record and comment key issues to be addressed if and when subsequent proposals are put forward		

3.4	Does the model output documentation clearly identify the purposes of the run and the unique model run identifier? Is there a logical and auditable link between the run identifier and the particular application (eg. licence/trade number)?		
4.0	***SENSITIVITY AND UNCERTAINTY ANALYSES***		
4.1	Have the potential errors in the proposal processes been discussed?		
4.2	Have the potential uncertainties in the proposal outputs been estimated, Are these estimates commensurate with the magnitude of the proposed impact.		
4.3	Has an appropriate set of future model improvements been identified and scheduled? Where appropriate, do the proposed model improvements take account of increased data availability in the future? What do the reports indicate regarding the likely sensitivity of the predictions to the proposed improvements?		
4.4	Has the SIMRAT model been used to test the sensitivity of results? Will the assumed boundary conditions or flow/salt processes greatly affect the prediction? For example: • Could the seller/buyer site be so close to the river that the boundary conditions and timelag processes are inappropriate? • Could the seller/buyer site so large that the actual location of the development is uncertain? • Could the information available regarding water use efficiency likely to affect the accuracy/reliability of the predictions What is the minimum requirement for adequate information be available for the spatial and temporal context for the assessment (seller/buyer details)		

5.0	***MONITORING***		
5.1	Does the Proposal provide sufficient detail to assess the adequacy of the current monitoring network to support ongoing assessment and reviews,? If not provide comment on what is needed		
5.2	Are recommendations made to upgrade the monitoring network where it is inadequate?		
6.0	***ADMINISTRATIVE AND LEGISLATIVE ARRANGMENTS***		
6.1	Are the administrative and reporting arrangements relevant to this proposal sufficient to allow for review, reporting and audit consistent with the intent of section 3.7 of the protocols		
7.0	**Other**		
	List any other criteria as appropriate		

Appendix 3.11

SIMRAT – DESCRIPTION AND ADMINISTRATIVE ARRANGEMENTS

Description

The Salinity IMpact Rapid Assessment Tool (SIMRAT) is a modelling tool that has been developed to assess the salinity impacts arising from the application of water on greenfield developments within the Pilot Interstate Water Trading area – the Mallee Zone of Victoria, New South Wales and South Australia. The model provides for the movement of water from the ground surface into recharge, and discharge from a nominated “discharge edge” into the River Murray. Relationships derived from MSM-BIGMOD modelling provide the means to translate salt inputs at particular points to salinity impacts at Morgan and the corresponding salinity cost effects.

SIMRAT’s primary purpose is to provide estimates of increases or decreases in salt load to the River Murray arising from the trading of irrigation water. These estimates will allow the Commission to adjust the salinity registers established under Schedule C of the Murray Darling Basin Agreement. SIMRAT covers the extent of the Pilot Interstate Water Trading Project, from approximately Nyah to Goolwa. It encompasses a 15 km buffer either side of the River Murray, within which assessments can be made.

The SIMRAT model assesses unconfined aquifer discharge responses arising from changes in recharge occurring at some distance. The model combines this with groundwater salinities to calculate changes to salt inflows to the river. If a floodplain exists, SIMRAT allows for attenuation of the salt inflows.

- Once salt loads have been calculated, MSM-BIGMOD is used to convert salt inflows to EC changes and the salinity cost effects at Morgan. The impacts of water trades can then be assessed on a consistent basis.

SIMRAT may be used for other purposes such as assessing the impacts of irrigation and infrastructure rehabilitation, or improving irrigation efficiency. In these cases SIMRAT should be regarded as a specific purpose assessment model and the principles in Chart 2.2 apply.

How SIMRAT works

SIMRAT uses 5 steps to convert the application of traded water to a salinity impact at Morgan:

- **Step 1: Application to root zone drainage**
  The volume traded is assumed to all be contributing to a greenfield development that will operate at 85% water use efficiency. This leaves 15% not taken up by the plants. Of this amount, 1/3 (i.e. 5%) is allowed for losses such as surface runoff, evaporation and removal via subsurface drains. The assumption therefore is that 10% of the irrigation and effective rainfall will leave the root zone as Root Zone Drainage (RZD) and recharge the unconfined aquifer.

- SIMRAT will take the sum of the water traded and the effective rainfall to be the effective application to a greenfields development. If there is convincing evidence that these assumptions are incorrect for a particular transaction, then site-specific variations may be introduced into the SIMRAT model.

  - **Step 2: From root zone drainage to recharge**
    A lognormal algorithm is used to describe behaviour over time as irrigation development at an arrival site creates a 'wetting' scenario where the dry unsaturated profile is 'wet up' by the increased RZD. When calculating a salinity credit generated from the retirement of irrigation at a departure site, a 'drying' scenario is used to describe the draining of the wet profile. The recharge to the unconfined aquifer thus decreases over time as the wet profile gradually drains.

  - **Step 3: From recharge to impact at the discharge edge**
    Recharge to the unconfined aquifer calculated in step 2 causes a groundwater discharge response for a unit recharge based on distance from river and aquifer properties of transmissivity and specific yield. There is an assumption that all discharge occurs within a single cell, and that cell is the closest cell on the discharge edge to where the recharge occurs. The amount of salt induced from the recharge is relative to the salinity of the groundwater being driven into the river valley. Having determined groundwater salinities at the discharge edge, SIMRAT multiplies total flux responses by the salinity at the closest edge cell. This stage utilises the Unit Response Equation (URE) discussed below.

  - **Step 4: River connectivity and flood plain attenuation**
    In NSW and Victoria, the Parilla Sands aquifer is occasionally separated from the river by a clay layer. Where this is known to occur, SIMRAT applies a river connectivity factor to the outputs of stage 3 to compensate for this. Similarly, a floodplain attenuation factor can be applied to account for the amount of salt attenuated in the floodplain.

  - **Step 5: Conversion to assessment units**
    Outputs from stage 4 are converted to EC impacts at Morgan and $ costs to downstream users with factors derived from MSM-BIGMOD. If the results indicate that that the trade has given rise to a significant effect, then it can be reported to the Commission for possible entry into Register A.

SIMRAT Accreditation Status

The SIMRAT model is an approved model under Schedule C Clause 38(5) of the Murray-Darling Basin Agreement. In June 2004 the Commission approved the SIMRAT model as "fit for purpose" on the basis of recommendations from the Water Trade Salinity Impacts Evaluation Panel (WTSIEP) and Basin Salinity Management Strategy Implementation Working Group (BSMSIWG).

SIMRAT is approved for the assessment of the salinity impacts of new irrigation due to interstate water trade in the Mallee Zone. In particular, the use of the SIMRAT model output is approved as a basis for the adjustment of Register A where no other agreed method exists.

The key conditions applying to the use of SIMRAT are:

- Applications to new irrigation due to interstate water trade in the Mallee Zone
- SIMRAT may be used for the assessment of arrival site debits, and for departure site credits when the history of water use can be proved
- Assessments should be made using best available data for each specific trade, with jurisdictions ensuring best available data is made available for use in SIMRAT data inputs.

Administrative principles for SIMRAT

The use of SIMRAT to adjust Register A must be highly controlled, properly managed and accountable. The following principles apply:

- The Commission will coordinate the use of the model, and ensure that appropriate training and support is provided for model users;
- The model, its default layers and variables will be given controlled document status;
- The Commission will retain a copy of the model, and the default layers and variables including site specific information used for each assessment;
- Estimation of Register A debits will be undertaken by the States in collaboration with the Commission;
- The model will be run at least annually for the purpose of estimating Register A debits for the cumulative impacts of relevant trades in that year;
- The model, default layers and variables will be presented to the Independent Audit Group annually;
- The States will provide basic data needs,being the volume of trade, the spatial location of irrigation development, the relevant default layer metadata and variables including site specific data for each trade;

- The States will provide hydrogeological expertise to advise on the appropriate parameters and adjustments to model runs to ensure applicability or identify limitations of the URE for each trade;

- As with all accountable actions, initial estimates of the salinity impacts of new irrigation development will be based on a number of theoretical assumptions (eg location of irrigated area, root zone drainage rates). Monitoring of *accountable actions* (Protocol 5.4.2) should focus on testing key assumptions, with estimated impacts revised, as appropriate, through the Five Year Reviews (Protocol 5.7.5).

Support processes

The Commission will establish the following support processes:

1. Convening an inter-jurisdictional reference group to oversight the implementation and maintenance of SIMRAT. Terms of reference for the group will include: The review of data layers:
    - The review of assumptions and algorithmic (model) changes
    - Recommendations to BSMSIWG regarding changes to SIMRAT
    - Delivery of revised versions of SIMRAT and/or data layers to jurisdictions
    - Oversight and review of SIMRAT reporting protocols.

2. An interstate trade numbering system to internally track interstate trades and to ensure appropriate coupling of departure side and arrival side impacts.

Appendix 5.1

DETAILED REGIONAL REPORT—OUTLINE

Structure of a typical annual progress report from a State government, based on the 9 intervention themes of the BSMS:

1 Developing capacity to implement the strategy

If applicable, report on activities undertaken to support catchment communities in the implementation of the BSMS.

2 Identifying values and assets at risk

If applicable, report on the identification of important values and assets at risk from salinity, and the nature and timeframe of the risk.

3 Setting salinity targets

Progress towards finalising targets and monitoring regimes

3a Report on *end-of-valley targets*

Measured flow and EC at end-of-valley and intermediate sites

3b Report on within-valley targets

Initially this report should focus on the processes to develop these targets and a timetable of milestones.

4 Managing trade-offs with the available within-valley options

If applicable, report on progress towards establishing within-valley targets, assessment of the predicted impacts and proposed monitoring arrangements for tracking these targets.

5 Implementing salinity and catchment management plans

If applicable, report on the status of development, accreditation and implementation of regional plans, and aprediction of the impact of works, expressed in terms of EC at Morgan and the relevant end-of-valley site.

5a Allocation and uptake of salinity disposal entitlements

Expressed in terms of EC at Morgan, clearly state the basis and assumptions for calculating the uptake.

6 Redesigning farming systems

If applicable, report on the type and extent of on-ground works or research projects undertaken.

7 Targeting reforestation and vegetation management

If applicable, report on the area and location of vegetation protected by physical works (such as fencing), the area and location of vegetation protected by covenants (or similar) and the area, location and species of revegetation.

8 Constructing salt interception works

If applicable, report on cost ofworks, completion date and expected salinity benefits.

9 Ensuring basin-wide accountability, monitoring, evaluating and reporting

If applicable, give adescription of the models used in assessing the impact of actions on within-valley, end-of-valley and basin targets; report on the monitoring regimes established, and provide asummary of the results of any evaluations undertaken this financial year that differ from the rolling 5-year audit.

Source: MDBC memorandum to States re annual reports, 24 July 2002.

Appendix 5.2

ATTRIBUTES OF 5-YEAR ROLLING REVIEWS

The attributes and parameters for the quantification of salinity impacts in the rolling audits need to allow for consistent basin-wide assessments without limiting the ability of the States to choose the analytical tools.

The assessments should be made for rational sub-units of each catchment and should refer to current conditions (refer to Baseline and Benchmarks), and for predictions for at least the years 2015, 2050 and 2100. The resulting report should include:

(a) the land area likely to be affected,

(b) the salt mobilised (tonnes per year per unit area or per length of river)

(c) the salt retained in the landscape and/or mobilised to the streams

(d) the stream salinity changes, (EC at target sites)

(e) the ecological thresholds (including endangered species protection),

(f) the implications for key values and assets including cultural heritage aspects

(g) the economic impacts.

The updated audit will be retained in a salinity reporting database which could be based upon land management units, groundwater flow systems or other appropriate geographic units defined by the catchment managers. It could incorporate biophysical parameters such as:

(a) rate of rise or depth to groundwater, groundwater salinity, equilibrium times, predictions of time to reach the surface

(b) areas at risk of waterlogging or salinisation (km 2)

(c) salt wash-off or base flow contributions to streams, (t/km 2, or T/km)

(d) implications for stream salinity and salt loads (EC %iles, and T/year)

(e) agricultural productivity at risk, in both dryland and irrigated regions (Ha , $$)

(f) public and private infrastructure (classes, $$)

(g) terrestrial and aquatic biodiversity (classes, Ha & reaches)

(h) cultural heritage (classes and significance attributes)