Australian Government

Murray–Darling Basin Authority

Basin Salinity Management 2030

2022–23 Comprehensive report

January 2024

Published by the Murray–Darling Basin Authority
MDBA publication no: 08/24
ISBN (online): 978-1-922699-52-7

GPO Box 1801, Canberra ACT 2601
engagement@mdba.gov.au
1800 230 067
mdba.gov.au

Cataloguing data
Title: Basin Salinity Management 2030, Murray–Darling Basin Authority Canberra, 2024. CC BY 4.0

Accessibility
The Murray–Darling Basin Authority makes its documents and information available in accessible formats. On some occasions the highly technical nature of the document means that we cannot make some sections fully accessible. If you encounter accessibility problems or the document is in a format that you cannot access, please contact us.

Acknowledgement of the Traditional Owners of the Murray–Darling Basin
We acknowledge the Traditional Owners and Custodians of Country throughout the Murray–Darling Basin and their continuing connection to land, waters and community. We offer our respects to the people, the cultures and the Elders past, present and emerging.

Aboriginal people should be aware that this publication may contain images, names or quotations of deceased persons.

Contents

Foreword

I have pleasure in releasing the Murray–Darling Basin Authority's (MDBA) 2022–23 comprehensive report of the Basin Salinity Management 2030 (BSM2030) strategy, the fourth comprehensive report since the strategy came into effect in 2015.

Basin governments have been working together with their communities for 35 years to manage salinity in the Murray–Darling Basin. The BSM2030 strategy is delivering a strategic, cost effective and streamlined program of coordinated salinity management. The results for the 2022–23 period demonstrate the effectiveness of the actions taken since 1975 to reduce river salinity. This outcome is beneficial to the environmental, social and economic values of the River Murray.

The 2022–23 reporting period follows three years of La Niña weather conditions and the largest River Murray flood in living memory that brought significant challenges to the Basin. Despite these challenges and high salt load exports from this event, the Basin salinity target at Morgan in South Australia continued to be met which is a key achievement.

A significant part of the 2022–23 BSM2030 key achievements is due to mitigation works and measures such as the improvement of land and water management practices over many years and the operation of salt interception schemes. The benefits provided by these works and measures are affected by climate, which delivers variations in flows and changes in catchment salt mobilisation. Considering this variability and its impact on salinity outcomes, modelling is undertaken to understand how the improved practices deliver salinity benefits across both wet and dry periods.

Modelling shows that for each of the last 14 years, partner governments and the MDBA have worked together to meet the Basin salinity target of maintaining the average daily salinity at Morgan, South Australia, at less than 800 EC for at least 95% of the time. This measure is simulated over both wet and dry climatic sequences and reflects the successful actions taken by partner governments and communities in managing salinity in the Basin.

The Independent Audit Group for Salinity conducted their audit of the BSM2030 strategy in November 2023. The auditors reviewed the strategy implementation by MDBA and the partner governments in accordance with Schedule B and associated procedures. The executive summary of the audit report, including their recommendations, is provided in this report.

The success of the BSM2030 strategy is only possible with the cooperation of partner governments and the dedication of the people involved. In particular, the commitment by partner governments to deliver salinity management activities in their valleys and the cooperation extended to the MDBA is commendable.

Although great progress has been made, managing salinity remains a challenge in the basin. The collective effort and commitment for salinity management through the BSM2030 strategy will take us through to 2030 and beyond. I look forward to continued success with the partner governments working together to implement the BSM2030 strategy.

Andrew McConville
Chief Executive

Abbreviations

AWRC	Australian Water Resources Council
BOC	Basin Officials Committee
BSMS	Basin Salinity Management Strategy
BSM2030	Basin Salinity Management 2030
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EC	electrical conductivity (measured as µS/cm)
EoVT	end-of-valley target
IAG–Salinity	Independent Audit Group for Salinity
LoH	Legacy of History
MDBA	Murray–Darling Basin Authority
MDBC	Murray–Darling Basin Commission
MSM–BigMod	daily flow and salinity model for the River Murray
SIS	Salt Interception Schemes
TLM	The Living Murray

Executive Summary

Basin Governments and the MDBA have been working together to implement strategies to manage salinity in the Basin for more than 30 years. To continue this collective effort, the Basin Salinity Management 2030 (BSM2030) strategy was adopted by Ministerial Council in November 2015 to guide basin-wide salinity management until 2030. The BSM2030 strategy focuses on continuing to ensure salinity is kept at levels appropriate to protect economic, environmental, cultural and social values.

This is the fourth comprehensive report prepared by the MDBA under the BSM2030 strategy highlighting progress in implementing basin-wide salinity management. The report provides an overview of outcomes and achievements against the key elements of the BSM2030 strategy and includes the executive summaries from the reports prepared by each of the Basin States and the Australian Government for the period 1 July 2021 to 30 June 2023.

Salinity accountability framework

The salinity registers remain a critical aspect of the salinity management accountability framework under the BSM2030 strategy. The 2023 salinity registers indicate that New South Wales, Victoria and South Australia (ACT and Queensland do not have any register entries) continue to be in net credit positions as required under the BSM2030 strategy.

Under the BSM2030 strategy, the Basin salinity target continues to provide a key reference point for achievement in Basin salinity management. This target aims to maintain the average daily salinity at Morgan in South Australia at a simulated level of less than 800 EC for at least 95% of the time.

Comparing modelled salinity against the baseline, based on 2022–23 levels of land and water use, river salinity at Morgan was 786 EC for 95% of the time; hence the strategy is meeting the Basin salinity target.

This long-term modelled outcome is supported by measured salinity levels which have remained below 800 EC at Morgan in South Australia since 1998.

Management of Salt Interception Schemes (SIS)

Management of SIS continued to include a focus on varying the level of scheme operations in response to forecast salinity and flow conditions throughout the reporting period 1 July 2021–30 June 2023, in addition to addressing key knowledge gaps about system responses to the changing level of operations and minimising running costs where practical.

During the 2022–23 year, extended high floods in the River Murray were experienced, resulting in a number of schemes, consistent with operating rules, being de-energised or incurring damage. Based on recent experience from the 2016 flood event, it is anticipated that repairs to schemes will be

contingent on access, inclement weather and availability of labour and materials. It is anticipated that repairs may take in the order of 12-24 months.

Throughout the reporting period about 655,951 tonnes of salt was diverted away from the river system and nearby landscapes (374,810 tonnes and 281,141 tonnes in respective years). The annual amount of salt diverted over the past two years has been different reflecting the varying operating conditions over this period.

Implementation of the trial of responsive management of SIS continued throughout the reporting period. In 2021–22 an extension of the trial to 2025 was achieved to allow for a more complete understanding of system responses to changed SIS operations. The sites that are part of the trial of responsive management sites were severely impacted by flood events. The monitoring equipment at the trial sites was decommissioned to ensure they were not damaged in the flood events. Planning is underway to reestablish these sites. The salinity outlook tool continued to be used to inform operational decisions in support of the trial of responsive management of SIS.

Salinity management

The BSM2030 strategy supports operational management of the Basin Plan flow management salinity targets at Lock 6, Morgan, Murray Bridge, Milang and Burtundy. Assessment of the salinity levels at the Basin Plan reporting sites found that the salinity target values were met (percentage of days above the target was less than 5% over the five-year reporting period) at three of the five reporting sites, with exceedances occurring at Burtundy and Milang.

Exceedance of both the Burtundy target and the Milang target over the five-year reporting period has decreased since last year's result. This was due to the substantial widespread flooding across the Murray – Darling Basin providing an opportunity for removal of salt from the landscape and significant freshening of the floodplain and watercourses.

In general, salinity levels along the River Murray were relatively low during 2022–23. Operation of the SIS had a reduced influence due to the removal of SIS infrastructure due to the floodplain inundation. It is estimated that 4.57 million tonnes of salt was exported through the barrages in 2022–23 and over the three-year period from July 2020 to June 2023 the annual average export was 2.38 million tonnes. The significant amount of salt exported in 2022–23 was due to an annual flow to South Australia (SA) of nearly 23,000 gigalitres (GL), which was substantially larger than the 9,090 GL received in 2021–22. This is significantly above the normal regulated entitlement flow of 1,850 GL plus environmental water flows which are on average up to 1,000 GL per year.

The high flow in 2022–23 led to substantial floodplain inundation and watering of areas in the River Murray system which hadn't received water since the 1970's. Significant volumes of salt can accumulate on the lower River Murray floodplains and this flow event would have led to a substantial mobilisation of salt, albeit with a significant dilution impact.

Under the BSM2030 strategy, jurisdictions continue to monitor flow and salinity for the nominated end-of-valley target sites. In the southern connected system, the 50th and 80th percentile salinities for long-term datasets were reported for salt load and EC levels.

Efficient governance

The consolidated BSM procedures and the BSM Modelling Procedures were provided for endorsement to the Basin Officials Committee (BOC) on 14 June 2023 and were subsequently published on the MDBA website in September 2023.

The TWGSM endorsed the re-estimated baseline conditions salt inflows report and concluded that the report remains a work in progress and will need to be updated as the transition to Source progresses.

Work is in progress to compare outputs of the BIGMOD 2018 version and Source and the MDBA expects to use the Source model to prepare the 2024 salinity registers.

The Review Plan tracking template also continued to be used to highlight progress in undertaking reviews as set out in the Review Plan and to document any changes to the timing of reviews. The BSM procedure: Developing the review plan has been revised in consultation with jurisdictions. The intent of the update to this procedure was to provide a more risk-based approach on higher risk actions and to allow for the better use of resources.

Strategic knowledge improvement

A number of projects to address the BSM2030 knowledge priorities were undertaken in 2021–23. These included:

- The final phase of developing the transfer functions models is being undertaken using the Sunraysia regions of New South Wales and Victoria as a trial area.
- CSIRO and MDBA continued to collect robust field data for vegetation evapotranspiration, aiming to improve the accuracy of evapotranspiration data used in numerical models.
- MDBA, SA DEW and University of Queensland have completed three phases of the floodplain inundation and drying study to quantify and better understand how water and salt move within floodplains. The fourth and final phase of work will be undertaken in 2023–24.
- MDBA, with Flinders University, established the floodplain understorey vegetation evapotranspiration study, to assist estimating the floodplain total evaporative loss of water.
- Investigations continued at six locations along the River Murray to address a number of the key knowledge gaps associated with the trial of responsive management of SIS.
- MDBA continued to develop the floodplain processes body of knowledge, with the objective of making existing and new material on floodplain processes more easily discoverable and accessible online.
- A review of the salinity cost functions.

Community engagement and communication

In 2021–23, MDBA communicated salinity management outcomes and progress with implementing the BSM2030 strategy through its status and summary reporting to Ministerial Council. These reports were published on the MDBA website.

Priorities for future work

In 2023–24, priorities to be implemented through the BSM2030 strategy include:

- finalising the transition to the Source model for preparing the Salinity Registers
- continuing the trial of responsive management of SIS and implementing knowledge gap investigations at the trial sites
- progressing the BSM2030 knowledge priority projects
- reviewing register entries and models consistent with the Review Plan
- convening the fourth Basin salinity forum to promote discussion and collaboration between Basin salinity managers, river operators, environmental water managers to share lessons learnt and to support BSM2030 implementation
- supporting the assessment of salinity impacts from the SDLAM projects
- an economic assessment of the benefits of salinity management
- preparation for BSM2030 Review
- completing the biennial audit of BSM2030 strategy implementation.

Introduction

Basin governments have been working together with their communities for more than 30 years to manage salinity in the rivers and catchments of the Murray–Darling Basin. To continue the ongoing collective efforts in salinity management, the Basin Salinity Management 2030 (BSM2030) strategy focuses on ensuring that salinity within the Murray–Darling Basin is maintained at appropriate levels to protect economic, environmental, cultural and social values.

Key elements of the BSM2030 strategy include:

- Maintaining the existing salinity accountability framework and incorporating new issues related to environmental water and flow management.
- Using risk-based approaches to improve the cost effectiveness of salinity management.
- Trialing different options to manage SIS so that operations and costs can be reduced when river salinity is forecast to be low.
- Investing in knowledge priorities to reduce uncertainty around future salinity risks, which may assist in avoiding future capital investment in new works to manage salinity.

Reporting has been rationalised under the BSM2030 strategy. Given the progress in Basin salinity management over the period 2001 to 2015, and the maturity of the collaborative arrangements, BSM2030 reporting was able to be streamlined without risk to strategy implementation or achievement of strategy objectives.

This report is the fourth comprehensive report prepared by the MDBA under the BSM2030 strategy.

Salinity Accountability Framework

One of the key elements for the success of salinity management in the Basin is the commitment of all jurisdictions to a strong salinity accountability framework implemented through the salinity registers.

Status of the BSM2030 salinity registers

The salinity registers are a critical aspect of the BSM2030 strategy and are an effective environmental accountability framework that considers economic impacts as well. The registers provide the primary record of jurisdictional accountability for actions that affect river salinity.

The registers are an accounting tool that record the debit and credit balance of accountable actions that significantly affect[1] river salinity at Morgan in South Australia. This accounting system provides a transparent basis for making decisions on basin-wide trade-offs on salinity management actions and investments in joint works and measures.

Actions that reduce river salinity are recorded as credits, while actions that increase river salinity are recorded as debits. Actions such as constructing and operating SIS and improvements in irrigation practices can generate a credit. Actions such as irrigation development may generate a debit because in some areas they may lead to increased salt loads entering the River Murray. In addition, actions such as permanent water transfers in or out of an irrigation area may result in either a credit or a debit.

State and territory governments report annually to the MDBA, providing new or updated information on accountable actions. This information is collated and analysed to update the registers each year. This enables changes in river salinity impacts to be tracked over time. It also provides estimates of the economic costs and benefits arising from these salinity effects. The updated registers are audited biennially by independent auditors and published on the MDBA website.

There are two salinity registers, Register A and Register B:

- Register A records the impacts of each accountable action that occurred after the baseline date (1988 for New South Wales, Victoria and South Australia, 2000 for Queensland and the Australian Capital Territory) and includes jointly funded works and measures.
- Register B accounts for delayed salinity impacts, which have an effect on salinity levels after 2000 but which are the result of actions taken before the respective baseline dates.

The success of past salinity strategies in delivering significant salinity improvements for the Basin stems from jurisdictional agreement to be accountable for both salinity debits and credits on the registers and to undertake collective actions that lead to material improvements in river salinity.

---

[1] A Significant Effect is:
(a) a change in average daily salinity at Morgan which the Authority estimates will be at least 0.1 E.C. by the year 2100; or
(b) a salinity impact which the Authority estimates will be significant.

Such collective actions include those jointly undertaken under MDBA–coordinated programs (authorised works or measures) and those undertaken by two or more states independently of MDBA (shared state actions). 'Authorised works or measures' and 'shared state actions' are shown separately on the salinity registers, with the benefits shared between states. They are distinguishable from individual state actions for which the particular state gains either a debit or a credit.

The registers were reviewed and amended as part of the development of the BSM2030 strategy. A summary of the amendments is provided in **Appendix B**. The updated 2023 salinity registers, including updated entries, are provided in **Appendix B** and summarised in Table 1.

The 2023 salinity registers indicate that the states of NSW, Victoria and South Australia are in a net credit position as required under the BSM2030 strategy. ACT and Queensland do not have any register entries.

Table 1: Summary of the 2023 salinity registers (excluding provisional entries)

Actions	NSW ($m/yr)	VIC ($m/yr)	SA ($m/yr)	QLD ($m/yr)	ACT ($m/yr)	Australian Government contribution (EC)
Authorised works or measures	2.397	2.397	0.801	0	0	27.2
State shared works and measures	0.190	0.190	0.000	0	0	0
State actions	2.514	2.048	6.629	tbd	tbd	1.0
Total register A	5.117	4.744	7.430	tbd	tbd	28.3
Transfers to register B	0.593	0.473	1.372	0	0	0
Total register B[a]	0.224	-0.236	0.901	0	0	0
Balance — registers A and B	5.341	4.508	8.332	0	0	28.3

tbd - to be determined

[a] *total includes transfers from Register A*

Proposed or new Accountable Actions

In 2022–23, there were two new accountable actions under the South Australian Riverland Floodplain Integrated Infrastructure Program (SARFIIP):

- Pike SARFIIP
- Katarapko SARFIIP.

The Pike Floodplain is a major floodplain and anabranch system of the South Australian River Murray spanning approximately 6,700 ha. The Pike floodplain and anabranch system is located in South Australia near the towns of Renmark and Berri. The anabranch system bypasses Lock 5, thus presenting the opportunity to manipulate water levels in the system using the artificial head difference created across the lock.

The Katarapko Floodplain is located on the Katarapko–Eckert Creek anabranch system in the Riverland and is part of the Murray River National Park. The floodplain covers 9,000 hectares and is situated opposite the town of Loxton and south-west of Berri. Inflows to the floodplain occur upstream of Lock 4 and outflows occur downstream, between Locks 4 and 3. Surface water within Katarapko Floodplain can impact and be impacted by surface water at other sites, including Lock 4, Pike Floodplain, Gurra Gurra and Disher Creeks.

Bridging the Gap dilution benefits

Dilution of river salinity due to the delivery of Basin Plan water (Commonwealth environmental water holdings or other environmental water held by a State to offset the reduction in the long-term average sustainable diversion limit set by the Basin Plan) is recorded as a provisional entry in the register as *Bridging the Gap dilution benefits from water delivery*. Each year the provisional entry for *Bridging the Gap dilution benefits from water delivery* is updated based on the volume of recovered water that is available as a held environmental water entitlement.

The estimated salinity benefit at Morgan of a 2,800 GL water recovery scenario for 2015 compared to 2015 Basin Plan Baseline Diversion Limit (BP BDL) was 58 EC (MDBA 2014 [2]). It should be noted that this modelling provides indicative results of likely changes to long-term salinity levels against the benchmark period given early assumptions about patterns of water recovery and delivery.

As at 30 June 2022, 2,039.5 GL of recovered water was held in environmental water entitlements. The 58 EC estimated salinity benefit based on the 2,800 GL water recovery scenario is adjusted using a pro rata approach to determine the salinity benefit from the delivery of water recovered at that time. This provisional entry was first included in Register A in 2016 (- 34.7 EC) and updated for 2023 (- 43.3 EC) based on the increased level of water recovered.

Salinity outcomes relative to Basin salinity target

Under the BSM2030 strategy and Schedule B to the Murray–Darling Basin Agreement, salinity targets have been established for the Basin in the River Murray at Morgan in South Australia and for major tributary valleys at end-of-valley target (EoVT) sites.

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. This is modelled over the benchmark period (1975–2000) under the current land and water management regime. The benchmark period provides a mechanism for consistently assessing river salinity outcomes over a climatic sequence that includes both wet and dry periods.

[2] General review of salinity management in the Murray–Darling Basin, MDBA 2014

Performance against the Basin salinity target at Morgan

Long-term salinity levels are being maintained below the Basin salinity target. Table 2 indicates that, based on 2022–23 levels of development (including salinity mitigation), river salinity at Morgan was less than 800 EC for 97% of the time – hence, the strategy is achieving the target. As a comparison, under baseline conditions salinity would have been less than 800 EC for only 72% of the time. This demonstrates that under benchmark period flow and climate conditions, the incidence of salinity exceedance of 800 EC at Morgan has substantially declined.

Table 1: Simulated salinity (EC) summary statistics at Morgan, South Australia, for baseline and 2023 conditions over the 1975 to 2000 climatic period

Period	Time interval	Average	Median (EC)	95 percentile (EC)	% time greater than 800 EC	% time less than 800 EC
25 years	Modelled 1988 conditions 1975–2000	665	666	1058	28	72
25 years	Modelled 2023 conditions 1975-2000	502	466	786	3	97

Note: Baseline conditions are the conditions that influenced flow and salinity within the Basin on 1 January 2000. For New South Wales, Victoria and South Australia, these baseline conditions include the Accountable Actions arising from development activities between 1988 and 2000.

Figure 1 further illustrates the success of current management interventions by showing the progressive reduction in modelled river salinity in response to changes in development and the implementation of mitigation works and measures over time. Salinity impact assessment of the new Pike SARFIIP accountable action completed in 2022–23 resulted in a reduction to the modelled 95 percentile salinity at Morgan in 2023. The reduction was primarily due to the salinity benefits provided by the surface water infrastructure changes and operation of the highland and floodplain salt interception infrastructure.

Achievement of the Basin salinity target in 2010, and the subsequent maintenance of that achievement, is a significant outcome. This provides a tangible demonstration of the benefits that have accrued through substantial and cooperative investment in salinity mitigation and management by the Australian, South Australian, Victorian and New South Wales governments.

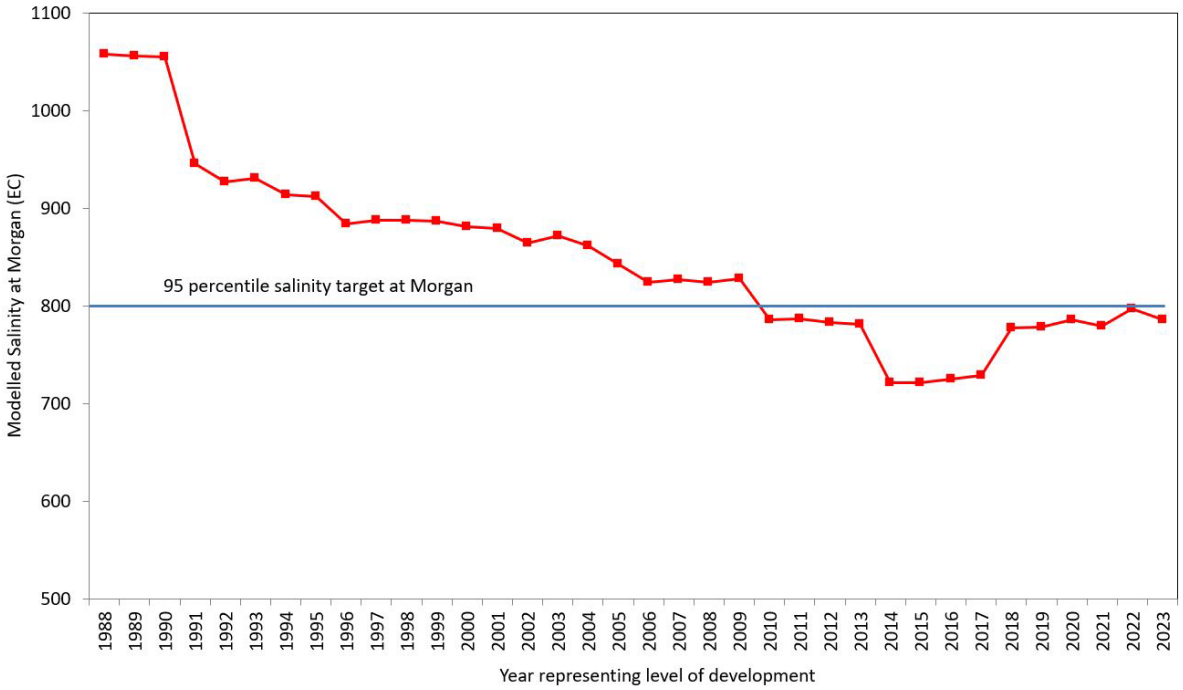


Figure 1 - Modelled 95 percentile salinity over the 1975–2000 Benchmark period at Morgan in South Australia due to the implementation of salinity management programs from 1988 to 2023

Measured salinity levels

While progress against BSM2030 salinity targets is assessed based on modelled river salinity outcomes over the benchmark period, salinity management actions have also had a notable positive impact on measured river salinity. Measured river salinity showed that salinity at Morgan remained below 800 EC throughout 2022–23. The peak river salinity at Morgan has not exceeded 800 EC since 1998.

Table 3 provides statistics on salinity levels measured at Morgan over four periods (1, 5, 10 and 25 years) to June 2023 and enables a comparative assessment of average, median, 95 percentile and peak salinity outcomes for 2022-23.

The 2022–23 salinity statistics were lower compared to the 25-year period and slightly elevated compared to the 5 and 10 year period presented in Table 3. The peak salinity was the lowest compared to all other time periods presented in Table 3. This outcome is a consequence of the prevailing climatic periods covered by the respective reporting periods and the progressive implementation of the salinity mitigation programs mentioned above.

Table 2: Summary of measured salinity levels (EC) at Morgan, South Australia

Period	Time interval	Average	Median	95 percentile	Peak	% time > 800 EC
1 year	July 2022 - June 2023	349	284	579	622	0%
5 years	July 2018 - June 2023	261	236	499	622	0%
10 years	July 2013 - June 2023	295	269	502	732	0%
25 years	July 1998 - June 2023	380	361	646	826	0%

Impacts of salinity management actions

In addition to climatic factors and river conditions, the cumulative benefits of salinity mitigation works and measures, such as SIS and improvements in irrigation practices and delivery systems, have also contributed substantially to the low salinity levels summarised in Table 3. The SIS are highly beneficial to river salinity outcomes during extended periods of low flows.

Figure 2 presents mean daily salinity levels over the period from July 2021 to June 2023 recorded at Morgan and also the simulated (modelled) salinity levels representing a 'no further intervention' scenario for the same period. The 'no further intervention' scenario estimates the river salinity levels that would have occurred if post-1975 SIS and improved land and water management actions were not undertaken. The modelled data shown in Figure 2 does not include the dilution benefits of delivering water recovered under either the Basin Plan or the Living Murray Initiative.

The word 'further' is used because a number of SIS were operating before 1975, so their effects are not included in the simulated salinity levels. The simulated no further intervention salinity levels are derived from river model runs which can model historical salinity levels with and without intervention activities. The difference between the observed and the simulated no further intervention salinity levels are assumed to be the effect of management interventions.

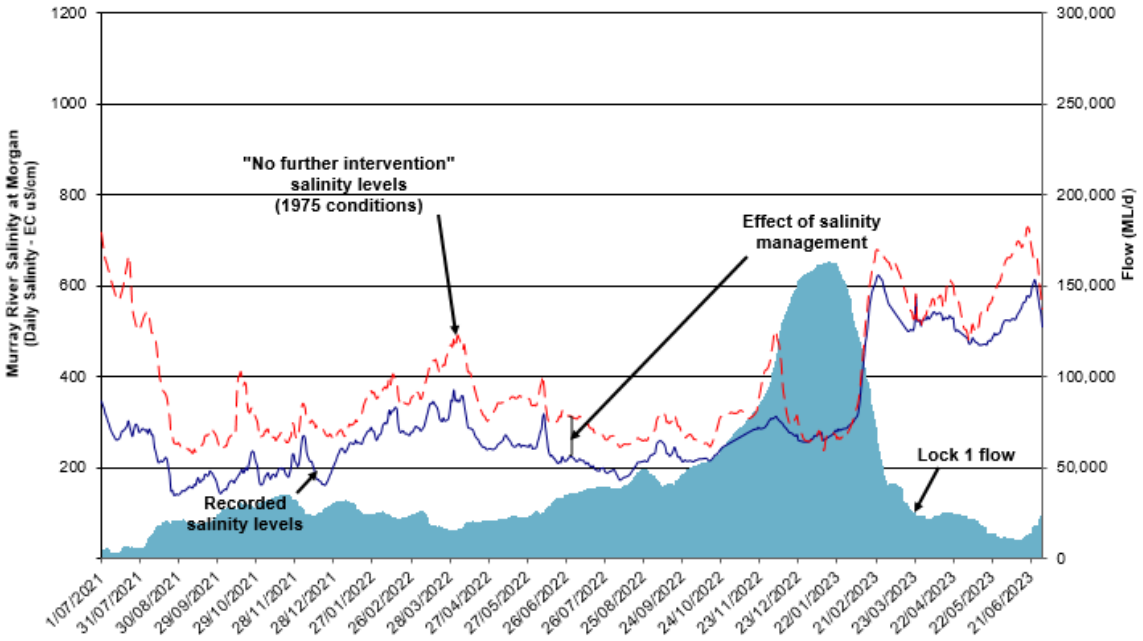


Figure 2 - Comparison of mean daily recorded salinity levels at Morgan from July 2021 to June 2023 to modelled 1975 'no further intervention' salinity levels

River salinity levels progressively increase downstream because of both natural groundwater discharge to the river and accelerated salt mobilisation caused by development activities. The cumulative effects of these factors result in higher salinity in the lower River Murray. Figure 3 demonstrates this progressive increase in salinity downstream with four datasets at specific reaches along the River Murray.

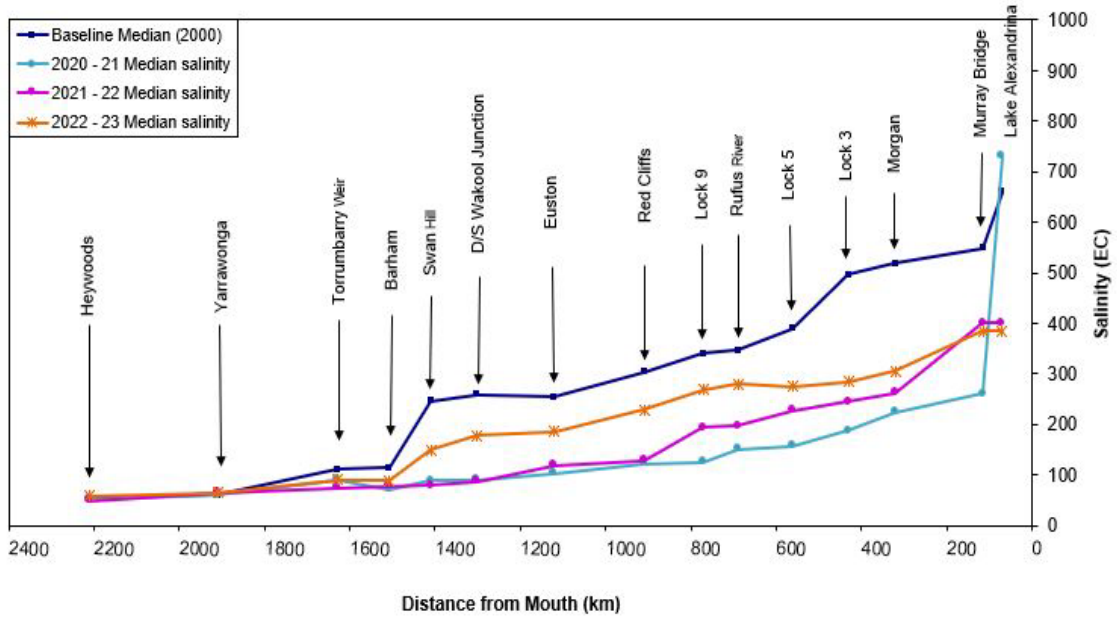


Figure 3 - River Murray salinity profile: comparison of observed median salinity levels of 2022–23 with those of recent past years and the modelled baseline median salinity level for the benchmark period (1975–2000).

Management of Salt Interception Schemes

Operation of the authorised works or measures under Schedule B has focused on the ongoing efficient and effective management of SIS to maintain water quality in the River Murray for agriculture, environmental, urban, industrial and recreational uses.

Scheme operation and maintenance

New South Wales, Victoria and South Australia, together with the Australian Government, have constructed and now operate and maintain 13 Salt Interception Schemes (SISs) under the River Murray Operations (RMO) Joint Venture arrangements. Under the BSM2030 strategy, the focus continues to be on optimising scheme operations and investing in learning and knowledge development for SIS operations.

Operation of the various SIS has continued to be highly successful in terms of in-river outcomes. During the reporting period, operation and maintenance of the existing joint SIS assets continued to focus on minimising running costs, in particular the energy costs associated with pumping.

Table 4 compares salt diverted over the past decade, while Table 5 below details the performance of the joint SIS in 2021–23. Jointly managed schemes diverted about 655,951 tonnes of salt away from the River Murray and adjacent landscapes in 2021-23.

Table 3: Total salt load diverted from the River Murray and adjacent landscapes from 2011–12 to 2022–23

Reporting year	Salt load diverted (tonnes/annum)
2022–23	281,141
2021–22	374,810
2020–21	452,431
2019–20	471,471
2018–19	474,201
2017–18	484,586
2016–17	395,388
2015–16	524,728
2014–15	432,454
2013–14	397,739
2012–13	322,686
2011–12	362,508

Table 4: Joint salt interception scheme performance report 2021–22 and 2022–23

Salt interception scheme	Year	Volume pumped (ML)	Salt load diverted (tonnes)	Average salinity (EC units)	Actual target achieved (% of time)	Power consumption (kWh)
Pyramid Creek	21/22	1,024	26,745	43,000	100	144,715
	22/23	212	5,463	42,920	29	47,439
Barr Creek	21/22	2,272	4,055	5,298	100	44,569
	22/23	665	3,902	3,892	100	33,941
Mildura-Merbein	21/22	1,316	77,672	80,799	59	167,483
	22/23	791	45,151	84,000	7	189,926
Mallee Cliffs	21/22	890	30,949	53,596	97	223,309
	22/23	264	8,895	51,750	25	47,445
Buronga	21/22	1,870	50,858	42,802	98	365,660
	22/23	1,603	43,117	41,875	68	309,982
Upper Darling	21/22	62	1,940	47,520	68	55,933
	22/23	145	4,107	34,053	22	20,696
Pike River	21/22	389	16,299	51,905	46	112,332
	22/23	449	17,513	50,798	100	128,627
Murtho	21/22	1,085	25,493	38,750	93	1,389,377
	22/23	215	5,198	39,027	15	167,113
Bookpurnong	21/22	735	13,218	31,804	80	253,495
	22/23	81	1,493	27,644	16	33,389
Loxton	21/22	605	7,569	21,608	85	235,495
	22/23	64	937	20,556	8	26,896
Woolpunda	21/22	4,030	76,959	30,592	95	2,296,047
	22/23	5,116	94,915	29,507	68	2,824,487
Waikerie	21/22	2,670	43,052	28,820	91	968,159
	22/23	3,322	50,451	27,986	67	1,187,886
Rufus River	21/22	0	0	0	100	4,268
	22/23	0	0	0	100	0
Totals	21/22	**16,949**	**374,810**			**6,261,138**
	22/23	12,928	**281,141**			5,017,827

Note: Operation of pumps varies from year to year based on a number of factors, including; operational decisions under the Responsive Management of SIS; operational advice from the MDBA due to budgets; operational and maintenance requirements; and loss of access and/or scheme operating rules during periods of high flow.

Responsive management of SIS

Under the BSM2030 strategy, responsive management of SIS seeks to reduce operating costs by reducing operation of salt interception bores during periods when flow and/or water source with low salinity provide adequate dilution for in-river salinity to remain below the level at which water remains 'fit for purpose'. It has the potential to provide an acceptable trade-off of operating cost against minimising actual river salinity.

The trial of responsive management of SIS commenced in July 2016 following the inaugural SIS Operators Workshop in May 2016. During the trial period a precautionary approach is being applied to ensure that, to the extent reasonably and operationally possible, in-river salinity is maintained at appropriate levels. Initially the trial period was set for a three-year period from 2016–2019. However, in late 2019, given delays in establishing knowledge gap investigations, primarily resulting from the 2016 high river event and associated allocation of resources during this time to re-establish scheme infrastructure, the Basin Officials Committee (BOC) agreed to extend the trial period until 2025. The extension provides more time to observe system responses to changed operations at the trial sites with the outcomes of the trial informing the BSM2030 strategic review in 2026. The effectiveness of the trial will be reviewed in 2025, and the results will determine whether or not responsive management of SIS should continue beyond 2025 and if so under what policy conditions.

SIS operations under responsive management continued to be determined through the SIS Operators Workshop. Workshop participants include the SIS Managers from each State Constructing Authority, the MDBA Senior Assets representative and the MDBA River Operator representative. Workshops are convened quarterly, and the meetings conducted throughout 2021–22 and 2022–23 are listed in Appendix F. The workshops provide a forum for SIS Managers to draw on a range of information, including the monthly salinity outlooks and operation and maintenance activities to recommend the level of SIS operations moving forward.

The observed salinity has remained below the Basin Plan Target (800 µS/cm), and only briefly exceeded the Responsive Management threshold (600 µS/cm) at Morgan in South Australia on two occasions, following the 2022–23 floods, as shown in Figure 2. This has enabled some schemes and/or components of schemes to be operated at reduced levels (refer Table 6 for more detail).

A high-level summary of the status of key tasks to be completed by the MDBA in conjunction with the SIS Managers from each State Constructing Authority, for the trial of responsive management of SIS, is shown in Table 7.

Table 5: Decisions regarding SIS operations under the responsive management trial during 2022–23

Operational decisions	Change in operations
Workshop 25 – September 2022 The September 2022 Salinity Outlook (MDBA REF D22/24124) and accompanying models indicated that salinity was expected to remain well below the threshold for all four reporting sites (Lock 6, Morgan, Murray Bridge and Milang) over the 6-month outlook period. Key consideration to continue previous SIS responsive management operating levels and the inclusion of Waikerie SIS was attributed to the favourable flow conditions (unregulated flow). Waikerie SIS previously operated at full capacity following the completion of maintenance to test operational capability and have now reduced to SIS operating levels.	Waikerie SIS to operate at reduced levels.
Workshop 26 – December 2022 The November 2022 Salinity Outlook (MDBA REF D22/30618) and accompanying models indicated that salinity was expected to remain below the threshold for all four reporting sites (Lock 6, Morgan, Murray Bridge and Milang) over the 6-month outlook period. Key consideration to continue previous SIS responsive management operating levels was attributed to the continued high flows within the Murray–Darling and the salinity forecast at Morgan remaining below the responsive management threshold of 600EC for the outlook period.	No Change
Workshop 27 – May 2023 The March 2023 Salinity Outlook (MDBA REF D23/6951) indicated that salinity was expected to remain within the Basin Plan Salinity Target thresholds at all four reporting sites (Lock 6, Morgan, Murray Bridge and Milang) over the 6-month outlook period for the modelled scenarios. The forecast report noted the potential for future breaches of the responsive management salinity threshold (600 EC) at Morgan under Moderate and Near Average annual exceedance probability (AEP) scenarios. Key considerations to continued SIS responsive management operating levels was a result of the staged return to operations for schemes impacted by flood. The March Salinity Outlook modelling was amended to better represent the bores that were decommissioned due to high flows as per operating rules.	No Change
Workshop 28 – June 2023 June 2023 Salinity Outlook (MDBA REF D23/13048) indicated that salinity was expected to remain within the Basin Plan Salinity Target thresholds at all four reporting sites (Lock 6, Morgan, Murray Bridge and Milang) over the 6-month outlook period for the modelled scenarios. The responsive management salinity threshold (600 EC) at Morgan is exceeded under all modelled scenarios, the exception being the Wet (25% AEP) scenario. Key considerations to update directives for SIS operation were attributed to the continued post flood remediation, including the energising of Murtho SIS, which in previous outlook was non-operational due to flood impacts.	Murtho SIS to operate at full capacity.

Table 6: Summary of high level tasks, timing and status

Task	Original Date (2015)	Status	Revised Date (2023 update)
Responsive Management Trial Commence	July 2016	● Complete	Unchanged
Knowledge Gap Investigation Commence	No later than July 2016	● Ongoing	Unchanged
Salinity Risk Outlook Review	Every month to 3 months–ongoing (or higher frequency as required) Inaugural review to be in April 2016	● Ongoing	Unchanged
Responsive Management Operation Decision	Every month to 3 months–ongoing (or higher frequency as required). Inaugural decision to be undertaken no later than 2 months prior to the commencement of the trial.	● Ongoing	Unchanged
Preparation of Draft Knowledge Gap Investigation Implementation Plans	November 2015	● Complete	Unchanged
Site Inspections and review of Draft Knowledge Gap Investigation Implementation Plans	December 2015	● Ongoing - Monitoring activities evolving over time to incorporate learnings, subject to budget availability.	Ongoing - will be continuously updated as learnings are applied
Preparation of Final Knowledge Gap Implementation Plans	December 2015	● Ongoing	Ongoing - will be continuously updated as learnings are applied
Finalisation of Triple Bottom Line Assessment Tool	March 2016	● Ongoing	Ongoing–will be continuously updated as learnings are applied
BSMAP Updates	6-monthly	● Ongoing	Updates provided as part of SIS program updates to BSMAP
Review of Governance Arrangements	On completion of the trial and to be included within the trial review	● Ongoing	Unchanged
Review of Bore Assessments	Ongoing	● Ongoing	Unchanged
Review of salinity spikes and long term in-river salinity	On completion of the trial and to be included within the trial review	● Ongoing	Ongoing
Review of Salinity Risk Outlook	Ongoing–to be a standing task at the Operators Forum to review previous operation decision making and salinity risk outlooks	● Ongoing	Unchanged
Responsive Management Trial Report	No later than December 2019 (timing has made allowance for end of year data acquisition and initial processing by SCAs)	● Ongoing–status report completed July 2019.	Final report to be completed to inform the BSM2030 strategic review in 2026

Six-monthly salinity outlook tool to support decision making

The MDBA has continued to prepare monthly six-month salinity outlooks, which SIS Operators draw upon to inform the level of SIS operations and responsive management decision making at SIS Operators Workshops. Other considerations include planned maintenance activities during the forecast period and the current and forecast climatic and river conditions. When the salinity outlook indicates that salinity at Morgan may rise above 600 EC, as far as operationally and practically possible, preparations can then be made to ensure adjustments to SIS operations such that the 600 EC at Morgan is not exceeded as a result of the trial of responsive management of SIS.

Salinity management

Flow-based management

The BSM2030 strategy aims to facilitate continuous improvement in flow management by periodically reviewing and providing advice on flow management practices, particularly in response to elevated salinity events in the shared water resources.

The inclusion of flow management provides the opportunity to look at the effectiveness of in-river salinity management and the collective outcome for the shared water resource from individual actions and accountabilities.

Outcomes for 2022–23

Operational Context

In 2022–23 there was a substantial widespread unregulated flow event which had a significant influence on lowering salinity levels in the Lower Darling and Lower River Murray system where the Basin Plan reporting sites are located. The flow across the South Australian border peaked at approximately 185,000 megalitres per day (ML/d), which was the most substantial flow since the floods in the 1970's. This flow had a significant impact in both mobilising salt from the floodplain and importantly diluting it, resulting in historically low salinity levels including in the Lower Lakes at the terminus of the River Murray.

Salinity targets for managing flows

Salinity levels at the five Basin Plan reporting sites (Lock 6, Morgan, Murray Bridge, Milang and Burtundy) were monitored continuously over the five-year reporting period (July 2018 to June 2023). The targets at the reporting sites are deemed to have been met if the percentage of days above the target is less than 5%, or the salinity has been below the target 95% of the time over the five-year reporting period.

Over the reporting period the assessment indicates the targets have been met at all reporting sites except Burtundy and Milang with these sites being impacted by low flows for some of the 5-year period. This predominantly relates to below average rainfall and inflows for both sites but also the occasional estuary migration from the Coorong into Lake Alexandrina.

The target value at Burtundy is 830 EC and the target was not achieved over the five-year reporting period. Salinity levels at Burtundy were above the target for 13.3% of days over the reporting period. Following an extended period of low or no flow conditions, the lower Darling River re-commenced to flow at Burtundy in April 2020 with flows being maintained between normal operating releases to meet downstream demands to flood operations. Over the 12-month period from 1 July 2022 to 30 June 2023, recorded salinity levels at Burtundy peaked at 528 EC on 31 January 2022.

The target value for Milang is 1,000 EC. The target was not achieved over the five-year reporting period as salinity levels were less than 1,010 EC 95% of the time, which is just above the target.

Salinity levels for the reporting period exceeded the target for 7.1% of days. In the 12-month period from 1 July 2022 to 30 June 2023, recorded salinity levels at Milang peaked at 855 EC on 12 July 2022. This was prior to the significant volume of unregulated flow arriving predominantly over spring and summer which saw salinity levels decline to historically low levels. The lowest salinity value was recorded on 278 EC on 4 November 2022 and was prior to the peak of the flood which arrived in late December 2022 to early January 2023 into Lake Alexandrina.

As recommended in the 2017 Basin Plan Evaluation, the 2020 review of the water quality and salinity targets in the Basin Plan examined the appropriateness of salinity targets, particularly at Burtundy and Milang. The review found that exceedance of the salinity target at Burtundy, and potential for future exceedance of the salinity target at Milang, warrants further detailed investigation to determine whether the target values represent an acceptable level of risk to Basin Plan objectives, and need to be redefined, and/or whether further management action is required to reduce salinity levels at these sites. These findings will be progressed as part of the Basin Plan Review.

Elevated salinity events

During 2021–23 there were no elevated salinity events that BSMAP determined warranted review. BSMAP had reviewed an elevated salinity event in the lower Darling River in 2020. That review provided a number of important insights, especially about the recommencement of flows, which remain relevant in the current context and will be considered when managing the recommencement of flows.

The salt export objective

The Basin Plan includes a salt export objective which aims to ensure adequate flushing of salt from the River Murray system into the Southern Ocean. Achievement of the salt export objective is assessed each year by the MDBA. Over the three-year period July 2020 to June 2023, the annualised rate of salt export over the barrages was 2.38 million tonnes. This is more than the Basin Plan's indicative figure of two million tonnes per year. The total flow across the South Australian border was estimated at approximately 22,994 GL in 2022-23 and up from 9,090 GL in the previous year, which is significantly above the normal regulated entitlement flow of 1,850 GL plus environmental water flows which on average is up to 1,000 GL per year.

Flushing salt from the river systems helps avoid salt accumulation and adverse impacts on water users. Flushing salt also supports healthy river and floodplain ecosystems. Salt interacts with in-stream biota (animals and plants), changing the ecological health of streams and estuaries.

Generally, more salt is flushed out to the ocean during wet years and less in dry years. The level of salt flushing in a year is also impacted by river regulation, irrigation diversions and current levels of development, including salt interception works.

As recommended in the 2017 Basin Plan Evaluation, the 2020 review of water quality and salinity targets in the Basin Plan examined the appropriateness of the indicative figure of 2 million tonnes for the salt export objective as an indicator of adequate flushing of salt from the river system in the context of a variable climate. The review found that the salt export objective was not effective and recommended that the salt export objective be improved ahead of the 2026 review of the Basin Plan. This recommendation will be progressed as part of the Basin Plan Review.

End-of-valley outcomes

Under the BSM2030 strategy, the role of EoVTs changed to provide a valley scale context to the identification and management of salinity risks. While there is no longer a compliance requirement for these targets, continued monitoring at EoVT sites in all valleys will inform understanding of changes in salinity risk to shared water resources and within-valley assets.

Contracting Governments must consider the impacts of catchment salinity on shared water resources. In practice, this involves consistent monitoring, reporting and reviewing salt exports from each of the main tributary catchments. EoVTs play an important role in building an understanding of salinity trends and risks to the shared water resource arising from tributary catchments.

Variability in hydrological conditions in catchments from year to year is a typical characteristic of the Basin. This variability has significant impacts on the amount of salt mobilised annually into tributaries and river systems.

Additional monitoring at 'interpretation sites' is highly useful in supporting an understanding of the salt mobilisation and salinity dynamics within the catchments.

Up until 2021, annual reporting of outcomes at EoVT sites compared salinity and salt load targets based on modelled long-term data with statistics derived from annual observed data. Reporting outcomes were reviewed by IAG-Salinity together with Contracting Governments in 2019.

The IAG-Salinity recognised the need for the MDBA and BSMAP to reconsider the appropriateness of the reporting method so it can be improved in a fit-for-purpose fashion. It was therefore recommended that (recommendation 6.4): “In the lead up to the 2026 review of the BSM2030 strategy the usefulness of current end-of-valley targets for management decisions be explored and consideration be given to other indicators such as trend analysis and mid-valley targets”.

Leading up to 2021, BSMAP members discussed approaches to improve annual reporting of outcomes at EOVT sites. BSMAP members agreed on an approach which involved comparing exceedance curves showing the distribution of modelled results over the benchmark period with the distribution for observed data over the last five years.

From November 2021, the MDBA, in consultation with BSMAP members, facilitated the development of exceedance curve templates for each EOVT site. Exceedance curves display the probability that salinity or salt load will remain below a concentration or amount over a period (percentage of days) and provides a comparison with the frequency of high and low measurements of the past.

The method compares the contemporary five-year rolling average salinity exceedance curves (5YRA) with all 5YRA curves over the period with modelled and observed data. The 5YRA approach balances out long- and short-term data trends. Residual mass rainfall curves are used to support the interpretation of the 5YRA as they help to contextualise catchment conditions. The method also shows upper and lower EC bounds (referred to as an ‘envelope’) on the 5YRA graphs to help understand salinity drivers. This envelope is a range driven by climate sequences. The 80th percentile of the upper and lower bounds of the salinity exceedance curves provides the range of salinity levels given climate and catchment conditions.

In October 2022, the BSM Procedures for Catchment Salinity (incorporating EoVTs) and Reporting were updated based on the improved reporting method for EoVT sites. The BSM Procedures were endorsed by BSMAP on 1 March 2023, approved by BOC on 14 June 2023 and were subsequently published on the MDBA website in September 2023.

State Contracting Governments for Queensland, New South Wales, Victoria, and South Australia have applied the improved reporting at EOVT sites for the first time in this BSM2030 comprehensive reporting 2023 period. The 5YRA salinity and salt load exceedance curves using continuous flow and salinity monitoring data are presented in each of these Contracting Government reports for 2023 and are provided in Appendix D as report extracts. The Basin salinity target site at Morgan was extracted from South Australia's BSM2030 Comprehensive report 2023 and is provided below (Figure 4 and Figure 5).

In 2021–22 and 2022–23, the 5YRA salinity at the Morgan site remained below the target levels (800µS/cm) (Figure 4). The 5YRA salt load for the reporting period was below the lower bounds of the benchmark period for most of the time (Figure 5). Given that salinity and salt loads at the Morgan site on the Murray River is driven by cumulative effects of regional scale flows from the upstream MDB valleys, the local rainfall departure curve has not been included for comparison in reporting for this site.

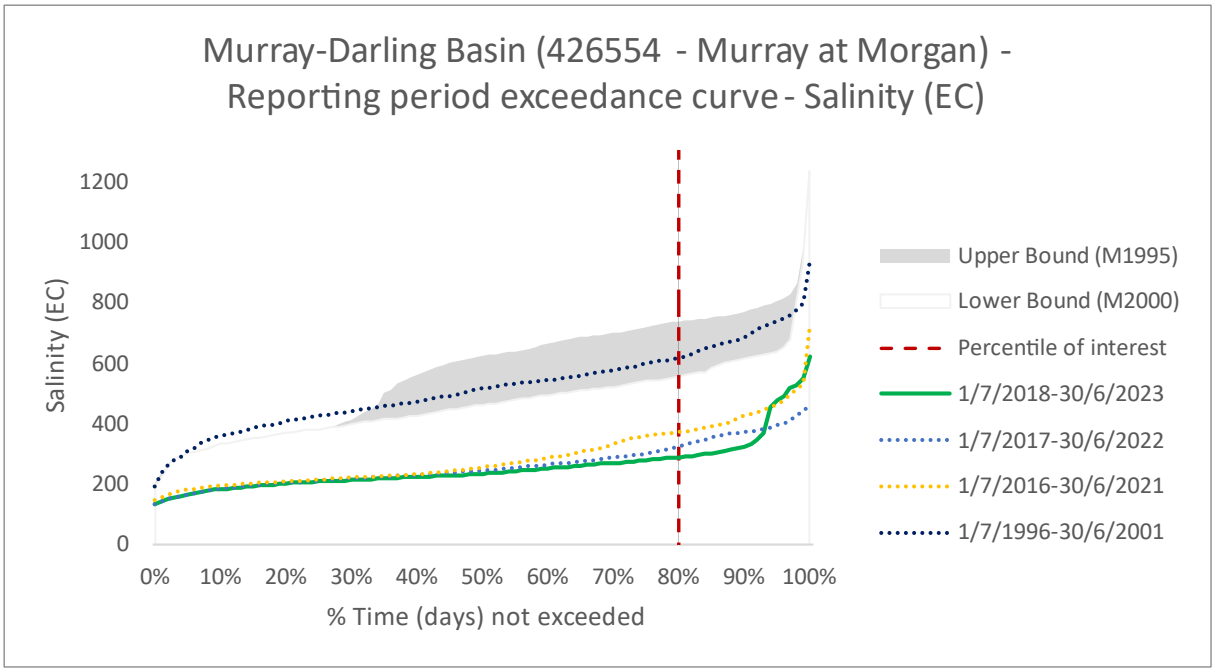


Figure 4 - Salinity level (EC) exceedance curve for Basin salinity target site, Morgan, South Australia.

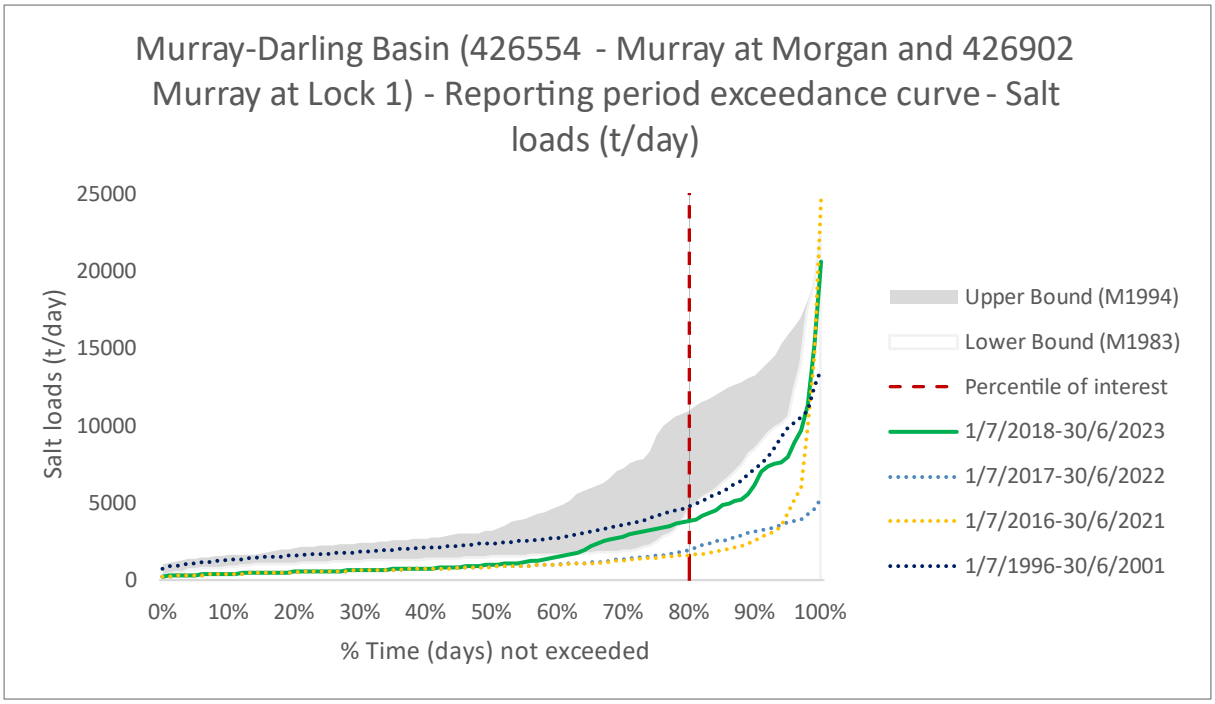


Figure 5 - Salt load exceedance curve for Basin salinity target site, Morgan, South Australia.

Progress in monitoring at EoVT sites over the period from 2000 to 2023 is summarised in Figure 6. The second column provides the percentage of days for which salinity (EC) measurements have been monitored for each site. The third column provides an indication of flow and available EC and is expressed as a percentage of time that salt load can be calculated.

Table 8 is a summary report card of flow and salinity data for each EoVT site for the years 2021–22 and 2022–23. The full details of state and territory government valley outcomes are provided in the individual governments' reports.

Graphs of flow and salinity at EoVT sites are provided in Appendix D, while Appendix E compares salinity levels and salt loads over the 2021–22 and 2022 -23 periods against long-term records. The length of the record varies from site to site. Owing to periods of extended dry conditions across much of the Basin over the past two decades (Millennium drought from 1997–2009 and the 2017– 2019 drought), there are some sites where river flows ceased for long periods. For those periods, measurements of salinity and flow are not accurate; therefore, salinity and salt load records may be incomplete.

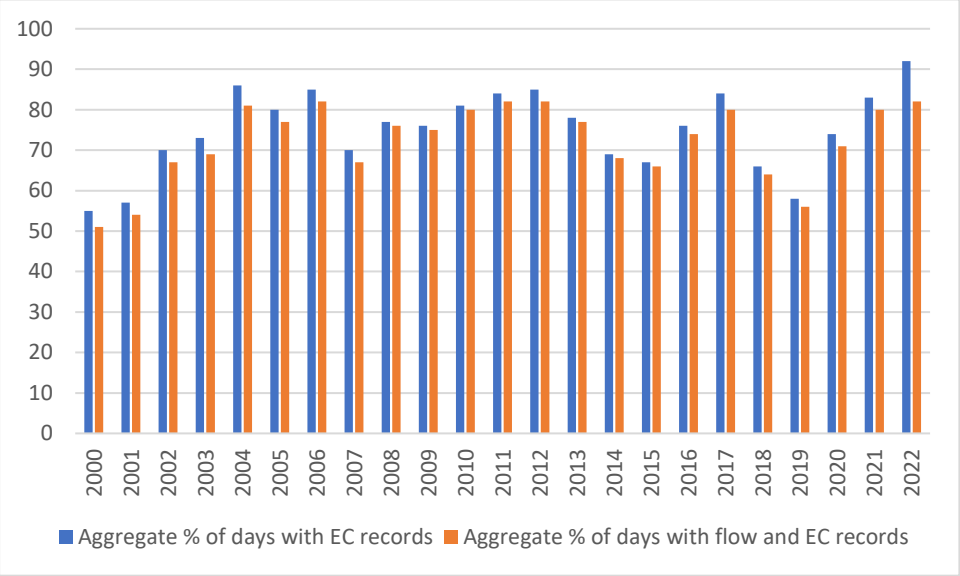


Figure 6 - Availability of monitoring data for all BSM2030 strategy end-of-valley and interpretation monitoring sites, 2000 to 2023.

Table 7: End-of-Valley summary report card 2021–22 and 2022–23

EoVT Site	AWRC No.	Year	No. of days with salinity records	No. of days with flow records	Days with flow above zero	Mean salinity (µS/cm)	Median salinity (µS/cm)	80%ile salinity (µS/cm)	Peak salinity (µS/cm)	Mean flow (ML/day)	Median flow (ML/day)	80%ile flow (ML/day)	Peak flow (ML/day)
All Partner Governments													
River Murray at Morgan [a]	426554	21/22	361	365	365	240	245	332	370	22926	23473	29935	35857
		22/23	322	308	308	349	284	579	622	44744	40000	62600	130000
South Australia													
SA border [b]	426200	21/22	365	365	365	190	191	248	349	25350	27030	31006	43390
		22/23	92	365	365	173	177	184	188	62996	46789	98306	185678
Lock 6 to Berri [c]	426514	21/22	365	365	365	206	204	260	332	23767	25008	30428	35407
		22/23	365	129	128	319	255	469	579	21537	22667	26852	37440
River Murray at Murray Bridge [d]	426522	21/22	364	NA	NA	258	262	309	409	NA	NA	NA	NA
		22/23	365	NA	NA	364	305	540	604	NA	NA	NA	NA
New South Wales													
Murrumbidgee at Balranald	410130	21/22	365	365	365	178	179	207	268	8181	8981	10300	12703
		22/23	365	365	365	219	210	256	458	13735	12778	23719	38765
Lachlan at Forbes	412004	21/22	142	365	365	408	366	565	678	7416	4629	12347	53630
		22/23	0	365	365	N/A	N/A	N/A	N/A	10871	3511	17850	97908

EoVT Site	AWRC No.	Year	No. of days with salinity records	No. of days with flow records	Days with flow above zero	Mean salinity (µS/cm)	Median salinity (µS/cm)	80%ile salinity (µS/cm)	Peak salinity (µS/cm)	Mean flow (ML/day)	Median flow (ML/day)	80%ile flow (ML/day)	Peak flow (ML/day)
Bogan at Gongolgon	421023	21/22	365	365	358	265	261	329	407	613	133	1030	3793
		22/23	365	365	365	484	451	693	789	3791	575	4781	33514
Macquarie at Carinda	421012	21/22	365	365	365	436	426	533	575	965	684	1742	2311
		22/23	365	365	365	292	260	394	662	4273	1935	9174	18813
Castlereagh at Gungalman Bridge	420020	21/22	240	365	365	807	540	1461	1768	1214	413	1524	12922
		22/23	361	342	336	1722	1722	2345	2835	2064	148	4170	13595
Namoi at Goangra	419026	21/22	365	365	365	475	466	570	883	3924	1494	4998	54288
		22/23	278	278	278	436	490	563	749	10407	2289	17318	90945
Mehi at Bronte	418058	21/22	365	365	364	438	444	537	666	422	128	880	2603
		22/23	365	365	365	438	419	564	831	1127	194	1654	18758
Barwon at Mungindi	416001	21/22	365	365	365	231	232	273	329	6465	4325	8860	70717
		22/23	365	365	359	285	280	379	459	3574	975	4419	34015
Darling at Wilcannia	425008	21/22	365	365	365	310	312	379	435	14605	15319	23049	29241
		22/23	365	365	365	525	396	833	1084	17722	22118	30181	38276
River Murray at Heywoods	409016	21/22	363	365	365	52	49	60	66	11081	10513	15526	34384
		22/23	360	365	365	58	58	60	64	21532	13970	35241	91412

EoVT Site	AWRC No.	Year	No. of days with salinity records	No. of days with flow records	Days with flow above zero	Mean salinity (µS/cm)	Median salinity (µS/cm)	80%ile salinity (µS/cm)	Peak salinity (µS/cm)	Mean flow (ML/day)	Median flow (ML/day)	80%ile flow (ML/day)	Peak flow (ML/day)
River Murray at Red Cliffs [e]	414204	21/22	365	0	0	135	130	158	186	N/A	N/A	N/A	N/A
		22/23	62	0	0	111	109	112	125	N/A	N/A	N/A	N/A
Flow to SA	426200	21/22	365	365	365	190	191	248	349	25350	27030	31006	43390
		22/23	92	365	365	173	177	184	188	62996	46789	98306	185678
Victoria													
Wimmera at Horsham Weir	415200D	21/22	309	365	364	1205	995	1205	22886	86	31	68	1471
		22/23	365	365	365	1190	1055	1511	4004	598	63	816	11699
Avoca at Quambatook [f]	408203B	21/22	334	362	240	1286	1150	1768	5216	26	7	35	230
		22/23	336	365	209	11202	1209	4305	785114	223	5	372	3457
Loddon at Laanecoorie	407203B	21/22	356	365	365	779	775	917	1151	146	97	226	506
		22/23	313	365	365	681	688	807	1595	1468	138	1061	107397
Campaspe at Campaspe Weir [g]	406218A	21/22	354	365	365	532	537	588	649	131	102	187	1368
		22/23	365	365	365	428	425	532	654	1742	139	850	125595
Goulburn at Goulburn Weir [h]	405259A	21/22	365	365	365	82	72	114	164	1840	925	2827	14481
		22/23	208	365	365	86	83	100	143	9908	1787	16535	150785

EoVT Site	AWRC No.	Year	No. of days with salinity records	No. of days with flow records	Days with flow above zero	Mean salinity (µS/cm)	Median salinity (µS/cm)	80%ile salinity (µS/cm)	Peak salinity (µS/cm)	Mean flow (ML/day)	Median flow (ML/day)	80%ile flow (ML/day)	Peak flow (ML/day)
Broken at Casey's Weir [i]	404217B	21/22	365	365	365	133	132	155	192	465	202	679	7969
		22/23	278	365	365	138	133	155	274	1545	333	2151	49450
Ovens at Peechelba East	403241	21/22	365	365	365	57	57	67	75	5106	3257	7687	27168
		22/23	365	365	365	61	60	72	93	9430	3568	17054	76258
Kiewa at Bandiana	402205	21/22	365	365	365	45	43	52	73	2102	1704	3022	8134
		22/23	352	245	245	48	47	53	72	1532	1265	1851	5510
River Murray at Heywoods	409016	21/22	363	365	365	52	49	60	66	11081	10513	15526	34384
		22/23	360	365	365	58	58	60	64	21532	13970	35241	91412
River Murray at Swan Hill	409204	21/22	365	365	365	81	80	85	105	10151	8225	14785	20404
		22/23	365	365	365	164	149	232	322	14936	14539	25140	30075
Flow to SA	426200	21/22	365	365	365	190	191	248	349	25350	27030	31006	43390
		22/23	92	365	365	173	177	184	188	62996	46789	98306	185678
Queensland													
Barwon River at Mungindi	416001	21/22	365	365	365	231	232	273	329	6465	4325	8860	70717
		22/23	365	365	359	285	280	379	459	3574	975	4419	34015

EoVT Site	AWRC No.	Year	No. of days with salinity records	No. of days with flow records	Days with flow above zero	Mean salinity (µS/cm)	Median salinity (µS/cm)	80%ile salinity (µS/cm)	Peak salinity (µS/cm)	Mean flow (ML/day)	Median flow (ML/day)	80%ile flow (ML/day)	Peak flow (ML/day)
Moonie at Fenton	417204A	21/22	335	365	332	158	145	203	271	1525	35	518	29767
		22/23	137	365	182	156	211	257	303	568	0	120	11803
Ballandool at Hebel—Bollon Rd	422207A	21/22	365	365	336	260	251	333	416	422	105	535	5224
		22/23	298	365	234	336	322	432	749	163	31	212	1684
Bokhara at Hebel	422209A	21/22	348	365	252	229	207	293	353	528	230	834	4210
		22/23	230	365	195	316	314	366	510	282	72	462	2123
Briarie at Woolerbilla—Hebel Rd	422211A	21/22	298	364	165	268	246	372	578	1652	0	2237	13665
		22/23	219	365	151	318	284	401	697	715	0	136	9069
Culgoa at Brenda	422015	21/22	365	365	330	221	223	253	299	4698	628	6883	42787
		22/23	365	365	285	506	460	727	1007	2820	147	3798	30763
Narran at New Angledool 2	422030	21/22	365	365	273	231	233	268	297	1910	229	4612	9046
		22/23	365	365	244	287	295	333	443	965	107	1131	7235
Paroo at Caiwarro	424201A	21/22	114	365	236	108	117	119	123	917	37	755	21127
		22/23	213	365	212	88	69	122	175	1451	14	376	23475

EoVT Site	AWRC No.	Year	No. of days with salinity records	No. of days with flow records	Days with flow above zero	Mean salinity (µS/cm)	Median salinity (µS/cm)	80%ile salinity (µS/cm)	Peak salinity (µS/cm)	Mean flow (ML/day)	Median flow (ML/day)	80%ile flow (ML/day)	Peak flow (ML/day)
Warrego at Barringun No 2	423004	21/22	242	365	365	100	102	138	188	210	51	344	2239
		22/23	233	365	365	107	110	134	258	167	12	230	2071
Cuttaburra at Turra	423005	21/22	293	365	169	99	86	158	187	226	0	144	3488
		22/23	351	365	138	118	116	146	171	206	0	134	3105
Australian Capital Territory													
Murrumbidgee at Hall's Crossing	410777	21/22	351	365	365	131	120	174	212	7411	4737	9394	77478
		22/23	350	365	365	189	192	226	312	5381	2509	6488	69637

a The 95%ile is reported here as the Basin salinity target at Morgan. Also note that flow data is measured at site 426902 (River Murray at Lock 1)

b Salinity measured at site A426510 (Murray @ Lock 6)

c Salinity measured at site 426537 (Berri pumping station)

d Flow is not measured at this site

e Flow data stops in October 1994

f Spot salinity data ends in Sep 2008 and continuous recording starts in Sep 2013

g Used flow data for 406202C (Campaspe at Rochester)

h Used flow data for 405200A (Goulburn River at Murchison)

i Used salinity data for 404224 (Broken River at Gowangardie)

NA Data not available

Salt load is determined using the following calculation: salt load (t/d) = flow (ML/d) x salinity (EC) x 0.0006

Efficient governance

The governance of the salinity management program has been developed over more than 30 years and is now well understood and accepted. Given this mature status, the BSM2030 strategy has implemented a streamlined approach to that developed under the BSMS by making it more risk-based and efficient.

The updated reporting, review and auditing arrangements will continue to ensure transparency and compliance with the agreed actions and accountabilities of BSM2030, while addressing the BSM2030 knowledge priorities will further improve the knowledge of future salinity risks.

Preparation of BSM Procedures

A number of BSM2030 processes were progressed or completed through 2021–23. This included preparation of Basin Salinity Management (BSM) procedures. The consolidated BSM procedures and the BSM Modelling Procedures were approved by BOC on 14 June 2023 and were subsequently published on the MDBA website in September 2023.

Improvements in modelling platforms and other technical elements

Salinity models

The MDBA's salinity registers are informed by a suite of models that assist in assessing progress against salinity targets and estimating the salinity impacts of accountable actions. These models require periodic review by states, an independent assessment and then accreditation by the Authority to ensure improvement in model predictions of the impacts of land and water management actions.

Basin states use surface water and groundwater models and other analytical models to estimate salinity, salt load and flow to the River Murray. Some of these models are used to determine the salinity, salt load and flow regimes at the EoVT sites and baseline conditions for the Basin catchments have been established (see Appendix C–Baseline conditions). The MDBA uses the datasets generated by the models as input to MSM–BIGMOD (the River Murray model). MSM–BIGMOD is used in the assessment of all register entries. With the aid of cost functions, MDBA is also able to provide estimates of the relative salinity cost effect of progressive increases in salinity along the river. The costs appear in the salinity registers as credits and debits in $m/year for each entry and are used for determining the register balance for each of the jurisdictions.

MSM–BIGMOD model

A new version of the MSM–BIGMOD river model (2018 version) has been prepared for comparison with the SOURCE model prior to adopting the SOURCE model for salinity register purposes. The 2018 version of BIGMOD is similar to the 2014 version except that the 2018 model includes environmental watering salinity impacts.

The MDBA and Basin governments are working on adopting a more contemporary SOURCE modelling platform for water resource and salinity management.

Transition to the SOURCE model

An independent peer review of the SOURCE model for BSM2030 purposes, completed in 2016, found that the SOURCE model is 'fit-for-purpose' to model flow and salt loads in the Murray. The independent peer reviewer endorsed the MDBA proposal to utilise SOURCE for the purposes of Schedule B and the BSM2030 strategy.

The Technical Working Group for Salinity Modelling (TWGSM), comprising representatives from the jurisdictions, was established to provide technical advice about suitability of the SOURCE model for salinity accountability purposes under Schedule B. The TWGSM endorsed the re-estimated baseline conditions salt inflows report and concluded that the report remains a work in progress and will need to be updated as the transition to Source progresses.

The MDBA is working towards completing the transition to the SOURCE model for preparing the 2024 salinity registers.

Other Basin Salinity Management 2030 strategy models

The review of the Pike-Murtho groundwater model was finalised. The review included changes in model software and new data regarding Salt Interception Schemes (SIS) pumping rates. This model is part of a suite of South Australian groundwater models for estimating the salt load impacts of accountable actions under the BSM2030 strategy. The model incorporates recent hydrogeological information including the latest hydrostratigraphy.

The Pike-SARFIIP and Katarapko-SARFIIP floodplain and groundwater models were developed.

The Pike-SARFIIP and Katarapko-SARFIIP accountable actions are new actions and have been entered into the 2023 salinity registers as South Australian state actions.

Other joint accountable actions that were reviewed included the Pyramid Creek SIS and the Upper Darling SIS.

Basin-wide core salinity monitoring network

The BSM2030 strategy commits MDBA and partner governments to nominate key salinity monitoring sites for inclusion in the Basin-wide core salinity monitoring network. This network will be maintained for the life of the BSM2030 strategy. Monitoring sites will be reviewed at least every five years to ensure the network continues to provide a sound basis for salinity assessment in response to an improved knowledge of risk and uncertainty.

The sites included in the network are those that MDBA and partner governments consider to be critical in providing information to support a range of activities under the BSM2030 strategy. The key salinity monitoring sites were identified and nominated by partner governments and the MDBA as appropriate to their responsibilities and accountabilities.

MDBA continued to use a Microsoft PowerBI dashboard as a repository for the Basin-wide core salinity monitoring network. The dashboard enables updates to individual key monitoring sites and keeps records of updates over time. The PowerBI dashboard has back-end data processing functions to quality check data tables and customise front-end display.

The dashboard is currently an MDBA internal facing, non-public product. The MDBA continues to work with partner governments through BSMAP to further refine the Basin-wide core salinity monitoring network dashboard.

Review Plan

The Review Plan sets out the frequency for the review of register entries, models and end-of-valley outcomes under the BSM2030 strategy. Consistent with the amended Schedule B:

- the Review Plan is reviewed annually and may be amended by the Authority on the advice of Contracting Governments, in order to alter the frequency or level of review of any item.
- the independent auditors must assess the implementation of the Review Plan, including the appropriateness of review periods.

The Review Plan tracking template continues to be used to highlight the progress in undertaking reviews as set out in the Review Plan and to document any changes to the timing of reviews. The template is provided to each BSMAP meeting, allowing Contracting Governments and the MDBA to provide updates on review progress and discuss any changes to timelines. Tracking progress of reviews and documenting the changes to the review frequency provides evidence as required for complying with Schedule B requirements.

Reviews progressed by MDBA in 2022–23

The Review Plan requires the Basin States and the MDBA to review register entries, models and outcomes at EoVT sites.

The following reviews were completed in 2022–2023:

- Pyramid Creek SIS
- Upper Darling SIS
- Murtho SIS
- Pike Stage 1 SIS

Details of reviews progressed by Basin States can be found in their respective BSM2030 comprehensive reports.

Contracting Governments' reported outcomes

Biennially the Contracting Governments provide a comprehensive report outlining progress made against the BSMS2030 strategy objectives, whereas the Commonwealth provides an annual report to the MDBA. Executive summaries of the Contracting Governments reports are included in Appendix G.

Outcomes from the audit report

Schedule B requires that the Independent Audit Group for Salinity (IAG–Salinity) be appointed by the MDBA to carry out an audit and assessment. Auditing is an integral part of the BSM2030 strategy, ensuring a fair and accurate assessment of the Contracting Governments' and MDBA's performance against the provisions of Schedule B.

An extract of the IAG-Salinity audit for 2021–23 is provided in Appendix A.

Response to 2019–21 audit recommendations

The third biennial audit under the BSM2030 strategy was undertaken in November 2021, and the *Report of the Independent Audit Group for Salinity 2019–21* (MDBA 2021) was noted by Ministerial Council (out-of-session 102 – 24 January 2023) and published on the MDBA website in September 2023.

The audit report included an assessment of the Contracting Governments and the MDBA's implementation of the strategy and provided recommendations to support continuous improvement. Formal responses to the audit recommendations were also noted by Ministerial Council in January 2023.

The 2019–21 audit report contained eight new recommendations for the Contracting Governments and the Authority to address in order to ensure continuous improvement in Basin salinity management and referred to six recommendations from the 2017–19 audit reports that were still relevant.

A number of the recommendations contained in the 2019–21 audit report are longer-term in nature and will be progressed in the lead-up to the 2026 review of the BSM2030 strategy. Several others are considered to be business as usual and are being addressed through activities already underway.

The audit recommendations that are applicable to the MDBA are itemised and progress is reported in Table 9.

Table 8: The MDBA's response on progress towards previous salinity audit recommendations

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2019–21 Recommendation 1: The IAG-Salinity recommends that work be accelerated to: a) review the provisional entries for the TLM works and measures b) clarify whether the salinity effects of SDLAM projects are to be a single entry or separate entries for each site c) ensure there is a line of sight between the salinity effects of individual actions and the cumulative effects of the TLM and SDLAM programs d) update the workplans to include provisional entries for SDLAM projects by the end of 2024 (underway)	The MDBA supports this recommendation.	a) When the transition to the Source Murray Model for preparing the salinity registers is complete for the 2024 register, the TLM works and measures accountable actions will be progressively reviewed. b) Where possible, it is likely that SDLAM projects will be grouped as a single register entry for each jurisdiction c) Both the individual and cumulative salinity effects of SDLAM projects and the TLM accountable actions can be determined using the Source Murray Model. d) It is possible that the salinity impacts of some SDLAM projects will be included on the registers by the end of 2024, however delays with progressing and the re-scoping of some SDLAM projects may extend this time period.

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2019–21 Recommendation 2: The IAG-Salinity recommends that: a) the draft procedures be finalised by the end of 2022 b) the review clause in the BSM Procedures be updated by the end of 2022 to require annual endorsement by BSMAP of the BSM Procedures and reviews after experience in applying the BSM Procedure indicates that significant changes are needed c) the BSM Procedure 'Developing the Review Plan' be updated by the end of 2022 to ensure that authorised works or measures that are within the baseline are included within the Review Plan d) BSMAP and/or the relevant Contracting Governments certify that the BSM Procedures have been followed when new entries to the Register are made and when review are undertaken	The MDBA supports this recommendation.	a) BSM Procedures are completed and were published on the MDBA website in 2023. b) completed. c) The BSM Procedure 'Developing the Review Plan' has been revised. A new schedule of reviews, identifying any high-risk reviews that need to be completed prior to the BSM2030 strategic review is being developed. d) In progress. Options are being investigated and will be discussed during audit week in November 2023.

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2019–21 Recommendation 3: The IAG-Salinity recommends that a Basin salinity management risk management Procedure be developed when the draft risk management framework is finalised	The MDBA supports this recommendation.	This work has been completed and published as part of the consolidated BSM procedures.

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2019–21 Recommendation 4: The IAG-Salinity recommends that: a) direct KPIs (e.g. groundwater levels at designated monitoring sites) should be consistently prepared and applied for all schemes that both align with Register entries and provide operators with the flexibility to optimise operations b) State Constructing Authorities include the SISs in modern asset management systems and that budgets with five-year expenditure outlooks be developed by the next audit c) MDBA work with the South Australian State Constructing Authority to review the Rufus River SIS by 2025 and with BSMAP to consider implications for the Register in advance of the BSM2030 review d) MDBA RMO provide an annual briefing to BSMAP about the performance of the SISs	The MDBA supports this recommendation.	a) The MDBA is continuing to work with SCAs to prepare KPIs, this is typically considered in conjunction with the respective scheme 5-year reviews. b) The MDBA with SCAs and Partner Governments has completed the Review of Joint Programs. The recommendations included moving to a multi-year funding model and improving the prudency and transparency of the RMO Program. This is being progressed as part of The Review's project implementation plan overseen by the JVBPC. c) The performance review of the Rufus River SIS and the salinity benefits review will be progressed prior to the BSM2030 strategic review. d) Completed.

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2019–21 Recommendation 5: The IAG-Salinity recommends the MDBA: a) use MSM BigMod to prepare the 2022 Salinity Registers b) progress the salinity functionality of Source so that it can produce 'shadow' Register entries for 2022 to enable policy issues to be identified and resolved. c) reactivate the TWGSM with surface water modelling experts from the States as a matter of priority to build confidence in the Source model. d) adopt Source outputs for the 2023 Registers.	The MDBA supports this recommendation.	a) complete. b) a report comparing the 2023 salinity register outputs from Bigmod (2018 version) and Source is in preparation for discussion at TWGSM meeting 4 (November 2023). c) TWGSM is scheduled to meet later in November 2023 to compare outputs from the Bigmod model (2018 version) and the Source model. d) The Bigmod model was used to prepare the 2023 salinity register. MDBA salinity modellers are working towards a salinity register prepared using Source for 2024.

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2019–21 Recommendation 6: The IAG-Salinity recommends that: a) the Source model be functional by 2022 to support reviews of register entries relating to river operations and environmental water. b) the MDBA and Contracting Governments ensure adequate resources are available to complete all scheduled reviews by 2025 in advance of the BSM2030 strategic review. c) BSMAP review opportunities to amalgamate entries by the end of 2022 and amalgamated entries are included in the 2023 Register. d) BSMAP ensure that the methods used to undertake reviews are proportionate to the risks	The MDBA supports this recommendation.	a) A Source 2023 salinity register and report comparing the Source model outputs against the Bigmod (2018 version) are in preparation for discussion at TWGSM meeting 4 (November 2023). The final clause 38(4) review requirements which involves comparing salinity, salt load and flow for Morgan at 1988 and 2000 for both the BigMod and Source models will be completed during the first half of 2024. b) The review plan template has been extended to 2026 and the priority reviews for completion ahead of the BSM2030 strategic review have been identified. c) To be considered during the preparation of the Source 2024 salinity register d) The BSM procedures provide guidance to ensure the methods are commensurate to the salinity risk.
2019–21 Recommendation 7: The IAG-Salinity recommends that BOC consider including a specific objective in the 'Objectives and Outcomes for river operations in the River Murray System' that describes the coordination arrangements for managing short term events including salinity spikes.	The MDBA supports this recommendation.	Ongoing discussions with MDBA river managers to determine the most appropriate place to capture and describe these coordination arrangements for managing short-term events including salinity spikes.

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2019–21 Recommendation 8: The IAG-Salinity recommends that: a) progress in implementing IAG-Salinity recommendations continue to be reviewed in future audits. b) where possible, future IAG Salinity recommendations include a suggested date for the recommendation to be implemented.	The MDBA supports this recommendation.	a) To be discussed during the audit meetings in November 2023.
2017–19 Recommendation 1 The MDBA immediately add a provisional register entry of 6 EC debit to account for the 5,800 ha of irrigation development in the NSW Sunraysia region as this is an accountable action under Schedule B of the MDB Agreement (Water Act (2007))	The MDBA supports this recommendation.	This work has been completed - a provisional entry of 3.7 EC (debit) has been placed on Register A
2017–19 Recommendation 2: NSW urgently increase resources to meet the BSM2030 Schedule B contractual agreement to complete the register entry and model reviews and reduce the uncertainty of the salinity impacts from the expected new development in the high salinity risk areas of Sunraysia	The MDBA supports this recommendation.	This work is ongoing. NSW has commenced the process to get ready for the next IPART submission in 2024 that will inform funding for the 2025–2030 period, which coincides with the final term of the BSM2030.

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2017–19 Recommendation 3: The MDBA and Contracting Governments develop a common risk assessment and management framework that is consistent with AS ISO 31000 and develop a risk profile for the Basin-wide program	The MDBA supports this recommendation.	This work is complete.
2017–19 Recommendation 4: The Commonwealth and State Contracting Governments continue to work with environmental water holders to understand the Basin-wide salinity risk and the cumulative debit impacts from environmental watering of sites	The MDBA supports this recommendation.	This work is underway and will proceed with SDLAM project development and finalisation.
2017–19 Recommendation 5: The Queensland Government assess the risk to Basin rivers from the brine ponds constructed by the CSG industry	The MDBA supports this recommendation.	This work is complete. The Queensland government has prepared and published a long-term CSG brine management action plan.
2017–19 Recommendation 6.1: In the lead up to the 2026 review of the BSM2030 strategy, the impact of climate change on the salinity in the shared water resources be explored.	The MDBA supports this recommendation.	The climate change impacts on salinity in the shared water resources will be considered as part of the Basin Plan Review. Planning for this work has commenced, and the work will be completed by mid-2025.

IAG–Salinity recommendations	MDBA response to Ministerial Council	Progress
2017–19 Recommendation 6.2: In the lead up to the 2026 review of the BSM2030 strategy, the economic impacts and opportunities provided to the Basin industries and communities from salinity mitigation be explored.	The MDBA supports this recommendation.	This work is underway. An approach for estimating the benefits from salinity management is being developed as part of the cost functions review. To be applied in 2023–24.
2017–19 Recommendation 6.3: In the lead up to the 2026 review of the BSM2030 strategy, the cost function framework of the registers be revisited.	The MDBA supports this recommendation.	Complete. The review of the salinity cost functions report was provided to BSMAP in July 2023.
2017–19 Recommendation 6.4: In the lead up to the 2026 review of the BSM2030 strategy, the usefulness of end-of-valley targets for management decisions be explored and consideration be given to other indicators such as trend analysis and mid-valley targets.	The MDBA supports this recommendation.	The work surrounding EOVT improved reporting is complete. The process for reviewing EOVT sites is underway which considers the usefulness of end-of-valley targets for decision making and the potential to use trend analysis and mid-valley targets.
2017–19 Recommendation 6.5: In the lead up to the 2026 review of the BSM2030 strategy, review key entries in the registers to reduce uncertainty and provide improved certainty in relation to available credits by 2080.	The MDBA supports this recommendation.	This work is underway. Priority register entries for review prior to 2026 will be identified in the process to update the BSM procedure for developing the review plan and included in the review plan template.

Strategic knowledge improvement

Knowledge is the key to salinity management in the Murray–Darling Basin. Steady improvements in knowledge about salinity processes have underpinned three decades of successful adaptive management.

The BSM2030 strategy continues that focus and aims to overcome critical information gaps and uncertainties to provide a solid basis for decision-making and future planning. Progress against key knowledge gaps will inform the 2026 review of the BSM2030 strategy and the development of future Basin-wide salinity management strategies.

BSM2030 Knowledge Priorities

The key knowledge gaps identified in the BSM2030 strategy are:

- Mallee Legacy of History – improved understanding of risk associated with the projected impacts of historic land clearing and water use in the Mallee regions of NSW, South Australia and Victoria will help to reduce the uncertainty surrounding the future magnitude and timing of salinity risks to the shared water resources.
- Improved understanding of environmental water management and watering practices will help to better assess the salinity impacts of environmental watering in the shared water resources including:
    i. environmental watering and floodplain dynamics–development of the next generation groundwater models to assess and predict potential salinity impacts from environmental watering
    ii. the cumulative, system-scale salinity impacts arising from environmental watering regimes (salinity accountability for environmental water management).
- Predictive forecasting for in-river salinity–improved surface water models to support predictions and forecasting of salt loads and river salinities will help to reduce the risks associated with responsive SIS management and inform other management actions.
- Responsive SIS management–improved understanding of the salinity impacts associated with responsive SIS management, with particular focus on the floodplain and in-river responses will help the potential to further reduce operating costs and improve SIS operations.

Progress against the BSM2030 knowledge priorities is listed below.

Mallee Legacy of History

Following the initial knowledge priority workshop on Mallee legacy of history salinity impacts held in June 2016, projects to review the conceptualisation and assumptions regarding the timing and magnitude for both the dryland and irrigation Mallee legacy of history were completed.

Those reviews highlighted some challenges and inconsistencies in how irrigation recharge is determined and noted some significant limitations in current approaches, namely:

- There is no direct modelling of the unsaturated zone to account for perching on clays. This is known to be widespread in the Mallee and influences the timing and magnitude of irrigation recharge and thus the timing and magnitude of salt loads to the river.
- There is inconsistent and insufficient use of agronomic data to constrain groundwater model calibrations and their outputs. In some cases, a forward (or deterministic) modelling approach is used. In other cases, an inverse modelling approach is used. Both the forward and inverse modelling approaches may lead to biases in salt load estimates due to irrigation and create uncertainty when linking on-ground actions (e.g. irrigation efficiency improvements) to salt loads in the river. The risk of biases can affect cost-sharing, rehabilitation and salinity planning.

To address these issues, the review recommended:

- the development of a transfer function (a simple model capable of simulating the influence of perching behaviour within the unsaturated zone)
- the implementation of a 'hybrid' modelling approach that includes parameters from the agronomic water balance and the transfer function within model calibration, and the use of agronomic data to constrain the calibration.

Further testing and development of the transfer function and hybrid modelling occurred in a pilot trial that used the Sunraysia model upgrade (EM2.3.1) in the Mallee regions of NSW and Victoria. This work validated the use of the transfer function and hybrid modelling as providing a robust and transparent approach for the treatment of irrigation recharge, with the major benefits being:

- The greater use of agronomic data (particularly information on irrigation drainage) to better constrain and calibrate estimates of irrigation recharge.
- The ability to simulate gross recharge and drainage explicitly, so that on-ground actions can be appropriately represented and instances where drainage rates may be derived from both root zone drainage and the interception of a groundwater mound can be unpicked and simulated explicitly by the model.
- A methodology to calibrate irrigation efficiency estimates, providing greater confidence in the formulation of scenarios which are used to predict salinity impacts.

The MDBA has appointed an expert panel to peer review the pilot trial of the transfer function using the Sunraysia model upgrade (EM2.3.1). The review reports and associated documents are expected to be finalised by December 2023 and this will conclude the Mallee Legacy of History knowledge priority project.

Environmental watering and floodplain salinity dynamics

A report arising from the floodplain processes workshop, held in November 2017, outlined a work plan (Figure 7) to address a range of floodplain knowledge priorities. The report summarised the key floodplain processes knowledge priorities into five themes. These are:

- developing a floodplain processes body of knowledge
- salinity risk framework
- improving the conceptual understanding
- modelling
- data and monitoring.

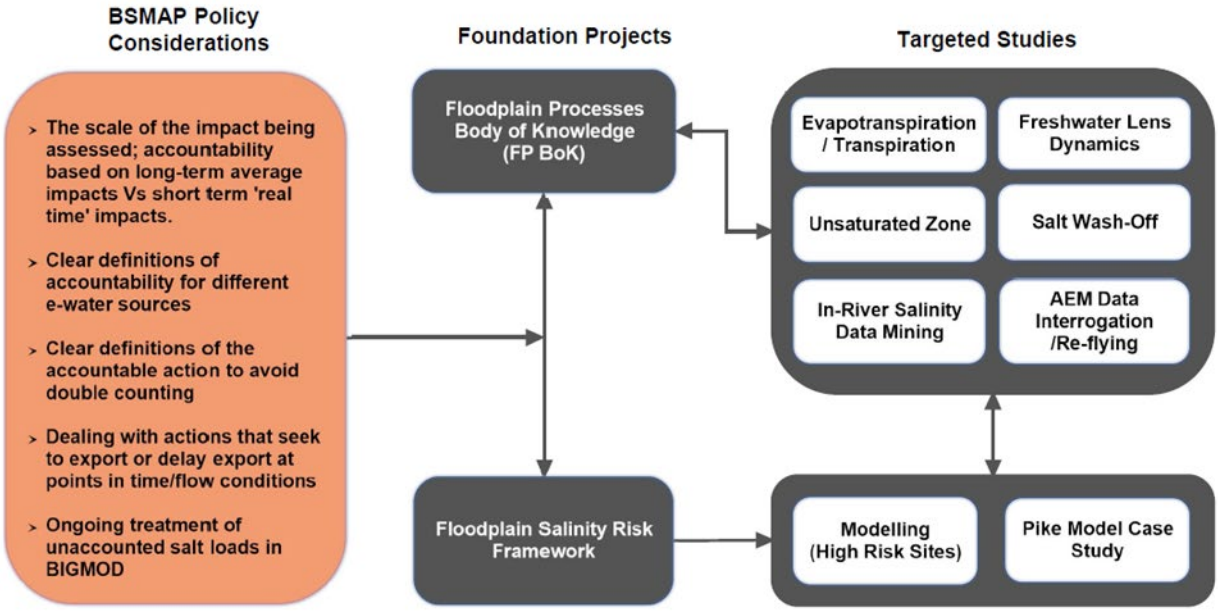


Figure 7 - Floodplain knowledge priorities–work plan framework.

Targeted studies – Floodplain woody vegetation evapotranspiration

The most immediate need identified in the floodplain knowledge priority workshop was the collection of data to support improving the estimates of evapotranspiration. This is being progressed through two complementary processes.

In May 2019, the CSIRO and MDBA commenced a three-year project, which was extended to June 2024 following interruption to data collection on the floodplain due to high River Murray flows and subsequent flood in 2022 and 2023. The project objective is to quantify total water losses or evapotranspiration from key floodplain vegetation located over saline groundwater within the Murray–Darling Basin. Lack of vegetation evapotranspiration data has been identified as a significant knowledge gap in the ability to understand and model salt mobilisation in the lower Murray. The study aims to provide robust field data for vegetation evapotranspiration, to improve river and saline floodplain management and improve the accuracy of evapotranspiration data used in numerical models.

From 2021–2023, CSIRO has installed equipment at an additional three sites, bringing the total number of monitoring sites to ten across the lower Murray floodplains (Bookpurnong and Calperum

in South Australia, Lindsay Island in Victoria and Mallee Cliffs and New South Wales). The field data has been used to validate a model to provide robust evapotranspiration outputs for river red gum and black box vegetation communities in saline groundwater locations. This work complements existing studies of black box communities at Mallee Cliffs being conducted in the trial of responsive management of SIS and by CSIRO at Calperum in South Australia, and earlier CSIRO studies in non-saline floodplain environments at Yanga National Park in New South Wales.

Field locations were selected in areas where there are predicted management actions in the future. This includes salt interception scheme manipulation to vary the operation of these schemes, as well as the influence of environmental flow actions on floodplain vegetation evapotranspiration and hence tree community canopy condition and reduction of water stress.

This is part of a wider program of environmental watering and floodplain dynamics projects that the MDBA has supported (Figure 8). These projects are underway to improve the science that underpins salinity management in the lower River Murray floodplains, to inform management of both river salinity and floodplain health. This is an interdisciplinary program of work to improve the conceptual understanding of floodplain processes based on field studies, laboratory tests, satellite data analysis and modelling.

The program of work aims to improve the conceptualisation of how water and salt move within saline floodplains, including vegetation water use, flooding and environmental watering.

MDBA is working with contracted researchers (from CSIRO, University of Queensland and Flinders University) and partner governments including SA Department for Environment and Water (SA DEW), SA Water and NSW Department of Planning, Industry and Environment to undertake these projects. Figure 8 describes the relationship between the major tasks including evapotranspiration fieldwork.

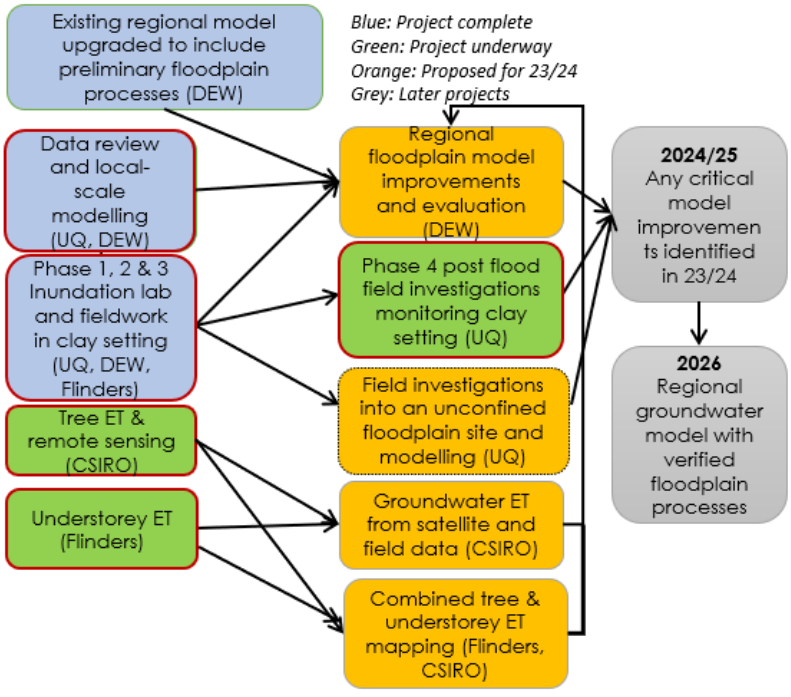


Figure 8 - Relationship between the major project tasks.

The data review and local scale modelling component was undertaken the 2022-23 financial year with SA DEW and the University of Queensland. The outcomes of that project found that there were further knowledge gaps about the groundwater partition of the ET and the combined tree and understorey ET component. In July 2023, further investigations into these were added to the program for 2023–24. Progress in 2021–2023 against projects (highlighted with a red border in Figure 8) that were completed or are currently underway with MDBA contributions is provided below.

Targeted studies – Floodplain understorey vegetation evapotranspiration

MDBA engaged Flinders University to measure understorey ET to supplement the tree transpiration measurement currently being undertaken by CSIRO. This will assist estimating the total evaporative loss of water in the floodplains.

The objectives of this study are: the characterisation and understanding of ET spatial and seasonal variation of selected floodplain understories and surfaces dominated by low vegetation; and the estimation of annual water loss via understorey and low-vegetation surface ET from the selected floodplain.

Field activities commenced in May 2021 at the Clark's Floodplain (Bookpurnong) study site. Four sites were established with different vegetation characteristics. These are: herbaceous understorey under dense river red gum in the riparian zone; dense lignum on the floodplain; open salt tolerant burr (*Sclerolaena sp.*) understorey on the floodplain; and understorey under black box in the riparian zone. These sites were also strategically selected within the Bookpurnong SIS site in consultation with CSIRO tree evapotranspiration project staff to consider potential correlations with the responsive management of SIS.

Deployed equipment includes three stations that record time-continuous radiation, and temperature and humidity sensors. The outcomes will be reported as millimetres per day and normalised across the surface area of the three sites, thus providing results that are comparable to the CSIRO tree ET study.

Flinders University met regularly with the CSIRO tree ET team, SA DEW and the MDBA to discuss scientific methods and results as they emerged throughout the program. This was particularly important for deciphering knowledge gaps that emerged during the project and ensuring robust science outcomes.

Data was unable to be collected from October 2022 to April 2023 due to site inundation from high river flows, which is when river flows are higher than 60,000 ML/day at the SA border. Subsequently, the project was extended by six months to continue data collection following the floods, with results and final reporting due to be completed in December 2023.

Floodplain inundation and drying study

Scientific knowledge of inundation and drying on floodplains is limited, particularly in floodplain areas with heavy surface clays since data is rarely collected during floods. Yet, water managers use models to evaluate and predict outcomes of river salinity and floodplain health with uncertainty from

using implied average homogeneous conditions, which are poorly constrained by data. This knowledge priority project was established to help address these data and knowledge gaps.

The project was delivered as a collaboration between the University of Queensland, SA DEW and the MDBA. The study was led by the University of Queensland and carried out a suite of fieldwork and laboratory experiments. The fieldwork took place in an oval-shaped, heavy clay basin at Murtho, South Australia. During the 2022–23 investigations, the study site was inundated when the River Murray flows reached 80,000 ML/day and peaked at 185,858 ML/day at the SA border between December to February. Prior to this, the basin was in the drying phase after receiving around 90 ML of Commonwealth environmental water that was pumped into the clay basin in 3 watering events to a ponding depth of around 1 metre between March 2021 to May 2022, and left to dry to about 0.5 meters below ground level in between e-watering events.

The drying and inundation events were monitored for a range of parameters used to calibrate water and salt balance models built during the first phase of work in 2020–21, and further refined in 2021–22 and 2022–23. Aspects of that knowledge acquisition were to identify interdisciplinary factors that influenced the floodplain dynamics, characterise these processes, and quantify the water and salinity balance and impacts from local changes. After three years, outcomes were disseminated to water and salinity managers at an online presentation held in July 2023. Findings presented were from monitoring and model refinements, robust data and modelling results of hydrological processes during managed inundation and recharge events, and new information about floodplain processes following the natural River Murray flood event.

Monitoring continues into 2023–24 to address the lack of data collected during and after natural flood events and provide information towards improving scientific understandings of water and salinity on heavy clay settings. The University of Queensland will present the outcomes from the overall study at the 4th Basin Salinity Forum.

Floodplain Processes Body of Knowledge

A key component of these knowledge priorities are activities related to addressing knowledge deficiencies across floodplain processes and interactions, particularly about the impact of environmental watering regimes on salinity. The floodplain processes body of knowledge (FP BoK) was identified as an initiative to help address the gap in knowledge deficiencies with the objective of making existing and new material on floodplain processes more easily discoverable and accessible online.

MDBA completed some initial scoping work in 2018 using Comprehensive Knowledge Archive Network (CKAN) instance, consistent with the Australian Government ‘data.gov.au’ information portal. Building on the earlier scoping work, throughout 2021 the MDBA built the FP BoK proof of concept. The FP BoK was then upgraded to a cloud-based server.

In 2021, a jurisdictional working group was established. In 2022, the MDBA completed firewall security access to enable jurisdictional staff to access the FP BoK, after which time the jurisdictional working group was convened to examine the platform. The working group then commenced an iterative phase of testing cataloguing resources and process improvements with the MDBA Data Analytics team throughout 2022 and 2023. The project will move to the final ‘production’ phase,

which will make the FP BoK live, when it is proposed to be officially launched at the 4th Basin Salinity Forum in November 2023.

Predictive outlook for in-river salinity

A modelling tool was developed and the MDBA Source Murray Model has been configured to prepare six-month forecasts on salinity levels in the lower Murray. These outlooks are used to inform decisions around the level of SIS operations to support the trial of responsive management of SIS.

The modelling tool applies a number of flow scenarios at the SA border, based on the river operations annual operation plan and multi-history flow outlooks, to cover the range of possible flow conditions. For a given level of SIS operations, forecast salinity levels are provided for the four Basin Plan reporting sites in South Australia (Lock 6, Morgan, Murray Bridge, and the Lower Lakes at Milang).

The modelling tool is used each month to prepare the outlooks on salinity levels in the lower Murray that inform decisions around the level of SIS operations. While the modelling tool is regularly being refined through its application, other MDBA modelling priorities have limited further development to date.

System responses to changed salt interception scheme operations

Six trial sites were established to address a number of the key knowledge gaps associated with the trial of responsive management of SIS, being the groundwater and salt inflow responses to changed operations, the relationship between pumped volumes and the extent of low salinity lenses, and the relationship between groundwater salinity and vegetation health. The trial sites were at Mallee Cliffs SIS, Mildura-Merbein SIS, Western's Floodplain, Clark's Floodplain, Thiele's Floodplain and Ramco Floodplain.

At the Mallee Cliffs site, monitoring has continued to be focused on the relationship of SIS bores to the freshwater lens adjacent to the river and in turn the effect on floodplain vegetation. Vegetation monitoring has focussed on tree water use (transpiration) to monitor the response of Black Box to SIS operational changes, with the establishment of two monitoring plots in February 2019, utilising a consistent method for evapotranspiration monitoring for the floodplain woody vegetation sites, as outlined above.

To support these investigations a six-month trial shutdown of the Mallee Cliffs scheme was undertaken in 2020. The scheme shutdown also enabled planned maintenance activities to be undertaken. In this reporting period, consistent with Scheme Operating rules, the scheme was deenergised when River Flows were high. Monitoring equipment was retrieved in advance of the floods and since re-established following the recession of the high flows. NSW DPIE is continuing to monitor the groundwater and vegetation response following re-energisation of the scheme. NSW DPIE and the MDBA are currently considering the outcomes of the trial shutdown and are working with CSIRO to scope options for vegetation monitoring going forward at the Mallee Cliffs site to further assist in addressing knowledge gaps.

At the four South Australian trial sites, groundwater and vegetation monitoring has been continuing with a range of monitoring activities including groundwater levels and salinity, groundwater vertical

salinity profiling and sap flow sensors and leaf water potential monitoring. In June 2021, CSIRO was engaged by SA Water with support from the MDBA to consolidate the existing tree transpiration measurements being collected through the trial of responsive SIS management in South Australia to two sites at Clarks Floodplain and another site at Westerns Floodplain. The consolidation of effort ensures a consistent method to transpiration monitoring with that at Mallee Cliffs (and other floodplain sites) as well as balancing robustness of data to support knowledge gap investigations with budget availability, site access challenges, vandalism risk and other factors. These sites will initially collect floodplain vegetation baseline data for later comparison under changed SIS operations. CSIRO has established two sites at Clark's floodplain and one site was established at Westerns Floodplain 2021. The high river events have resulted in interruptions to monitoring. In advance of the high rivers, monitoring equipment was retrieved and following the recession of the event have been re-established.

At the Mildura-Merbein trial site GMW has engaged consultants to assist with the establishment of vegetation and soil salinity monitoring activities. In addition to groundwater monitoring and pump performance data, leaf water potential and soil water potential monitoring activities are the focus of monitoring effort to support understanding of the relationship between pumped volumes, groundwater levels, soil salinity and vegetation health.

Drone imagery continues to be captured on a quarterly basis across the trial sites utilising SA Water's internal resources.

Strategic reviews

Review of the Salinity Cost Functions

Salinity cost functions are modelling tools that relate levels of river salinity to the economic impact of salinity (or its removal) on various river water users. The cost functions calculate the economic salinity cost effect ($ millions/year) of salinity on agricultural, household, commercial and industrial consumers and government instrumentalities. Their main role today is to provide a 'common currency' or the basis for understanding the relative costs and benefits of various actions to manage salinity for the purpose of the register.

The current cost functions were adopted in 2005 under the Basin Salinity Management Strategy. When introduced, the salinity cost functions served three purposes:

- To inform decisions to invest in salt interception measures
- To enable the effects of locations of actions to be taken into account for the purpose of calculating no net negative impacts on the registers
- To enable salinity cost effects in the registers to be calculated.

The 2020 Report of the Independent Audit Group for Salinity 2017–2019 found that "*The register framework including the cost functions needs to be reviewed. The cost functions are based on an economic assessment in 2005, are out-of-date and do not provide a sense of the value of ensuring water is managed to below 800EC at Morgan*".

The review of the salinity cost functions was completed by Frontier Economics in consultation with MDBA, the Commonwealth and Basin States. Key findings from the review included that the current salinity cost functions:

- continue to play a critical role for managing State accountability for salinity management obligations under the BSM2030 strategy
- do not reflect the benefits attributable to contemporary salinity management and therefore do not meet the needs of the States and the MDBA for a measure of the benefits of salinity management
- use underlying assumptions that are not based on the best available knowledge
- do not consider social, cultural and environmental impacts, although the magnitude of these impacts may be small because of ongoing actions to manage salinity.

The review recommended a pathway forward including that:

- use of the salinity cost functions be retained to enable the registers to continue to operate as a key accountability mechanism for the States' salinity management
- further work be undertaken to provide a narrative that demonstrates the benefits of current salinity management
- the salinity cost functions be updated as part of future processes, such as the 2026 BSM2030 strategic review or in establishing the next phase of joint salinity management.

Community engagement and communication

Community engagement and education

The responsibility for community engagement and communication rests with the Basin States who report on community engagement and communication activities undertaken through their salinity management programs as part of their comprehensive reports to the Ministerial Council.

From time to time the MDBA provides specific engagement and education support.

Communication activities

It is important that communities understand that salinity risk has been reduced through past investment and environmental water recovery under the Basin Plan. Similarly, it is important that they understand that salinity risks remain and that river salinity levels still require careful management to ensure the Basin Salinity Target is achieved.

Throughout 2021–23, the MDBA released the following salinity related publications:

- Assessment of the salt export objective and salinity targets for flow management 2020–21
- BSM2030 summary report 2021–22
- BSM2030 status report 2021–22
- BSM2030 comprehensive report 2020–21

Priorities for future work

In 2023–24, priorities to be implemented through the BSM2030 strategy include:

- continuing the transition to the Source model for preparing the Salinity Registers, including a special audit
- continuing the trial of responsive management of SIS and implementing knowledge gap investigations at the trial sites
- progressing the BSM2030 knowledge priority projects
- reviewing register entries and models consistent with the Review Plan
- convening the fourth Basin salinity forum to promote discussion and collaboration between Basin salinity managers, river operators, and environmental water managers to share lessons learnt and to support BSM2030 implementation
- supporting the assessment of salinity impacts from the SDLAM projects
- determining the requirements for undertaking detailed reviews and assessments of EoVTs
- ongoing updates to BSM Procedures as required
- an economic assessment of the benefits of salinity management
- completing the biennial audit of BSM2030 strategy implementation.

Appendix A – Extract from the Report of the IAG-Salinity 2021–23

Executive Summary

This Report presents the findings and recommendations from the fourth audit by the Independent Audit Group for Salinity (IAG) of the Schedule B Salinity Registers and the Basin Salinity Management 2030 (BSM2030) Strategy.

The audit has been carried out in accordance with the provisions of Schedule B of the Murray–Darling Basin Agreement, (Schedule 1 to the *Water Act 2007* (Commonwealth)) and the audit and reporting plan provided by the MDBA.

Since 1988 there has been a progressive reduction in river salinity at Morgan, in response to the consistent efforts over 35 years to implement the actions and policies in the S&DS (1988), BSMS (2001) and BSM2030 (2015), and with the Basin Salinity Target achieved since 2010. Measured river salinity levels at Morgan remained below 800 EC throughout 2022–23, the measured 95th Hipercentile salinity at Morgan has been below 800 EC for the past 25 years and the peak measured salinity level at Morgan has not exceeded 800 EC since 1998.

Finding 1: The IAG finds that the Basin Salinity Target at Morgan was met over the audit period.

Finding 2: The IAG finds that the 95th percentile measured salinity levels at Morgan have been below 800 EC for the past 25 years.

There are 63 entries on the 2023 Register A and 21 entries on Register B (11 entries on Register B are less than 1 EC and only 4 entries are greater than 2 EC in year 2100). The Registers are complex and difficult to understand.

Finding 3: The IAG finds that the large number of small Register entries draws attention away from the large entries that warrant close attention.

Recommendation 1: The IAG recommends that a focus of the 2026 review be to simplify the Registers and their presentation.

The 2023 Salinity Register position of each jurisdiction, expressed in million dollars per year as required by Schedule B of the Agreement, shows that each jurisdiction has a positive balance as required by Schedule B of the Agreement.

Balance — Registers A and B	NSW: $5.341m	Vic: $4.508m	SA: $8.332m

Finding 4: The IAG finds that the draft 2023 Register is fit for purpose and NSW, Victoria and South Australia are in a net credit position.

The Murray–Darling Basin Agreement and Schedule B prescribe how Register entries are to be made and amended. The BSM Procedures provide additional detail. The BSM Procedures are designed to provide practical guidelines to support the consistent implementation of BSM2030 and the obligations set out in Schedule B. Key features of the BSM Procedures from an audit perspective are that approved methods and models must be followed by proponents when assessing salinity impacts and reviewing Register entries.

Finding 5: The IAG finds that the BSM Procedures for managing the registers provide a high level of confidence in the integrity of the Register entries.

The IAG report of 2021 supported the use of provisional entries and noted that they have a material effect on the Register balance and made a series of recommendations to accelerate finalisation of the provisional entries. The MDBA have advised that finalisation of the provisional entries has been delayed until the transition to the Source model occurs.

Finding 6: The IAG supports that the conversion of provisional entries to standard entries be delayed until the transition to the Source model.

There were 6 reviews completed and two new entries added to the registers over the audit period.

- Morgan to Wellington numerical groundwater model 2021 update and review (2022)
- Sunraysia model upgrade project–Eastern Mallee (EM) 2.6 model update and review (2022)
- Upper Darling SIS Review (2022)
- Sunraysia Drains Drying Up accountable action review (2023)
- Psyche Bend Lagoon accountable action review (2023)
- Pyramid Creek SIS and Church's Cut Review (2023)
- Pike Murtho Model update 2023 review and register update (2023)
- Pike floodplain groundwater salinity impacts 2023 assessment (new register entry) (2023)
- Katarapko floodplain numerical groundwater model 2023 assessment (new register entry) (2023).

Each of these assessments and reviews was subject to an independent review and was judged to be fit for purpose.

The IAG recommended in 2021 that proponents certify that they complied with the BSM Procedures when conducting reviews and assessments of register entries. During this audit the IAG were advised this recommendation was not adopted purportedly because of concerns that a certification would add excessive bureaucracy.

Finding 7: The IAG finds that significant progress has been made to complete reviews and assessments in the past two years.

Finding 8: The IAG could not determine whether the BSM Procedures were applied to conduct the assessments and reviews and update Register entries.

Recommendation 2: The IAG recommends that the MDBA in consultation with BSMAP develop a streamlined process for certifying that reviews and assessments have followed the BSM Procedures.

The IAG noted the significant increase in the irrigation footprint in the Mallee zone, with recent permanent horticultural plantings in each State. It would be useful for each jurisdiction to estimate the change in the areas irrigated, at least in moderate and high salinity risk zones in their comprehensive reports.

Recommendation 3: The IAG recommends that future comprehensive reports include estimates of the area and locations of new irrigation developments and their potential salinity risks.

The consolidated BSM Procedures were endorsed by BSMAP on 1 March 2023, approved by BOC on 14 June 2023 and were subsequently published on the MDBA website in September 2023.

Finding 9: The IAG finds that the consolidated BSM Procedures are fit for purpose.

Schedule B requires the jurisdictions to continuously monitor salinity concentrations and salt loads at the end of valley target (EoVT) sites. The 2019 independent audit recommended that in the lead up to the 2026 review of the BSM2030 strategy, the usefulness of end-of-valley targets for management decisions be explored and consideration be given to other indicators such as trend analysis and mid-valley targets. The large range in annual flows in the valleys in the more arid parts of the Basin makes it very difficult to detect underlying changes in catchment conditions by examining end of valley salinity concentrations and loads.

It is likely that regular simple reviews drawing on existing monitoring and local expertise would provide better insights into the risks to shared water resources than the end of valley targets. It is also likely that local salinity issues and landholder concerns would determine if a state needs to do more detailed investigations.

Finding 10: The IAG finds that the use of salt load and salinity exceedance curves in reporting trends at EoVT sites is a step forward, but further development is needed.

The IAG considers that the effects of climate change on the intensity and/or frequency of wet climatic sequences like the one experienced during the audit period may increase salinity risks to shared water resources. More detailed analysis is required to identify the risks which should be considered further by the 2026 review.

Finding 11: The IAG supports the requirement for periodic simple reviews of the salinity risks to the shared water resources.

Recommendation 4: The IAG recommends that the BSM2030 strategic review consider replacing End of Valley Targets and Appendix 1 of Schedule B with an obligation to undertake simple risk reviews.

Recommendation 5: The IAG recommends that the MDBA in consultation with BSMAP investigate the effects of climate change on the severity and frequency of extreme wet events and their salinity impacts.

The MDBA must re-estimate the salinity impacts of entries on Register A and B in accordance with the Review Plan. The following matters are reviewed:

- Register entries (including provisional entries)
- models or assessment methods associated with Register entries
- End-of-Valley Targets, including, for each valley, a review of associated models and baseline data.

BSM Procedures set out the agreement process for updating the Review Plan. MDBA, in consultation with BSMAP, developed a revised procedure in 2023 (Trial Procedure-Developing and updating the Review Plan) that will be trialled to ensure prioritisation of effort.

The IAG notes that the successful implementation of the Review Plan is highly dependent on the successful transition from MSM-BIGMOD to Source. This task must be the highest priority and properly resourced.

Finding 12: The IAG supports the use of the Annual review of the Review Plan (Trial Procedure) including the Risk Based Needs Assessment noting that it could be simplified.

Recommendation 6: The IAG recommends that the 2023 draft Review Plan be adopted after confirming the costs of the proposed reviews can be funded.

The MDBA must prepare a plan to review BSM2030 by 31 December 2025, and commence a review of BSM2030 by 31 December 2026. The Roadmap has been developed to identify key activities that need to be completed to inform the BSM2030 strategic review.

The Roadmap would be strengthened by explicitly identifying a task to deliver the plan to review BSM2030 by 31 December 2025. This may require some additional tasks to develop the scope, objectives and matters to be covered by the review. It would also be prudent to ensure the scope of the review aligns with the funding available. The early step would be for both the MDBA and the jurisdictions to develop and prioritise indicative budgets for the tasks leading up to the review.

Finding 13: The IAG finds that the Roadmap is a useful planning document.

Recommendation 7: The IAG recommends that both the MDBA and the jurisdictions develop and prioritise indicative budgets for the tasks identified in the Roadmap.

The IAG Salinity Audit 2021 recommended that a Basin salinity management risk management Procedure be developed when the draft risk management framework was finalised.

A risk assessment procedure consistent with AS ISO 31000:2018 has now been finalised and is included in the consolidated BSM Procedures 2023. It focuses on the risks most relevant to achieving the objectives of the BSM2030 strategy. It also sets out the processes for preparing risk registers and governance arrangements.

Finding 14: The IAG finds that the risk management procedure is fit for purpose.

The MDBA is transitioning hydrological modelling from the current model, MSM-BIGMOD, to Source. This involves two work streams. The first is a technical work stream to ensure Source is suitable for salinity accountability purposes under Schedule B. Given the complexity involved in generating Register entries and tracing the cause of discrepancies there appears to still be a risk that not all Register entry differences will be able to be explained by February 2024. If this occurs it may be warranted to operate the Source Register and the MSM-BIGMOD register in parallel until such time as all differences can be explained. There is also strong likelihood that Source model updates will cause Register entries to change even after transition to Source occurs.

Finding 15: The IAG finds the transition from MSM-BIGMOD to Source has been complex and time-consuming but is progressing towards finalisation by mid 2024.

Recommendation 8: The IAG recommends that the MDBA prepare adequate documentation for each Register entry following the transition to Source.

Recommendation 9: The IAG recommends that the MDBA develop a Procedure to manage future updates of the Source model.

The second work stream will require BSMAP to identify and resolve policy issues that may arise because the transition to Source will change the value of Register entries. The significance of the adjustment to Register entries will not be known until Source is successfully run.

The IAG was advised that the 2026 strategic review of BSM2030 will consider updating the benchmark period and the cost functions used to quantify Register entries. The changes have the potential to change the jurisdictions' Register balances. Policies and decisions will be needed at that time to ensure Register adjustments are acceptable to the jurisdictions.

The approach to adjusting Register balances caused by the transition to the Source model should be determined as part of the 2026 BSM2030 strategic review. However, the transition to the Source model should not be delayed until the 2026 review. An interim solution is needed.

Recommendation 10: The IAG recommends that the Commonwealth salinity credits be used to offset changes to the jurisdictions' balances caused by the transition to Source until the 2026 review.

The BSM Procedures are not entirely clear about the process to be followed if the Register entries are to be amended as a result of transitioning to Source, and whether the agreement of the Ministerial Council, BOC or the MDBA is required before the Registers are adjusted by the Authority.

Finding 16: The IAG finds the BSM Procedures do not identify responsibilities for updating Register entries resulting from the transition to Source.

Recommendation 11: The IAG recommends that Procedure 2.3.5 (Management of major shifts in the registers) be updated once the transition to Source is agreed and the approach to adjust the registers has been determined.

Recommendation 12: The IAG recommends that, prior to the Authority approval of the salinity registers prepared using the Source Murray model, the Authority seeks the endorsement of BOC regarding changes to the register entries.

There are 12 Salt Interception Schemes on Register A that are joint program works under the Murray–Darling Basin Agreement. The salt interception schemes contribute a salinity credit (average EC at Morgan) of 98.4 EC.

The performance of the SIS in 2021 –23 was inferior to the previous audit period of 2019–21. The IAG was briefed by the MDBA that the last two years have been very challenging for the operation of the Schemes, largely due to the 2022–23 River Murray flood event that required some of the Schemes to be shut down and caused significant lasting damage to infrastructure that will require funding and will take some time to repair.

The IAG was advised that the Responsive Management of SIS trial project continued during the audit period with some schemes and/or components of schemes operated at reduced levels. However, the project was significantly disrupted by the floods. The project should provide valuable insights to the 2026 BSM2030 strategic review.

Finding 17: The IAG finds that progress has been made in improving the management of the SIS but continued effort is required.

Recommendation 13: The IAG recommends that the MDBA assign a high priority to repairing flood damaged salt interception schemes.

In 2022–23 the substantial widespread unregulated flow event mobilised salt from the floodplain and accordingly river operators were concerned that the salinity levels may spike as flows receded. Fortunately, unregulated flows were sufficient to dilute the increased salt loads from the floodplains. The MDBA advised the IAG that during 2021–23 there were no elevated salinity events. The IAG acknowledge that there are significant challenges in managing and quantifying the salinity effects of short-term environmental watering events. The possibility of replacing the long-term accountability arrangements of Schedule B with short-term operational management of salinity was briefly discussed with the IAG but not supported.

Finding 18: The IAG finds that flow based management of salinity will not replace the need for environmental works and measures to be included on the Registers.

Recommendation 14: The IAG recommends that the management of salinity peaks be considered as part of the Enhanced Environmental Water Delivery project.

The IAG reviewed reports summarising strategic knowledge improvement that have been developed to inform the 2026 review of the BSM2030. One key issue is that of environmental watering and salt mobilisation.

Finding 19: The IAG finds that coordinated programs of work are being undertaken to identify and address the BSM2030 strategic knowledge improvement priorities.

There was general agreement that ongoing effort was required to engage and communicate with

both the community and the agencies.

Finding 20: The IAG finds that ongoing effort is required to engage and communicate with both the community and the agencies.

The 2019–21 audit report contained eight new recommendations for the Contracting Governments and the Authority to address in order to ensure continuous improvement in Basin salinity management and referred to six recommendations from the 2017–19 audit reports that were still relevant.

Finding 21: The IAG finds that satisfactory progress has been made in implementing past audit recommendations considering available resources.

The IAG reviewed future work priorities and highlighted those that are likely to strategically improve and streamline accountability processes and affect the management of the shared water resources of the Murray. Priorities include:

- completing the transition from MSM-BIGMOD to Source and updating the Registers
- managing the Review of Register entries and models consistent with the Review Plan
- progressing projects identified in the Roadmap including the economic assessment of the benefits of salinity management
- assessing the salinity effects of SDLAM projects and entering them on the Register
- repairing salt interception schemes damaged by the recent flooding.

Appendix B – Salinity registers

The BSM2030 salinity registers present individual accountable actions as credits and debits expressed both in EC impacts and as cost effects in dollar values.

Register A includes accountable actions taken after the baseline date (1988 for New South Wales, Victoria and South Australia; 2000 for Queensland and the Australian Capital Territory) and joint-funded authorised works or measures. Accountable actions that are predicted to cause increases in salinity are referred to as salinity debits and are shown as a positive number. Accountable actions that result in a decrease in salinity levels are referred to as salinity credits and are shown as a negative number. Salinity debits can be offset by credits arising from authorised works or measures and other credit generating actions, such as improved land and water management practices.

Register B records delayed salinity impacts or the 'Legacy of History' 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 salinity impacts of actions aimed at addressing delayed salinity impacts, including contributions from joint works or measures, and their salinity cost effects. Delayed salinity impacts are salinity impacts that result from a pre-1988 action but for which the impact does not begin to occur until after 1 January 2000. That part of the impact which occurs before 1 January 2000 is incorporated into baseline conditions. Salinity and cost effects of relevant management actions that are nominated by Contracting Governments as specifically for offsetting 'Legacy of History' salinity impacts after 1 January 2000 are also entered in Register B.

Changes to the registers to accommodate the new requirements under the BSM2030 strategy

The flow regime of the Murray–Darling Basin is changing as a result of environmental water recovery, delivery and use under the Basin Plan. Environmental watering is estimated to have a net long-term salinity benefit for the shared water resources due to the substantial dilution benefits from delivering the water. However, there may also be some environmental watering actions that mobilise salt into the river system.

The expected salinity impacts (both positive and negative) from environmental water are accountable actions under Schedule B to the Murray–Darling Basin Agreement and as such are included on Register A of the BSM2030 Salinity Registers.

The design of the salinity registers was changed in 2016 to accommodate the new requirements under the BSM2030 strategy. The BSM2030 salinity accountability arrangements for environmental water required changes to the design of Register A. Changes included new Commonwealth and Collective columns to indicate the salinity cost effect. The amendments to Schedule B also included a requirement to forecast the salinity effect (EC at Morgan) at the year 2030 for all register entries to coincide with the end of the BSM2030 strategy. This change required a new 2030 column for both Register A and Register B.

Explanation of the BSM2030 salinity registers

Table 1 provides a summary of the BSM2030 salinity registers for 2021. Table 10 and Table 11 are the actual 2023 salinity registers, which provide more detail on the credits and debits of specific actions. This section explains the broad groups of register entries.

Authorised works or measures

The first line summarises the economic benefits in the river arising from authorised works or measures for each state and the Australian Government.

Authorised works or measures collectively refers to SIS constructed as part of the Salinity and Drainage Strategy (MDBC 1989) and those developed under the BSMS, and also includes any that may be constructed under the BSM2030 strategy or any future Basin-wide salinity management strategies. The registers demonstrate the benefits of the shared schemes between the investing states. The Australian Government has provided significant financial input to the schemes, which is reflected in the right-hand column showing a salinity benefit equivalent to that contribution. A proportion of credits generated by the joint program of joint works or measures developed under the BSMS is assigned to individual states to offset the debts recorded in Register B. In the registers summary (Table 1), these transfers are shown as 'Transfers to Register B'.

Shared state actions

Some states have carried out actions together, such as adopting targeted river operating rules that provide downstream salinity benefits. These benefits are shown as 'shared state actions' in the salinity registers.

State actions

The individual state actions reflect the land and water use salinity costs and benefits to the river. Typical examples of activities that increase salinity costs include new irrigation developments, the construction of new drainage schemes that mobilise salt to the river and wetland flushing. Offsetting activities include improved irrigation efficiencies and improved river operations.

Total Registers A and B

The overall cumulative accountability for salinity impacts on the river in 2022–23 is summarised in the 'Total Register A' and 'Total Register B' rows. Register A maintains accountability for actions after 1 January 1988 for New South Wales, Victoria and South Australia, and after 1 January 2000 for Queensland and the Australian Capital Territory. The 'Total for Register A' reflects the sum of the salinity cost of the state actions offset by 'Authorised works or measures' or 'State shared works and measures' and 'State actions' shown in the preceding lines.

Register B accounts for actions that occurred before the baseline year but for which the impacts were not experienced until after the baseline year because of the slow movement of groundwater and salt to the river. There have been significant improvements in confidence ratings for Register A items in recent years; however, many of the Register B items continue to have medium or low

confidence ratings. This suggests relatively wide uncertainty bands around the Register B totals compared with Register A totals.

Balance Register A and B

The register balance provides an overall assessment of whether each partner government is in net credit or debit. This balance needs to be interpreted in the light of the different levels of confidence in individual register entries provided by Register B. Uncertainty bands associated with the lower confidence in the Register B entries are incorporated into the overall balance for Register A and Register B items.

Table 9: 2023 salinity register A

	AUTHORITY REGISTER A (Accountable Actions)	Type	Date Effective	Provisional Salinity Credit ($m/yr)	Current Impact on Morgan 95%ile Salinity (EC)	Impact on Flow at Mouth (GL/y)	Salinity Effect^ (EC at Morgan)					Salinity Credits# (Interpolation to Current Year Benefits $m/year)									Commonwealth Contribution (EC)	BSM2030 review plan	
							2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)	NSW	Vic	SA	Qld	ACT	Collective Actions	Commonwealth	Total		Latest Review	Next Review
	JOINT WORKS & MEASURES																						
	Former Salinity & Drainage Works																						
1	Woolpunda SIS	SDS	Jan 1991		-76	0	-42.1	-43.5	-52.1	-59.1	-45.4	0.766	0.766						4.085	1	11.4	2018	2024
2	Improved Buronga and Mildura/Merbein SIS	SDS	Jan 1991		-8	0	-3.6	-4.2	-4.2	-4.2	-4.2	0.185	0.185						0.986	2	1.1	2022	2027
3	New Operating Rules for Barr Creek Pumps	SDS	Jul 1991		-8	0	-4.9	-4.9	-4.9	-4.9	-4.9	0.225	0.225						1.198	3	1.2	2011	2024
4	Waikerie Stage 1 SIS	SDS	Dec 1992		-22	0	-16.1	-14.2	-13.5	-13.7	-14.0	0.235	0.235						1.252	4	3.5	2018	2025
5	Changed MDBC River Operations 1988 to 2000	SDS	Apr 1993		-1	4	-1.6	-1.6	-1.6	-1.6	-1.6	0.150	0.150						0.797	5	0.4	2005	2024
6	Mallee Cliffs SIS	SDS	Jul 1994		-7	0	-5.0	-4.9	-5.1	-5.1	-4.9	0.276	0.276						1.475	6	1.2	2022	2027
7	Changed Operation of Menindee and Lower Darling	SDS	Nov 1997		3	8	0.9	0.9	0.9	0.9	0.9	-0.146	-0.146						-0.776	7	-0.2	2005	2024
8	Waikerie Phase 2A SIS	SDS	Feb 2002		-7	0	-3.3	-3.3	-3.6	-3.7	-3.4	0.055	0.055						0.294	8	0.8	2018	2025
9	Changed MDBC River Operations 2000 to 2002	SDS	Feb 2002		-5	-1	-1.4	-1.4	-1.7	-1.9	-1.5	-0.134	-0.134						-0.717	9	0.4	2006	2024
	Sub Total - Former Salinity & Drainage Works				**-131**	**11**	**-77.2**	**-77.1**	**-85.7**	**-93.4**	**-79.1**	**1.611**	**1.611**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**8.594**		**19.8**		
	Basin Salinity Management Strategy																						
10	Changed MDBC River Operations after 2002	BSMS	Dec 2003		1	7	-0.2	-0.2	-0.4	-0.4	-0.3	0.023	0.023	0.023					0.140	10	0.1	2005	2024
11	Pyramid Ck GIS	BSMS	Mar 2006		-5	-3	-3.6	-3.5	-3.5	-3.4	-3.5	0.135	0.135	0.135					0.823	11	0.9	2023	2028
12	Bookpurnong SIS	BSMS	Mar 2006		-8	0	-5.0	-4.4	-7.4	-7.9	-5.1	0.094	0.094	0.094					0.575	12	1.3	2000	2025
13	Improved Buronga SIS	BSMS	Mar 2006		-2	0	-0.6	-0.7	-0.7	-0.7	-0.7	0.026	0.026	0.026					0.162	13	0.2	2022	2027
14	Loxton SIS	BSMS	Jun 2008		-10	0	-7.0	-5.8	-10.5	-11.4	-8.8	0.132	0.132	0.132					0.804	14	1.7	2020	2025
15	Waikerie Lock 2 SIS	BSMS	Jun 2010		-9	0	-5.9	-6.1	-6.1	-6.2	-6.1	0.068	0.068	0.068					0.416	15	1.5	2018	2024
16	Upper Darling SIS	BSMS	Jun 2014		-3	0	-3.8	-3.9	-3.8	-3.9	-3.9	0.200	0.200	0.200					1.218	16	1.0	2023	2028
17	Joint Component of Murtho SIS	BSMS	Jan 2000		-6	0	-1.5	-1.5	-10.0	-9.6	-3.5	0.108	0.108	0.108					0.658	17	0.9	2023	2028
	Sub Total Joint Works under BSMS				**-43**	**4**	**-27.7**	**-26.2**	**-42.4**	**-43.6**	**-29.9**	**0.786**	**0.786**	**0.786**	**0.000**	**0.000**	**0.000**	**0.000**	**4.796**		**7.5**		
	Joint Works Sub Total				**-173**	**15**	**-104.9**	**-103.3**	**-128.1**	**-137.0**	**-109.0**	**2.397**	**2.397**	**0.786**	**0.000**	**0.000**	**0.000**	**0.000**	**13.390**		**27.2**		
	The Living Murray Works and Measures and Water for Rivers$**																						
18	TLM-RMIF 570 GL	TLM	Jun 2014	3.696							-24.4									18		2014	2023
19	TLM Works and Measures	TLM	Jun 2014	-0.902							4.6									19		2014	2023
	TLM Sub Total			**2.794**	**0**	**0**	**0.0**	**0.0**	**0.0**	**0.0**	**-19.8**												
	BSM2030																						
20	Responsive Management SIS	BSM2030	Jun 2016								12.0									20			
21	BtG Dilution benefits from delivery &	BSM2030	Jun 2015								-43.3									21			
22	MM SIS Refurbishment 2015	50V50B	Jun 2022		-1	0	0.0	-0.9	-0.9	-0.9	-0.9	0.015	0.109	0.015					0.187	22	0.0	2022	2027
	Sub Total under BSM2030				**-1.3**	**0.0**	**0.0**	**-0.9**	**-0.9**	**-0.9**	**-32.2**	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**				
	BSM2030 and TLM Sub Total				**-1**	**0**	**0.0**	**-0.9**	**-0.9**	**-0.9**	**-52.0**	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**				
	STATE WORKS & MEASURES																						
	Shared New South Wales and Victorian Measures																						
23	Permanent Trade Accounting Adjustment - NSW to Victoria	50N50V	Jun 2006		0	0	0.0	-0.1	-0.1	-0.1	-0.1	0.005	0.005						0.010	23	0	2006	2024
24	Barmah-Millewa Forest Operating Rules	50N50V	Mar 2002		-1	33	-1.9	-2.0	-1.9	-2.3	-2.0	0.185	0.185						0.371	24	0	2006	2024
	Shared Measures Sub Total				**-1**	**33**	**-2.0**	**-2.1**	**-2.0**	**-2.3**	**-2.1**	**0.190**	**0.190**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.380**		**0**		
	New South Wales																						
25	Boggabilla Weir	NSW	Dec 1991		0	0	-0.1	-0.1	-0.1	-0.1	-0.1	0.038							0.038	25	0	2007	2026
26	Pindari Dam Enlargement	NSW	Jul 1994		0	-17	0.7	0.7	0.7	0.7	0.7	-0.121							-0.121	26	0	2007	2026
27	Tandou pumps from Lower Darling	NSW	Sep 1994		2	-3	-0.1	-0.1	-0.1	-0.1	-0.1	0.034							0.034	27	0	2005	2024
28	NSW MIL LWMP's	NSW	Feb 1996		-4	57	-4.0	-4.0	-4.0	-4.0	-4.0	0.684							0.684	28	0	2010	2024
29	NSW Changes to Edward-Wakool and Escapes	NSW	Jan 1990		-2	4	-2.0	-2.1	-2.0	-2.0	-2.0	0.364							0.364	29	0	2005	2026
30	Permanent Trade Accounting Adjustment - NSW to SA	NSW	Jun 2006		-3	1	-0.5	-0.4	-0.4	-0.5	-0.4	0.106							0.109	30	0	2005	2024
31	NSW Sunraysia Irrigation Development 1967 to 2006	NSW	Jul 2003		3	0	0.0	0.9	4.5	6.1	1.7	-0.402							-0.402	31	0	2007	2025
32	NSW Sunraysia Irrigation Development 2006 to 2018	NSW	Jul 2020								3.7												2025
33	RISI NSW	NSW	Jan 2000		-6	0	-2.8	-3.9	-4.2	-4.2	-4.0	0.898							0.898	33	0	2022	2027
34	NSW S&DS Commitment Adjustment	NSW	Nov 2002		0	0	0	0	0	0	0	0.910							0.910	34	0		2024
	New South Wales Works and Measures				**-11**	**43**	**-8.9**	**-9.2**	**-5.7**	**-4.2**	**-4.7**	**2.514**							**2.514**		**0**		
	Victoria																						
35	Barr Creek Catchment Strategy	Vic	Mar 1991		-12	0	-7.7	-7.7	-7.7	-7.7	-7.7		1.963						1.963	35	0	2020	2025
36	Tragowel Plains SMP 2002 Drains	Vic	Mar 1991		2	4	0.8	0.9	0.8	0.8	0.9		-0.132						-0.132	36	0	2020	2025
37	Shepparton Irrigation Region Land and Water Management Plan	Vic	Mar 1991		10	-61	5.7	5.4	5.9	7.8	5.5		-1.078						-1.078	37	0	2010	2025
38	Nangiloc-Colignan S.M.P.	Vic	Nov 1991		-1	1	0.4	0.4	0.4	0.4	0.4		-0.102						-0.102	38	0	2013	2025
39	Nyah to SA Border SMP - Irrigation Development	Vic	Jul 2003		18	0	13.4	13.3	13.3	13.4	13.3		-3.057						-3.057	39	0	2020	2025
40	Kerang Lakes/Swan Hill Salinity Management Plan	Vic	Jan 2000		1	4	1.1	1.6	1.1	0.9	1.5		-0.347						-0.347	40	0	2010	2024
41	Campaspe West SMP	Vic	Aug 1993		0	0	0.0	0.0	-0.1	0.0	0.0		-0.039						-0.039	41	0	2017	N/A
42	Psyche Bend	50V50C	Feb 1996		-4	0	-2.1	-2.1	-2.1	-2.1	-2.1		0.237						0.474	42	1	2023	2028
43	Permanent Trade Accounting Adjustment - Victoria to SA	Vic	Jun 2006		-1	2	-0.7	-0.8	-0.8	-1.0	-0.8		0.182						0.182	43	0	2005	2024
44	Woorinen Irrigation District Excision	Vic	Sep 2003		-1	-2	1.3	0.8	1.0	1.2	0.8		-0.235						-0.235	44	0	2010	2024
45	Sunraysia Drains Drying up	Vic	Jun 2004		-2	-4	-2.3	-2.2	-2.2	-2.2	-2.2		0.591						0.591	45	0	2023	2028
46	Lamberts Swamp	Vic	Jun 2004		-7	0	-2.8	-2.8	-2.7	-2.7	-2.7		0.526						0.526	46	0	2017	2027
47	Church's Cut decommissioning	Vic	Mar 2006		0	0	-0.2	-0.3	-0.2	-0.2	-0.3		0.047						0.047	47	0	2023	2028
48	Mallee Drainage bore decommissioning	Vic	Jun 2008		-1	0	-0.1	-0.3	-0.3	-0.3	-0.3		0.067						0.067	48	0	2019	2029
49	RISI VIC	Vic	Jan 2000		-13	0	-5.6	-8.0	-8.6	-8.6	-8.1		1.823						1.823	49	0	2022	2027
50	GMW Connections Stage 1 and 2	Vic	Jun 2021								3.645									50	0	2022	
51	Victorian S&DS Commitment Adjustment	Vic	Nov 2002		0	0	0	0	0	0	0		1.600						1.600	51	0		2024
	Victoria Works and Measures				**-8**	**-56**	**1.4**	**-1.6**	**-2.1**	**-0.3**	**1.9**		**2.048**						**2.285**		**1.0**		
	South Australia																						
52	SA Irrigation Development Based on Footprint Data*	SA	Jul 2003		22	0	7.0	9.4	36.0	41.1	15.5			-1.595					-1.595	52	0	2023	2028
53	SA Irrigation Development Due to Water Trade	SA	Jun 2006		0	0	0.0	0.0	-0.2	-0.7	0.0			-0.125					-0.125	53	0	2014	2024
54	SA Irrigation Development Based on Site Use Approvals	SA	Jun 2010		0	0	-0.1	0.1	2.2	23.7	0.6			-0.088					-0.088	54	0	2014	2024
55	SA Component of Bookpurnong SIS	SA	Mar 2006		-3	0	-2.3	-2.0	-3.4	-3.6	-2.3			0.255					0.255	55	0	2020	2025
56	SA Component of Loxton SIS	SA	Jun 2008		0	0	-0.1	-0.1	-0.2	-0.2	-0.1			0.017					0.017	56	0	2020	2025
57	SA component of Waikerie Lock 2 SIS	SA	Jun 2010		-1	0	-0.4	-0.4	-0.4	-0.4	-0.4			0.026					0.026	57	0	2018	2024
58	SA Improved Irrigation Efficiency and Scheme Rehabilitation Reg A	SA	Jan 2000		-76	0	-14.9	-41.7	-48.7	-53.5	-43.3			6.191					6.191	58	0	2023	2028
59	Qualoo Sunlands GWCS	SA	Sep 2004		-9	0	-5.0	-5.2	-7.8	-8.5	-5.8			0.403					0.403	59	0	2018	2024
60	Pike Stage 1 SIS	SA	Jan 2012		-1	0	-1.2	-1.0	-1.2	-1.2	-1.0			0.177					0.177	60	0	2023	2028
61	SA Component of Murtho SIS	SA	Jan 2000		0	0	0.0	0.0	-0.2	-0.2	-0.1			0.013					0.013	61	0	2023	2028
62	Pike SARFIIP	SA	Jan 2000		-18	0	0.0	-8.5	-14.0	-15.1	-9.8			1.385					1.385	62	0	2023	2028
63	Katarapko SARFIIP	SA	Jan 2000		1	0	0.0	0.3	0.3	0.3	0.3			-0.031					-0.031	63	0	2023	2028
	South Australia Subtotal				**-85**	**0**	**-17.0**	**-49.2**	**-37.3**	**-18.3**	**-46.5**			**6.629**					**6.629**		**0**		
	Balance - Register A				**-280**	**34**	**-131.4**	**-166.2**	**-176.2**	**-163.0**	**-212.3**	**5.117**	**4.744**	**7.430**	**0.000**	**0.000**	**0.000**	**0.000**	**22.948**		**28.3**		

Table 10: 2023 salinity register B

	AUTHORITY REGISTER B (Delayed Salinity Impacts)	Type	Year of Predictions	Provisional Salinity Credit ($m/yr)	Current Impact on Morgan 95%ile Salinity (EC)	Impact on Flow at Mouth (GL/y)	2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)	Salinity Credits (Interpolation to Current Year Benefits $m/year) NSW	Vic	SA	Qld	ACT	Total	
	Transfers from Register A											0.593	0.473	1.372	0.000	0.000	2.438	
	New South Wales																	
64	Darling Catchment Legacy of History - Macquarie	NSW	Jan 2000		0	0	0	0.1	0.3	0.4	0.2	-0.043					-0.043	64
65	Darling Catchment Legacy of History - Macintyre	NSW	Jan 2000		0	0	0	0.0	0.0	0.0	0	0.000					0.000	65
66	Darling Catchment Legacy of History - Gil Gil Ck	NSW	Jan 2000		0	0	0	0.0	0.0	0.0	0.0	-0.001					-0.001	66
67	Darling Catchment Legacy of History - Gwydir	NSW	Jan 2000		0	0	0	0.0	0.0	0.0	0.0	-0.002					-0.002	67
68	Darling Catchment Legacy of History - Namoi	NSW	Jan 2000		0	0	0	0.2	0.4	0.5	0.2	-0.062					-0.062	68
69	Darling Catchment Legacy of History - Castlereagh	NSW	Jan 2000		0	0	0	0.0	0.0	0.1	0.0	-0.008					-0.008	69
70	Darling Catchment Legacy of History - Bogan	NSW	Jan 2000		0	0	0	0.1	0.2	0.3	0.1	-0.031					-0.031	70
71	Lachlan Legacy of History	NSW	Jan 2000		0	0	0	0.0	0.0	0.0	0	0.000					0.000	71
72	Murrumbidgee Catchment Legacy of History	NSW	Jan 2000		0	0	0	0.1	0.2	0.2	0.1	-0.023					-0.023	72
73	NSW Mallee - dryland	NSW	Jan 2000		0	0	0	0.1	1.2	1.7	0.4	-0.100					-0.100	73
74	NSW Mallee - Pre 88 Irrigation	NSW	Jan 2000		0	0	0	0.3	0.7	1.1	0.3	-0.098					-0.098	74
	Victoria																	
75	Campaspe Catchment Legacy of History	Vic	Jan 2000		0	0	0	0.1	0.2	0.3	0.1		-0.030				-0.030	75
76	Goulburn Catchment LoH	Vic	Jan 2000		0	-1	0	0.4	0.7	1.1	0.5		-0.111				-0.111	76
77	Loddon Catchment LoH	Vic	Jan 2000		1	0	0	0.6	0.9	1.3	0.7		-0.152				-0.152	77
78	Kiewa Catchment Legacy of History	Vic	Jan 2000		0	0	0	0.1	0.0	0.0	0.1		-0.029				-0.029	78
79	Ovens Catchment Legacy of History	Vic	Jan 2000		0	0	0	0.0	0.6	1.3	0.1		-0.035				-0.035	79
80	Victorian Mallee - dryland	Vic	Jan 2000		2	0	0	0.3	2.1	3.5	0.7		-0.174				-0.174	80
81	Victorian Mallee - Pre 88 Irrigation	Vic	Jan 2000		1	0	0	0.4	1.0	1.5	0.5		-0.179				-0.179	81
	South Australia																	
82	SA Mallee Legacy of History - Dryland	SA	Jan 2000		3	0	0	0.9	4.2	12.2	1.7			-0.247			-0.247	82
83	SA Mallee Legacy of History - Irrigation	SA	Jan 2000		39	0	0	11.3	33.9	43.0	16.5			-2.648			-2.648	83
84	SA Improved Irrigation Efficiency and Scheme Rehabilitation Reg B	SA	Jan 2000		-41	0	0	-17.7	-27.4	-32.6	-19.9			2.424			2.424	84
	Queensland																	
85	Queensland Legacy of History	Qld	Jan 2000	TBA														85
86	Queensland Irrigation Development pre 1 Jan 2000	Qld	Jan 2000	TBA														86
	Balance - Register B			0.000	7	-1	0.0	-2.7	19.2	35.9	2.3	0.224	-0.236	0.901	0.000	0.000	0.889	
	Balance - Registers A & B				-273	33	-131.4	-168.9	-157.0	-127.1	-209.9	5.341	4.508	8.332	0.000	0.000	23.837	
	Modelled Current Status				786	4,951	507	472	479	513	502							

Registers Explanatory Notes

TBA - To be advised

^Salinity Effect - Increase or decrease in average salinity at Morgan in EC

#Salinity Credits - Unit of account of Salinity and Drainage Strategy = Reduction in Salinity Costs ($m/year March 2005 values)

* These entries are comprised of multiple MODFLOW model outputs accredited at various times. As such they are not reviewed and updated in their entirety in one year but the component models are updated in line with the BSM2030 review plan. The review year reflects the latest model review. Some of the totals are affected by rounding

** Assessments based on preliminary reports. Further work is required on how these assessments are presented in the register. Salinity impacts not included in the totals.

& Based on 2039.5 GL representing the LTDLE volume of all HEW entitlements

Total Register A of $22.947 m/yr excludes transfers to Register B

Appendix C – Baseline conditions

The BSM2030 baseline conditions are the agreed suite of conditions in place within the catchments and rivers of the Basin on 1 January 2000. They include land use (level of development); water use (level of diversions); land and water management policies and practices (including the Murray–Darling Basin cap agreements); river operating regimes; SIS; run-off generation; salt mobilisation processes; and groundwater status and condition.

The baseline conditions have been set for all end-of-valley target sites as shown in Table 12.

Table 11: Basin Salinity Management Strategy end-of-valley baseline conditions

Valley	Salinity (EC) mean (50%ile)	Salinity (EC) peak (80%ile)	Salt load (t/y) mean	Valley reporting site	AWRC site number
All partner governments					
Murray–Darling Basin	570	920 (95%ile)	1,600,000	Murray R at Morgan (Salinity) Murray R at Lock 1 (Flow)	426554 426902
South Australia					
SA Border	380	470	1,300,000	Flow to SA	426200
Lock 6 to Berri	450	600	1,500,000	Murray R at Lock 4 (Flow)	426514
Below Morgan	600	820	1,600,000	Murray R at Murray Bridge	426522
New South Wales					
Murrumbidgee	150	230	160,000	Murrumbidgee R d/s Balranald Weir	410130
Lachlan	430	660	250,000	Lachlan R at Forbes (Cottons Weir)	412004
Bogan	440	490	27,000	Bogan R at Gongolgon	421023
Macquarie	480	610	23,000	Macquarie R at Carinda (Bells Bridge)	421012
Castlereagh	350	390	9,000	Castlereagh R at Gungalman Bridge	420020
Namoi	440	650	110,000	Namoi R at Goangra	419026
Gwydir	400	540	7,000	Mehi R at Bronte	418058
NSW Border Rivers	250	330	50,000	Barwon R at Mungindi	416001

Valley	Salinity (EC) mean (50%ile)	Salinity (EC) peak (80%ile)	Salt load (t/y) mean	Valley reporting site	AWRC site number
Barwon–Darling	330	440	440,000	Darling R at Wilcannia Main Channel	425008
NSW Upper Murray	54	59	150,000	Murray R at Heywoods	409016
NSW Riverine Plains	310	390	1,100,000	Murray R at Red Cliffs	414204
NSW Mallee Zone	380	470	1,300,000	Flow to SA	426200
Victoria					
Wimmera	1,380	1,720	31,000	Wimmera R at Horsham Weir	415200
Avoca	2,060	5,290	37,000	Avoca R at Quambatook	408203
Loddon	750	1,090	88,000	Loddon R at Laanecoorie	407203
Campaspe	530	670	54,000	Campaspe R at Campaspe Weir	406218
Goulburn	100	150	166,000	Goulburn R at Goulburn Weir	405259
Broken	100	130	15,000	Broken Ck at Casey's Weir	404217
Ovens	72	100	54,000	Ovens R at Peechelba East	403241
Kiewa	47	55	19,000	Kiewa R at Bandiana	402205
Vic. Upper Murray	54	59	150,000	Murray R at Heywoods	409016
Vic. Riverine Plains	270	380	630,000	Murray R at Swan Hill	409204
Vic. Mallee Zone	380	470	1,300,000	Flow to SA	426200
Queensland					
Queensland Border Rivers	250	330	50,000	Barwon R at Mungindi	416001 [a]
Moonie	140	150	8,700	Moonie R at Fenton	417204A
Condamine–Balonne	170	210	4,200	Ballandool R at Hebel—Bollon Rd	422207A

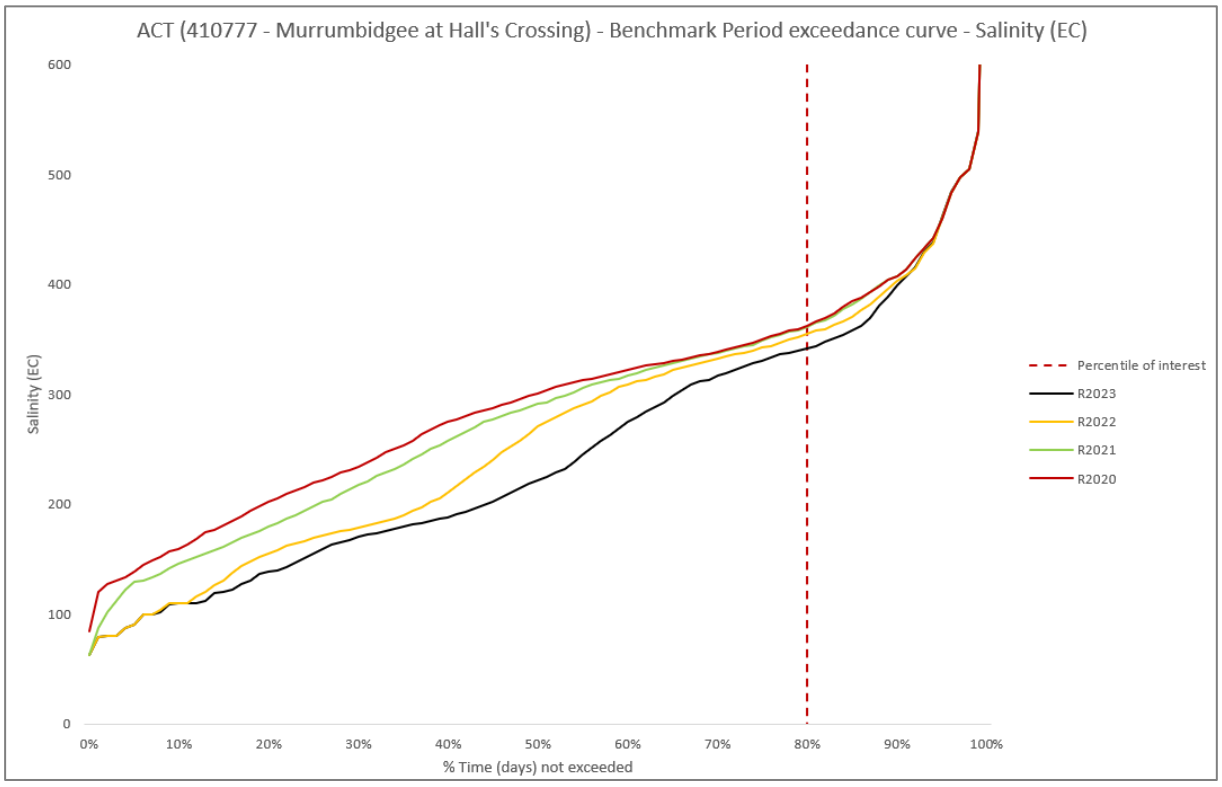
Valley	Salinity (EC) mean (50%ile)	Salinity (EC) peak (80%ile)	Salt load (t/y) mean	Valley reporting site	AWRC site number
	170	210	5,000	Bokhara R at Hebel	422209A
	150	280	6,500	Briarie Ck at Woolerbilla—Hebel Rd	422211A
	170	210	29,000	Culgoa R at Brenda	422015 [a]
	160	210	10,000	Narran R at New Angledool	422030 [a]
Paroo	90	100	24,000	Paroo R at Caiwarro	424201A
Warrego	101	110	4,800	Warrego R at Barringun No.2	423004 [a]
	100	130	5,500	Cuttaburra Ck at Turra	423005 [a]
Australian Capital Territory					
ACT	224	283	32,700	Murrumbidgee R at Hall's Crossing	410777

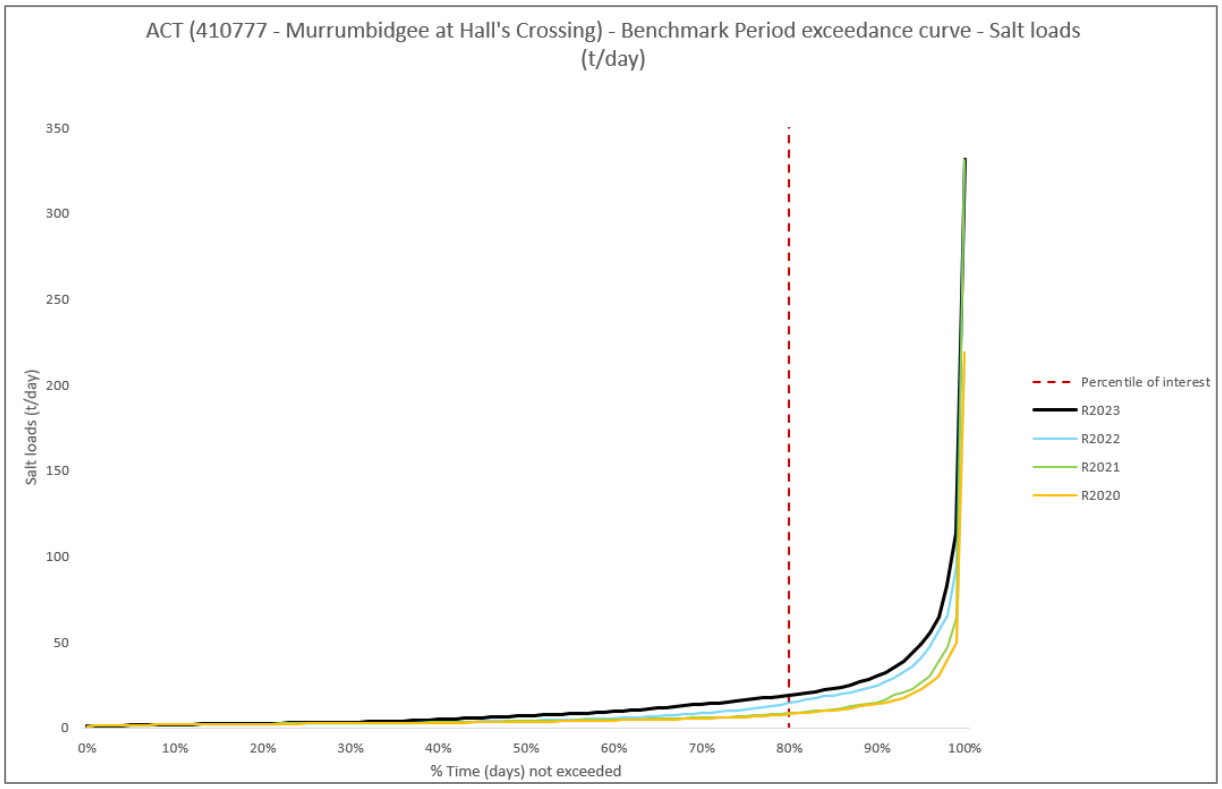
[a] *These sites are operated by New South Wales for Queensland*

Appendix D – Flow and salinity for EoVT sites

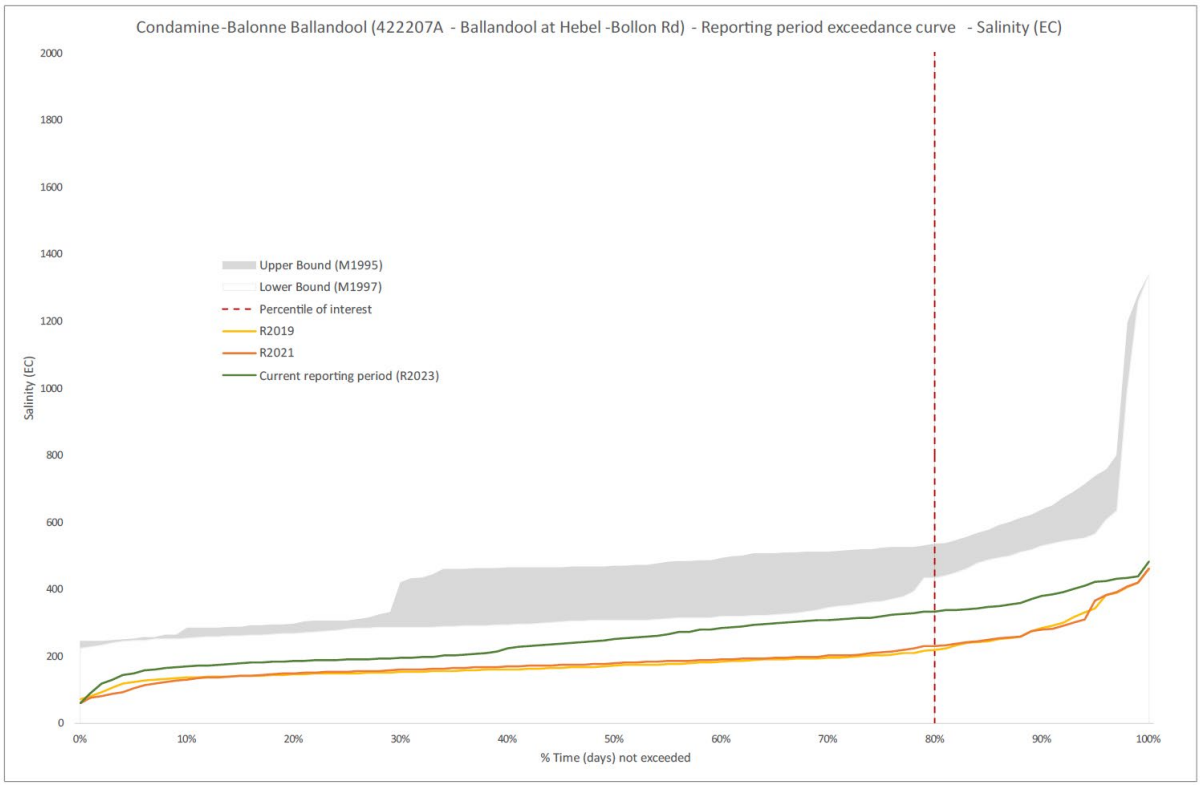
The graphs presented in Appendix D are related to the end-of-valley target sites and illustrate flow and salinity for the 2021–22 and 2022–23 period.

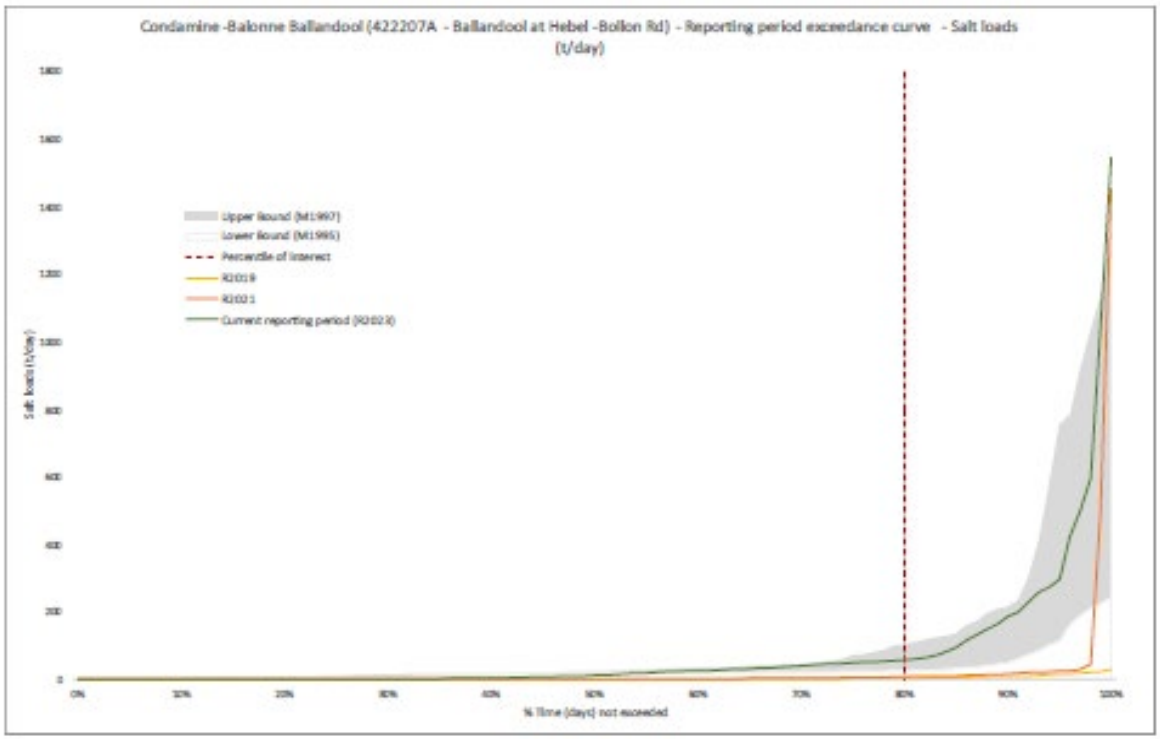
Australian Capital Territory

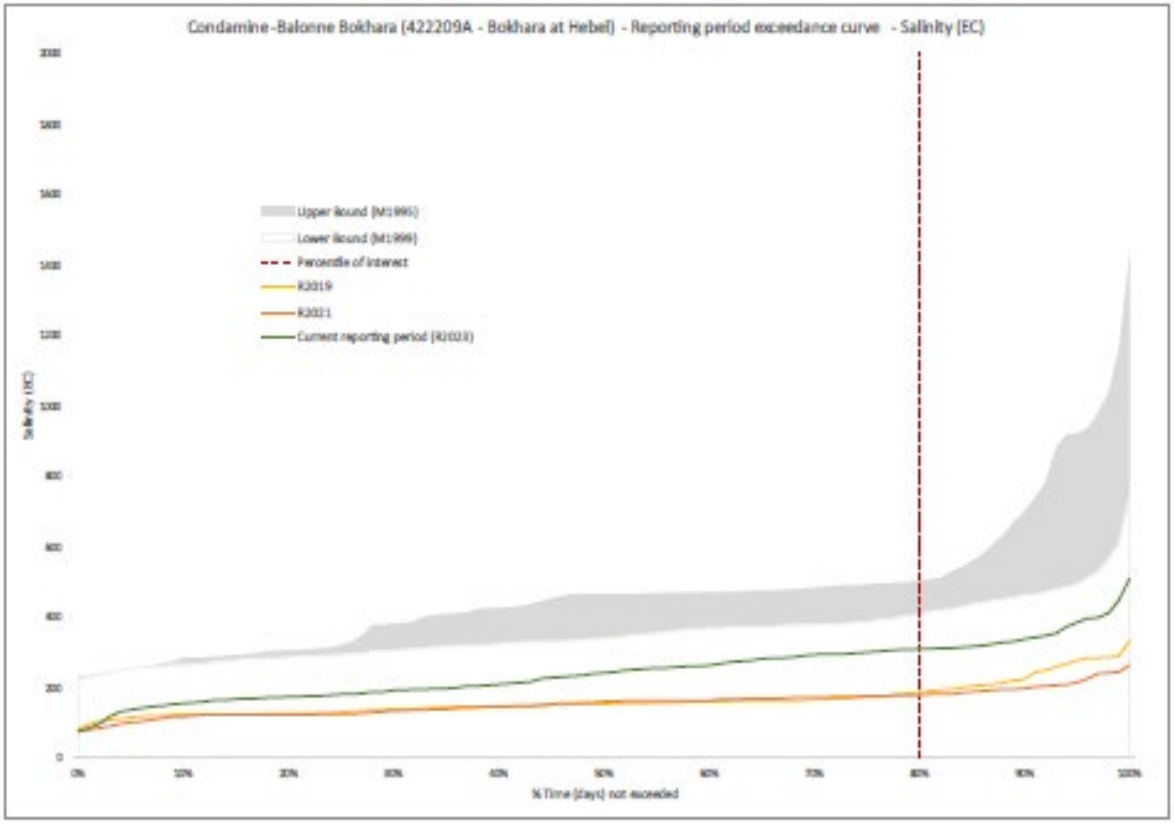


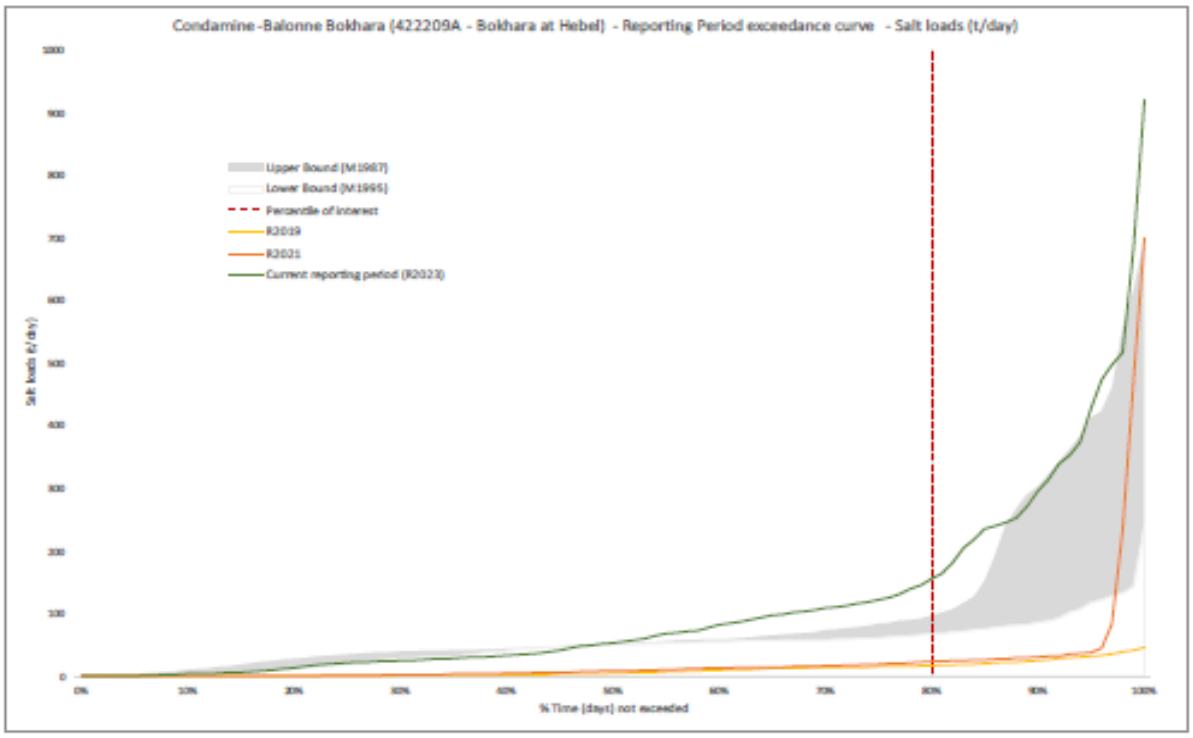

ACT (410777 - Murrumbidgee at Hall's Crossing) - Benchmark Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
350
300
250
200
150
100
50
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Percentile of interest
R2023
R2022
R2021
R2020

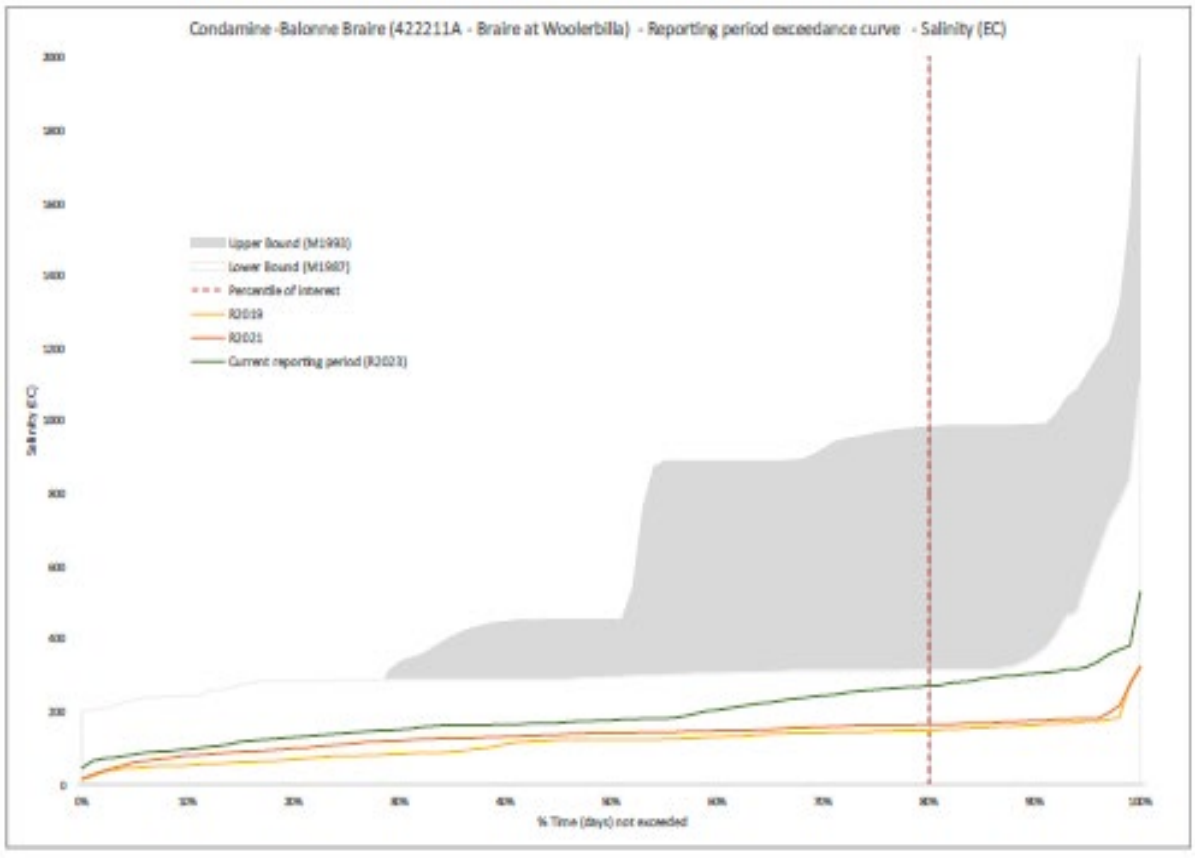
Queensland

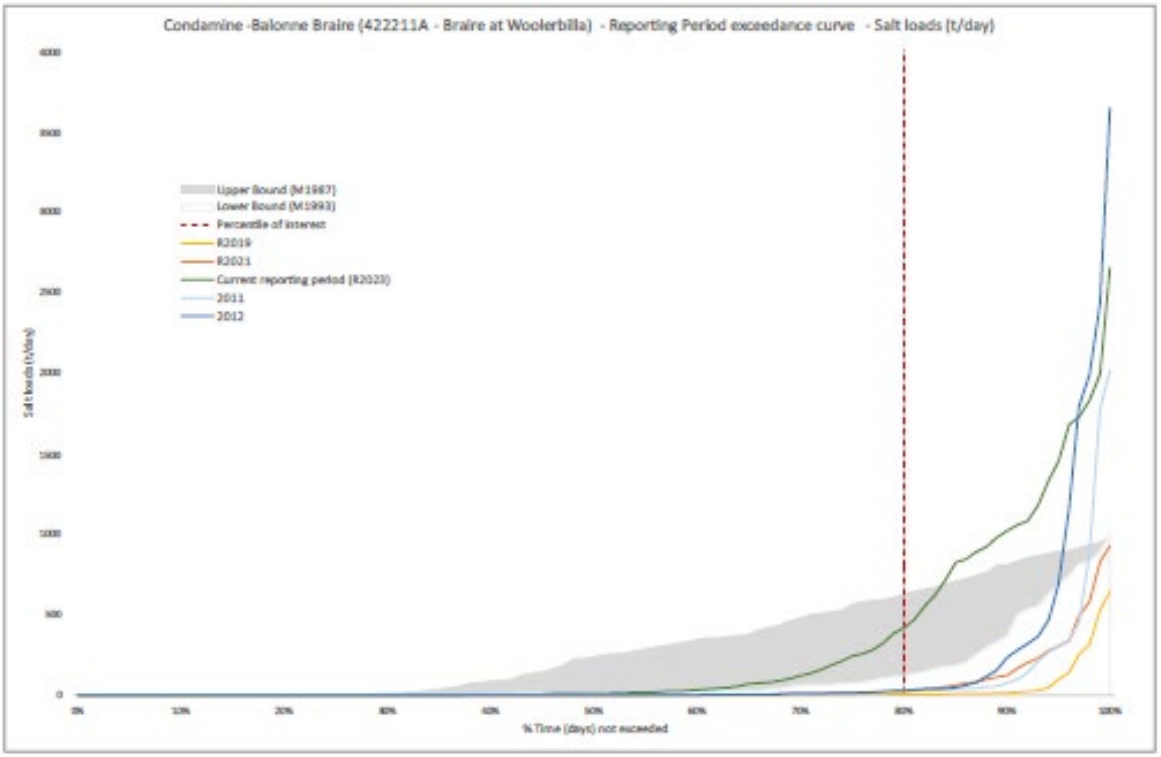

Condamine-Balonne Ballandool (422207A - Ballandool at Hebel -Bollon Rd) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1995)
Lower Bound (M1997)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

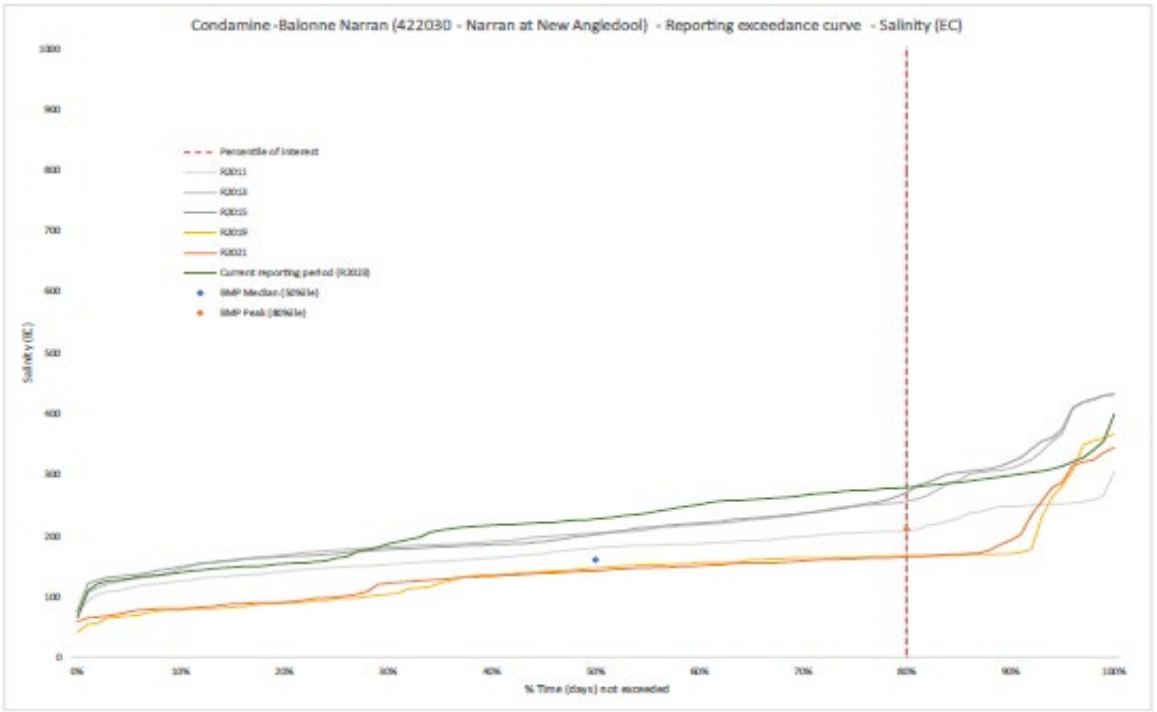

Condamine -Balonne Ballandool (422207A - Ballandool at Hebel -Bollon Rd) - Reporting period exceedance curve - Salt loads (t/day)
Upper Bound (M1997)
Lower Bound (M1995)
Percentile of interest
R2019
R2021
Current reporting period (R2023)
% Time (days) not exceeded

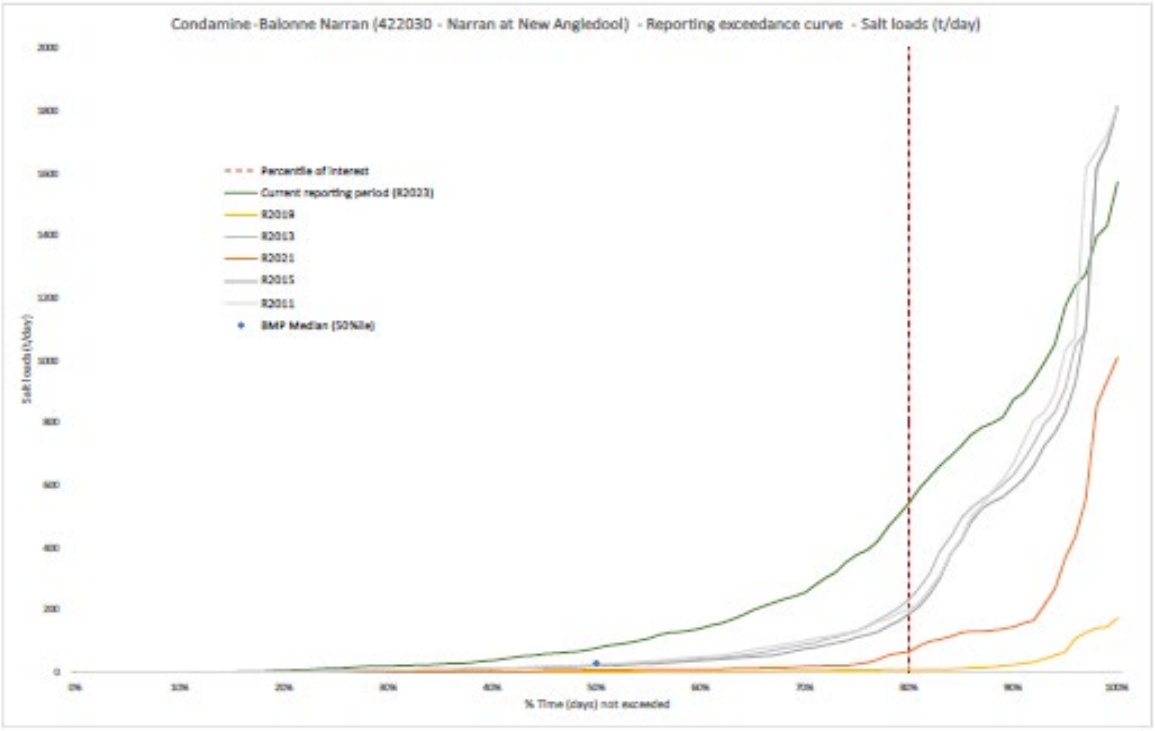

Condamine -Balonne Bokhara (422209A - Bokhara at Hebel) - Reporting period exceedance curve - Salinity (EC)
Upper Bound (M1995)
Lower Bound (M1999)
Percentile of interest
R2019
R2021
Current reporting period (R2023)
% Time (days) not exceeded

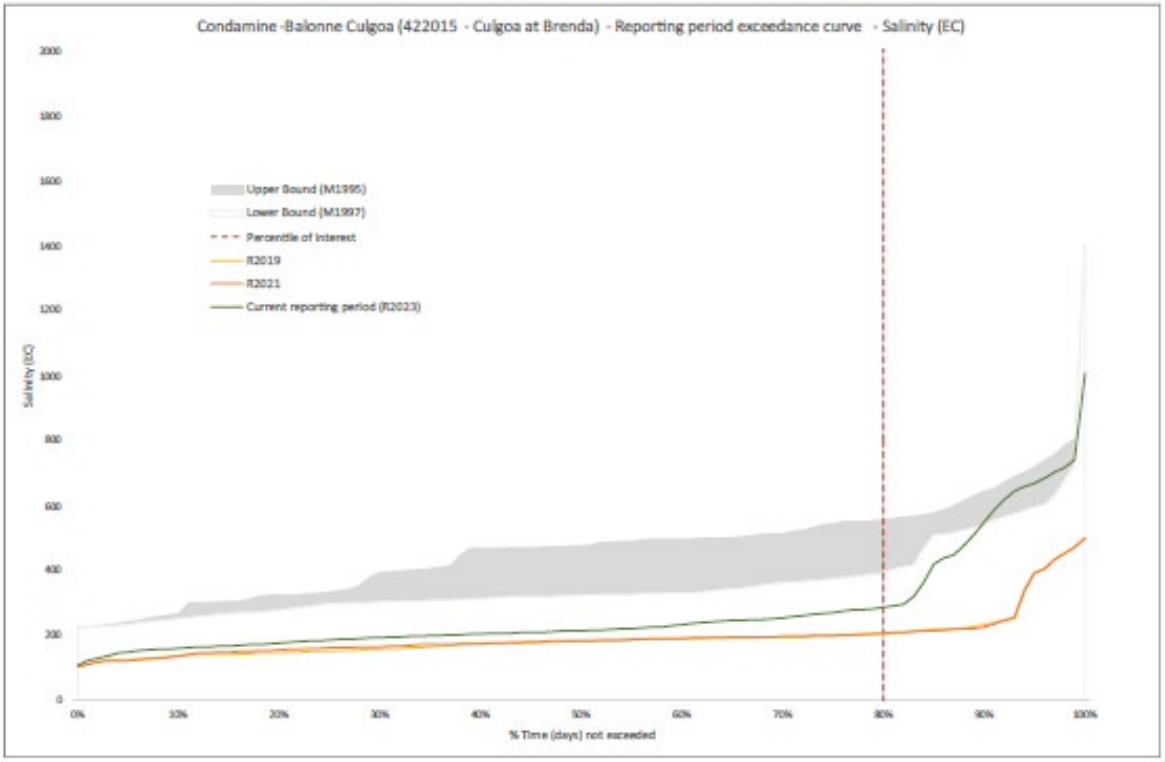

Condamine-Balonne Bokhara (422209A - Bokhara at Hebel) - Reporting Period exceedance curve - Salt loads (t/day)
Upper Bound (M1987)
Lower Bound (M1995)
Percentile of interest
R2019
R2021
Current reporting period (R2023)
Salt loads (t/day)
% Time (days) not exceeded

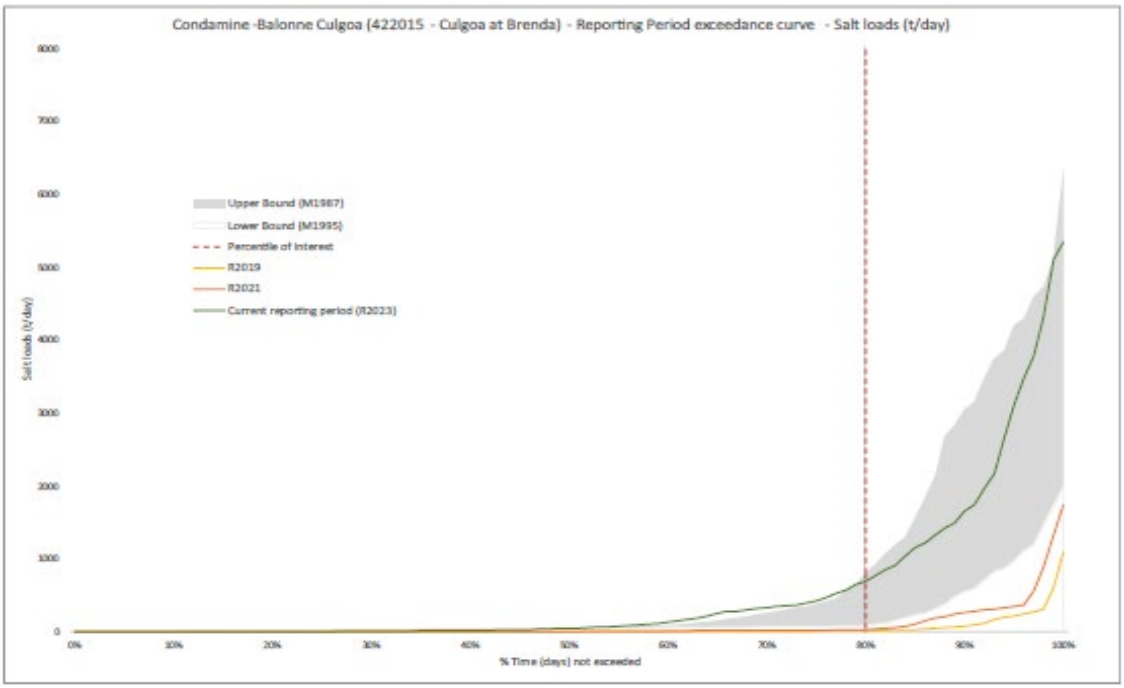

Condamine-Balonne Braire (422211A - Braire at Woolerbilla) - Reporting period exceedance curve - Salinity (EC)
Upper Bound (M1993)
Lower Bound (M1987)
Percentile of interest
R2019
R2021
Current reporting period (R2023)
Salinity (EC)
% Time (days) not exceeded

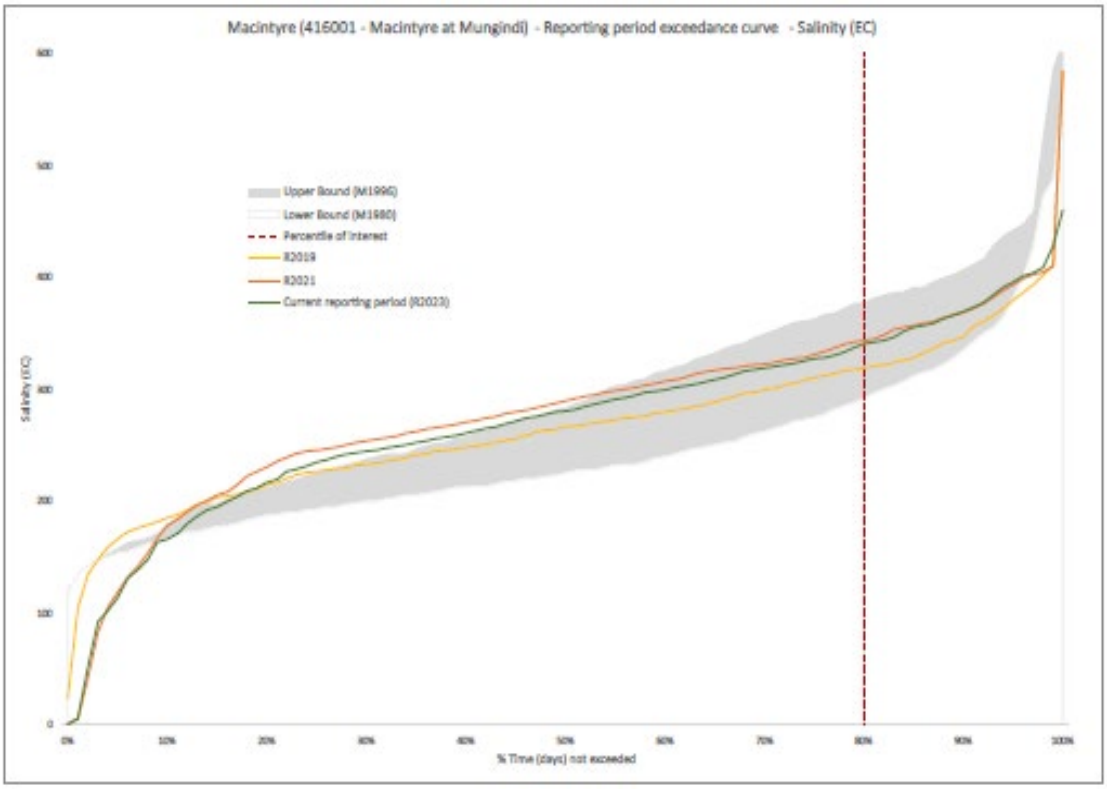

Condamine -Balonne Braire (422211A - Braire at Woolerbilla) - Reporting Period exceedance curve - Salt loads (t/day)
Upper Bound (M1987)
Lower Bound (M1993)
Percentile of interest
R2019
R2021
Current reporting period (R2023)
2011
2012
Salt loads (t/day)
% Time (days) not exceeded

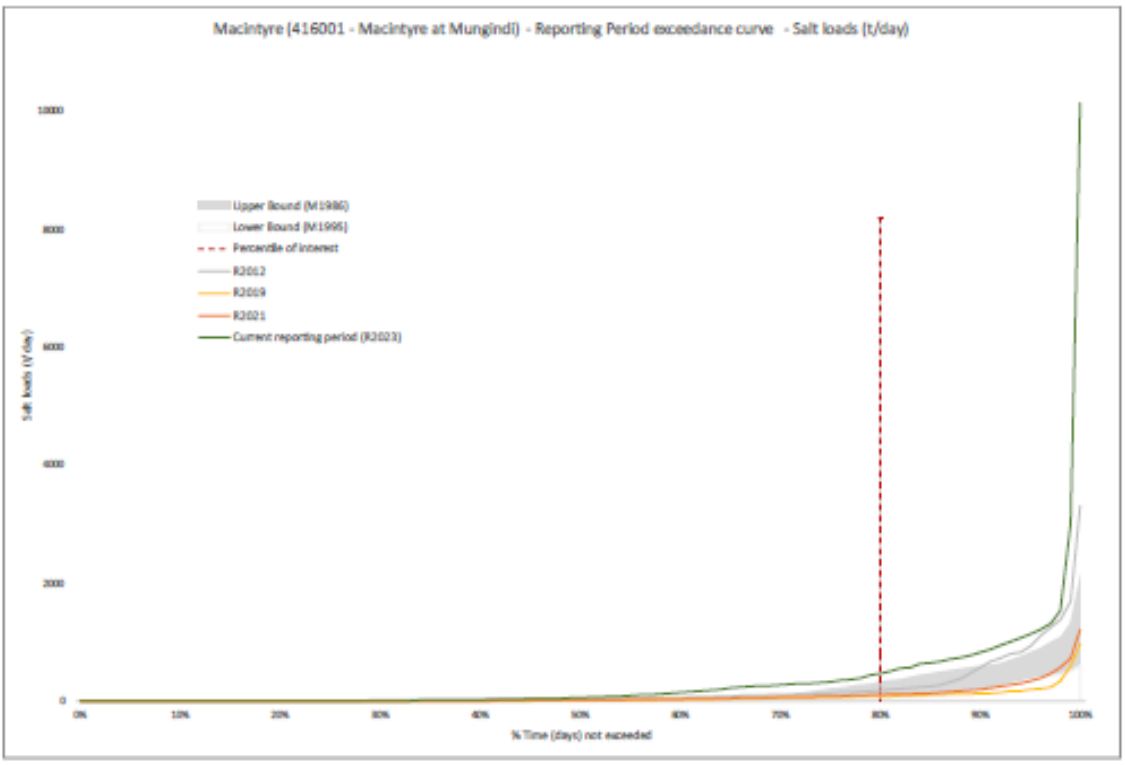

Condamine -Balonne Narran (422030 - Narran at New Angledool) - Reporting exceedance curve - Salinity (EC)
Percentile of interest
R2011
R2013
R2015
R2019
R2021
Current reporting period (R2023)
BMP Median (80%ile)
BMP Peak (80%ile)
Salinity (EC)
% Time (days) not exceeded

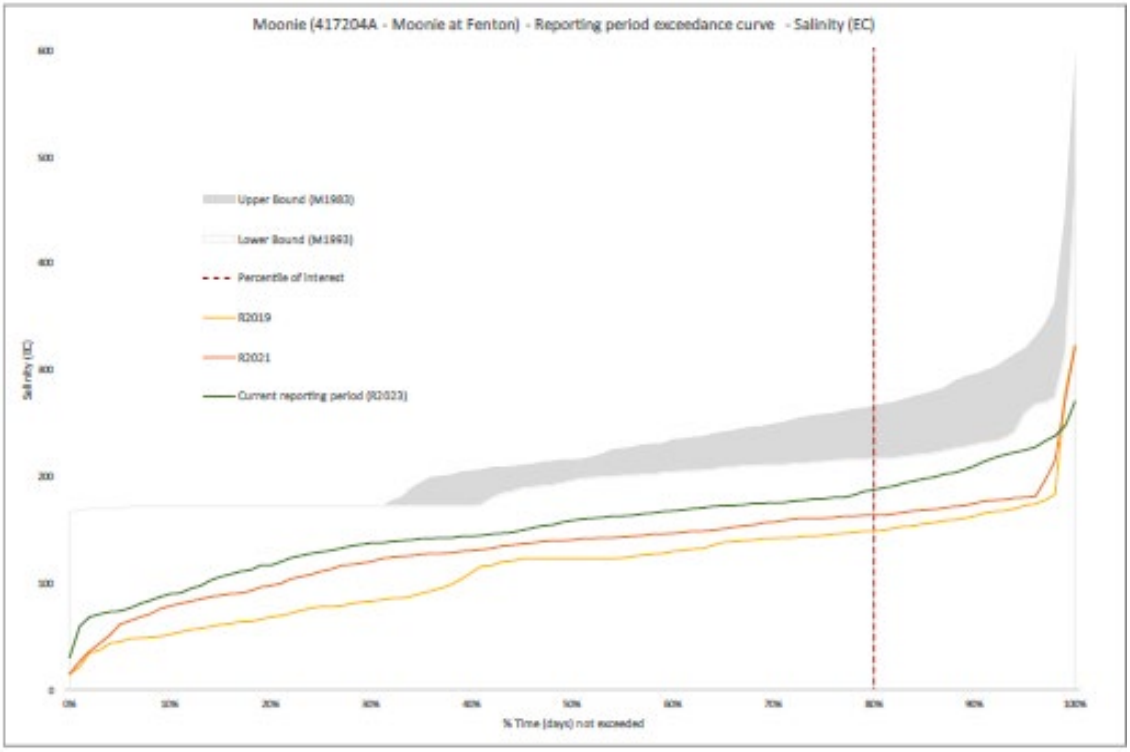

Condamine-Balonne Narran (422030 - Narran at New Angledool) - Reporting exceedance curve - Salt loads (t/day)
Percentile of Interest
Current reporting period (R2023)
R2019
R2013
R2021
R2015
R2011
BMP Median (50%ile)
Salt loads (t/day)
% Time (days) not exceeded

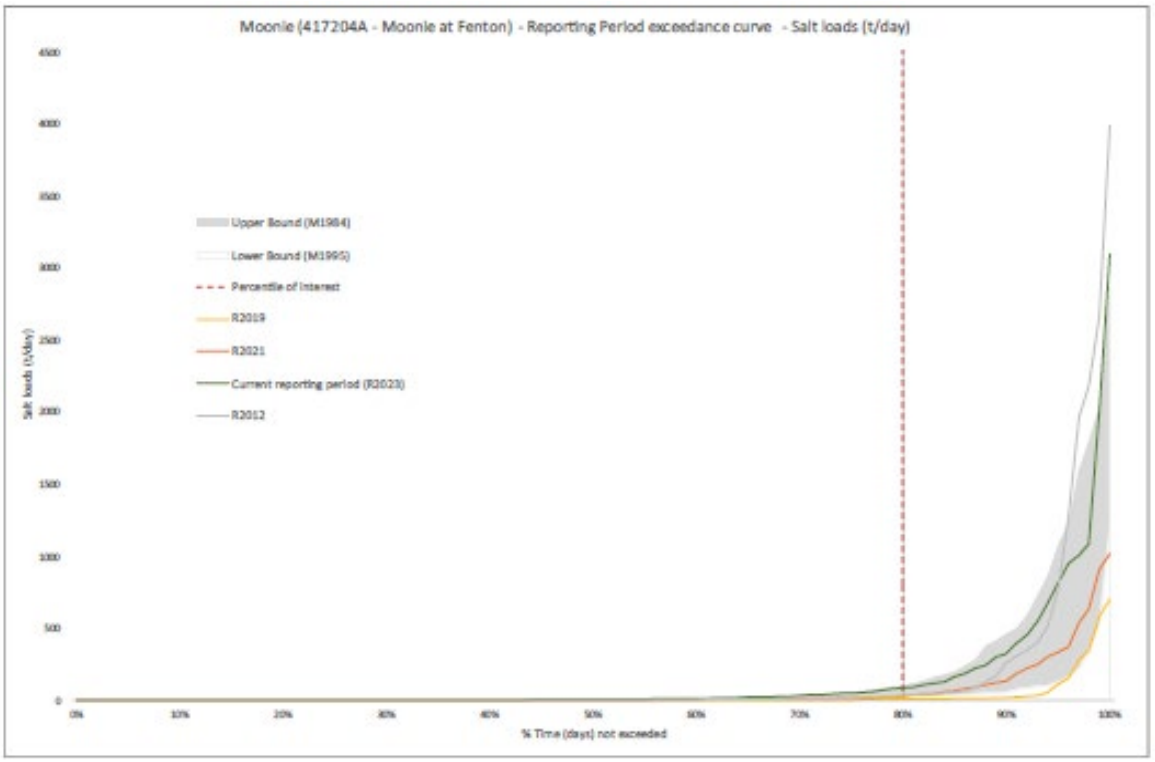

Condamine-Balonne Culgoa (422015 - Culgoa at Brenda) - Reporting period exceedance curve - Salinity (EC)
Upper Bound (M1995)
Lower Bound (M1997)
Percentile of Interest
R2019
R2021
Current reporting period (R2023)
Salinity (EC)
% Time (days) not exceeded

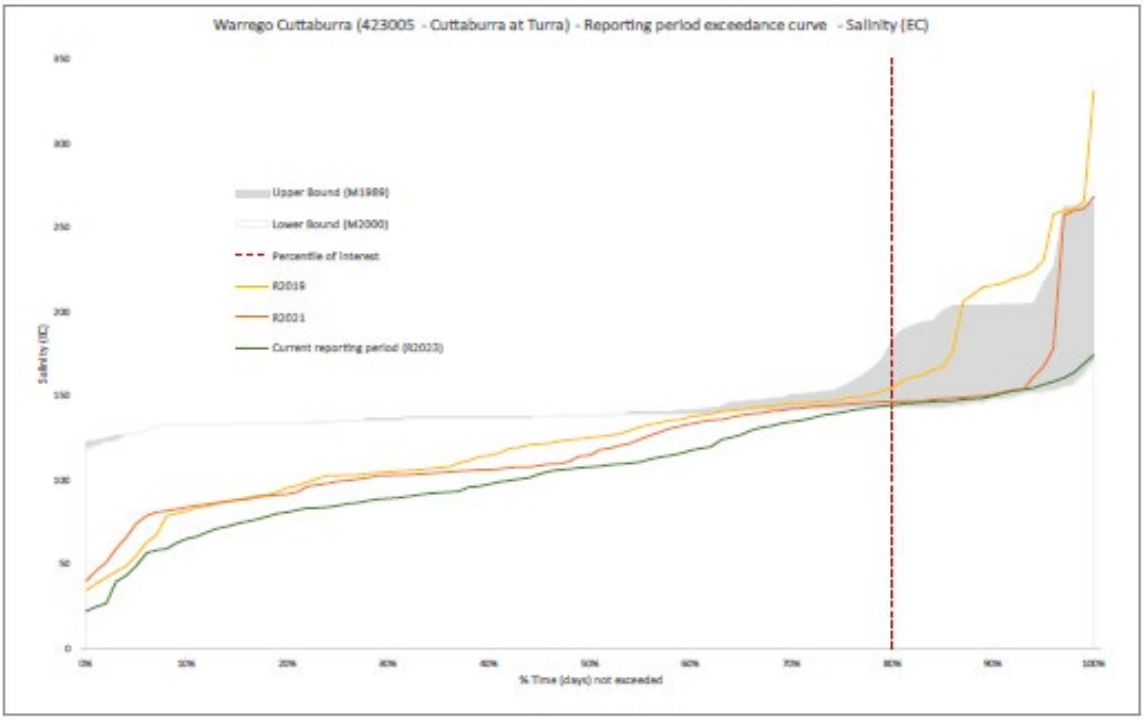

Condamine -Balonne Culgoa (422015 - Culgoa at Brenda) - Reporting Period exceedance curve - Salt loads (t/day)
Upper Bound (M1987)
Lower Bound (M1995)
Percentile of interest
R2019
R2021
Current reporting period (R2023)
Salt loads (t/day)
% Time (days) not exceeded

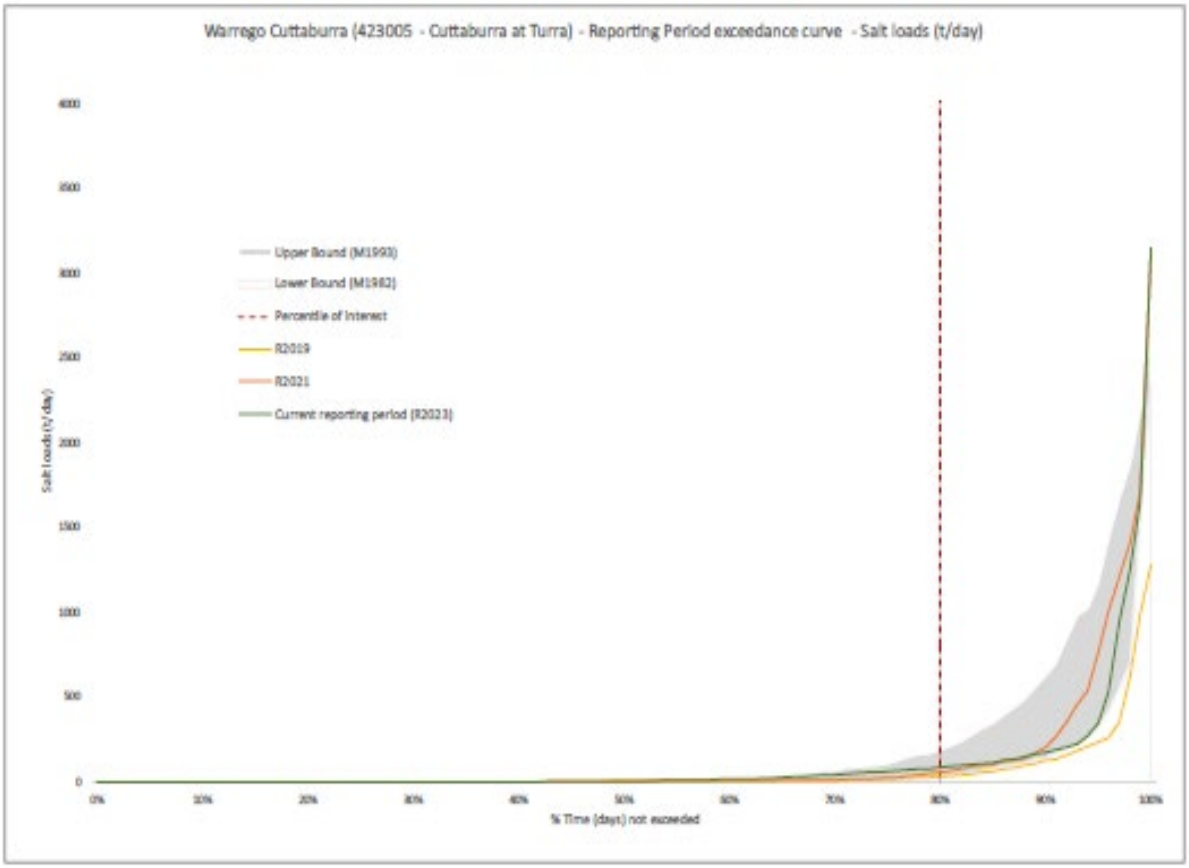

Macintyre (416001 - Macintyre at Mungindi) - Reporting period exceedance curve - Salinity (EC)
Upper Bound (M1996)
Lower Bound (M1980)
Percentile of interest
R2019
R2021
Current reporting period (R2023)
Salinity (EC)
% Time (days) not exceeded

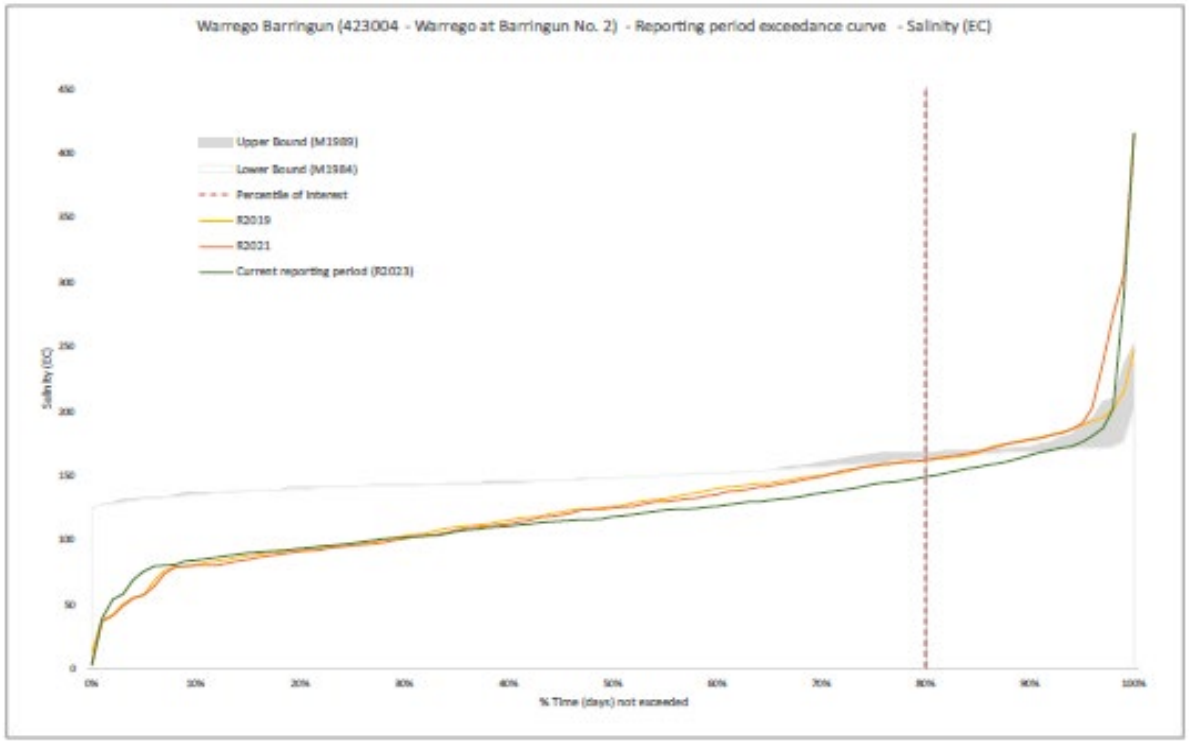

Macintyre (416001 - Macintyre at Mungindi) - Reporting Period exceedance curve - Salt loads (t/day)
Upper Bound (M1986)
Lower Bound (M1995)
Percentile of interest
R2012
R2019
R2021
Current reporting period (R2023)
Salt loads (t/day)
% Time (days) not exceeded

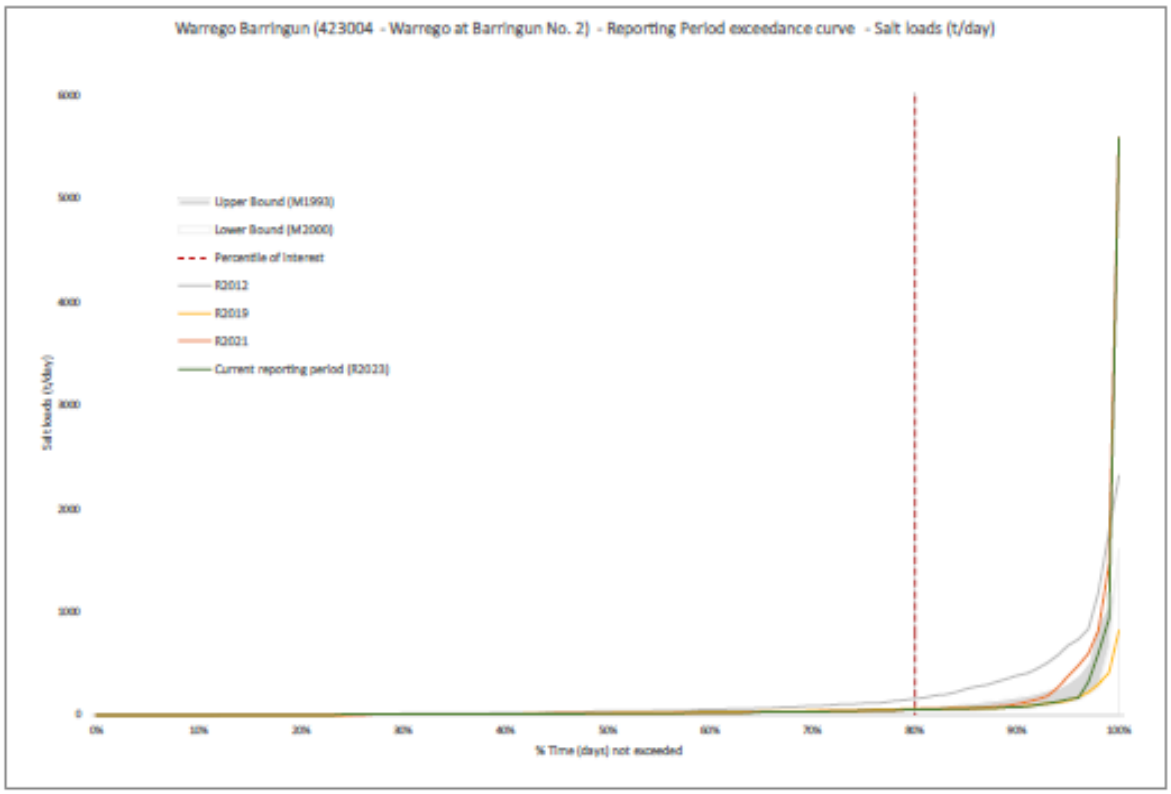

Moonie (417204A - Moonie at Fenton) - Reporting period exceedance curve - Salinity (EC)
Upper Bound (M1983)
Lower Bound (M1993)
Percentile of interest
R2019
R2021
Current reporting period (R2023)
Salinity (EC)
% Time (days) not exceeded

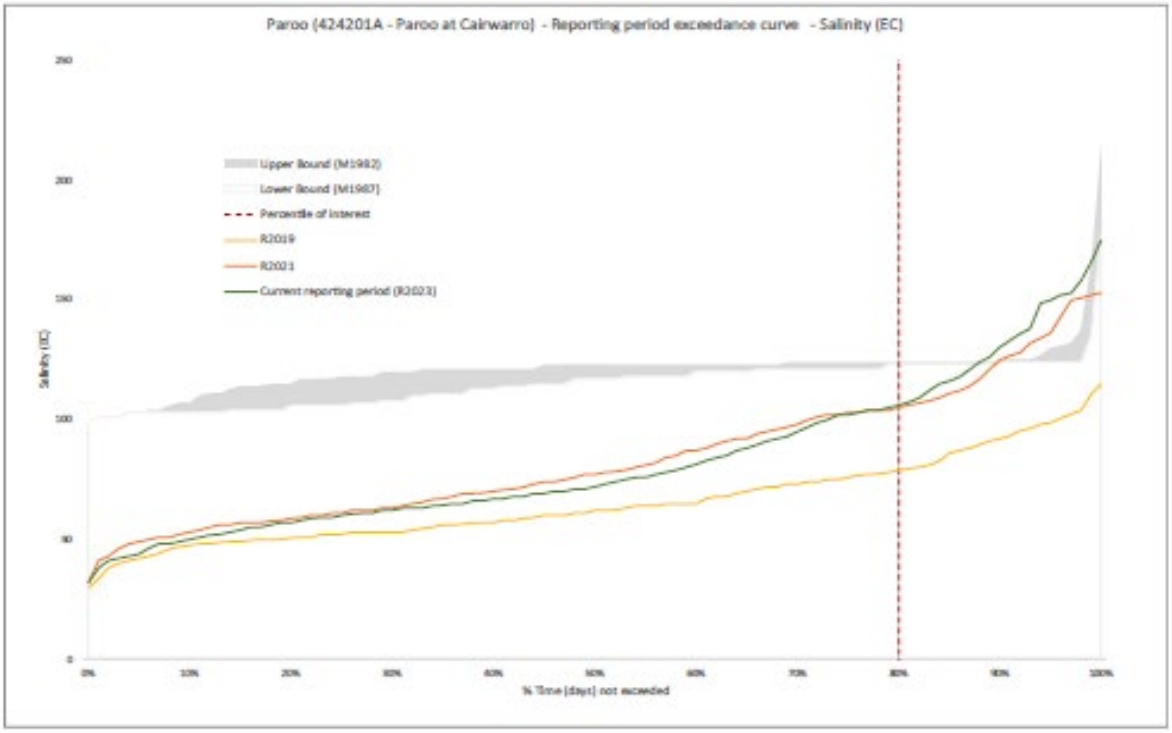

Moonie (417204A - Moonie at Fenton) - Reporting Period exceedance curve - Salt loads (t/day)
Upper Bound (M1984)
Lower Bound (M1995)
Percentile of Interest
R2019
R2021
Current reporting period (R2023)
R2012
Salt loads (t/day)
% Time (days) not exceeded

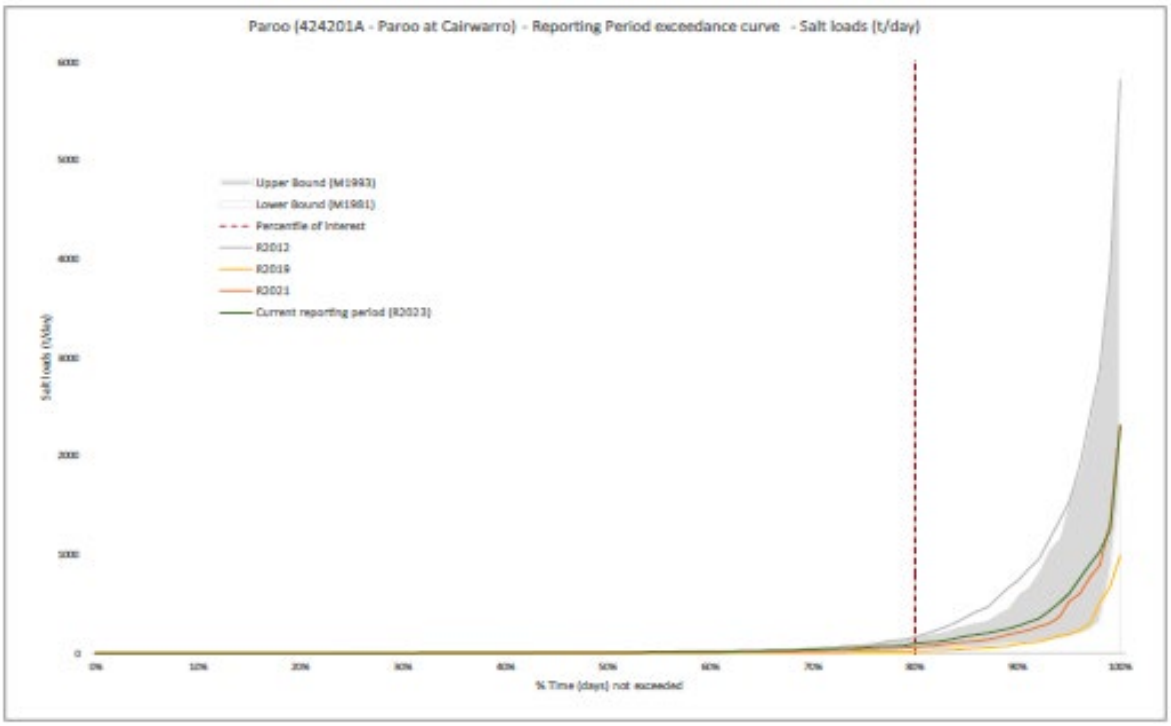

Warrego Cuttaburra (423005 - Cuttaburra at Turra) - Reporting period exceedance curve - Salinity (EC)
Upper Bound (M1989)
Lower Bound (M2000)
Percentile of Interest
R2019
R2021
Current reporting period (R2023)
Salinity (EC)
% Time (days) not exceeded


Warrego Cuttaburra (423005 - Cuttaburra at Turra) - Reporting Period exceedance curve - Salt loads (t/day)
Upper Bound (M1993)
Lower Bound (M1982)
Percentile of Interest
R2019
R2021
Current reporting period (R2023)
Salt loads (t/day)
% Time (days) not exceeded

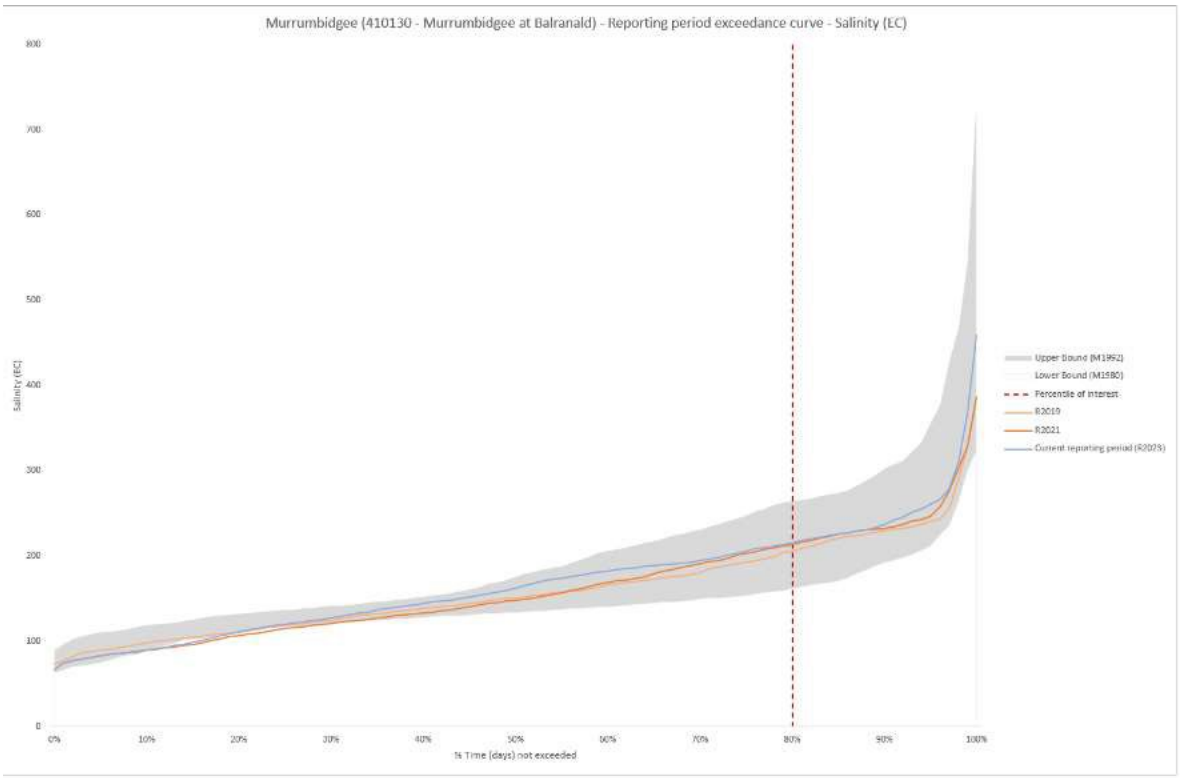

Warrego Barringun (423004 - Warrego at Barringun No. 2) - Reporting period exceedance curve - Salinity (EC)
Upper Bound (M1989)
Lower Bound (M1984)
Percentile of Interest
R2019
R2021
Current reporting period (R2023)
Salinity (EC)
% Time (days) not exceeded

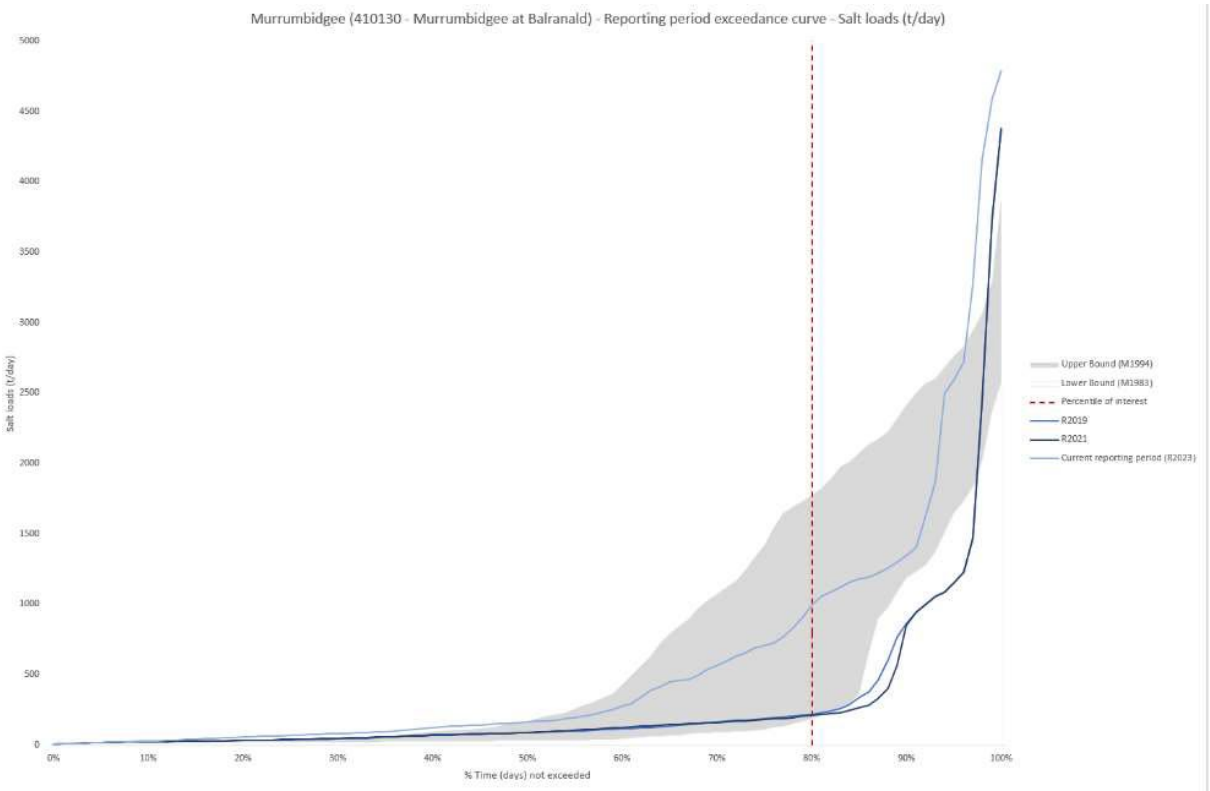

Warrego Barringun (423004 - Warrego at Barringun No. 2) - Reporting Period exceedance curve - Salt loads (t/day)
Upper Bound (M1993)
Lower Bound (M2000)
Percentile of Interest
R2012
R2019
R2021
Current reporting period (R2023)
Salt loads (t/day)
% Time (days) not exceeded

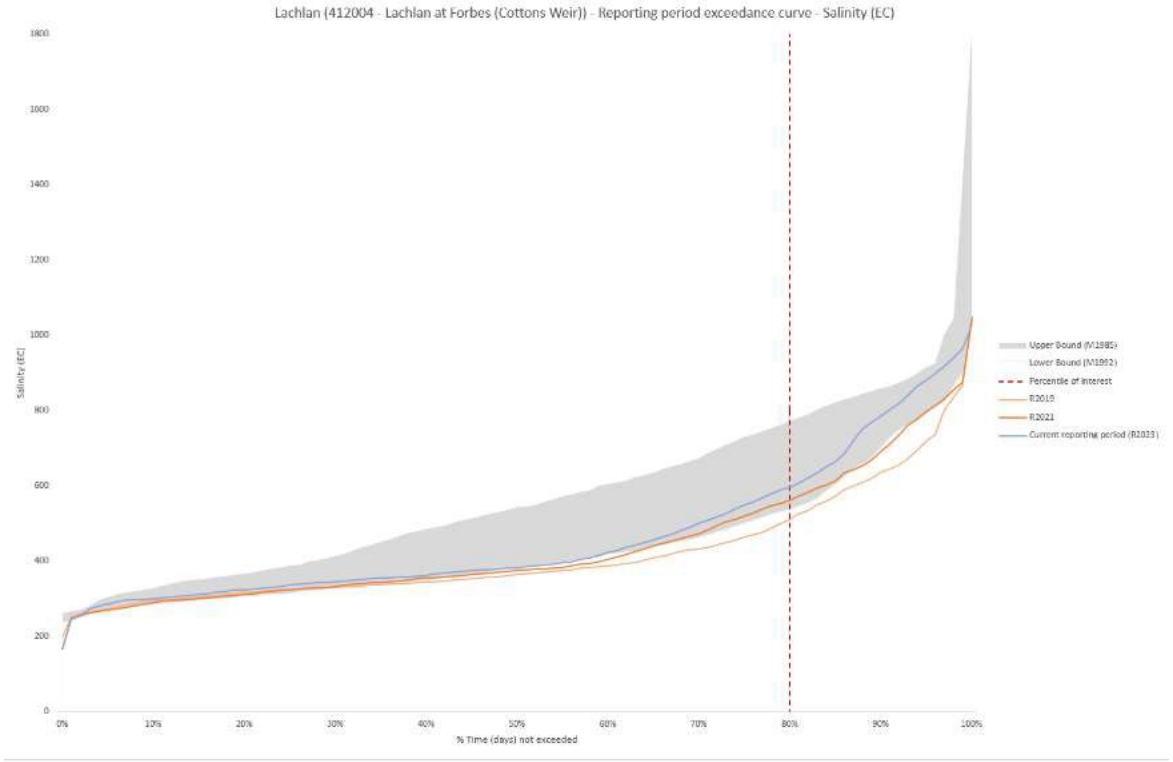

Paroo (424201A - Paroo at Cairwarro) - Reporting period exceedance curve - Salinity (EC)
Upper Bound (M1982)
Lower Bound (M1987)
Percentile of Interest
R2019
R2021
Current reporting period (R2023)
Salinity (EC)
% Time (days) not exceeded

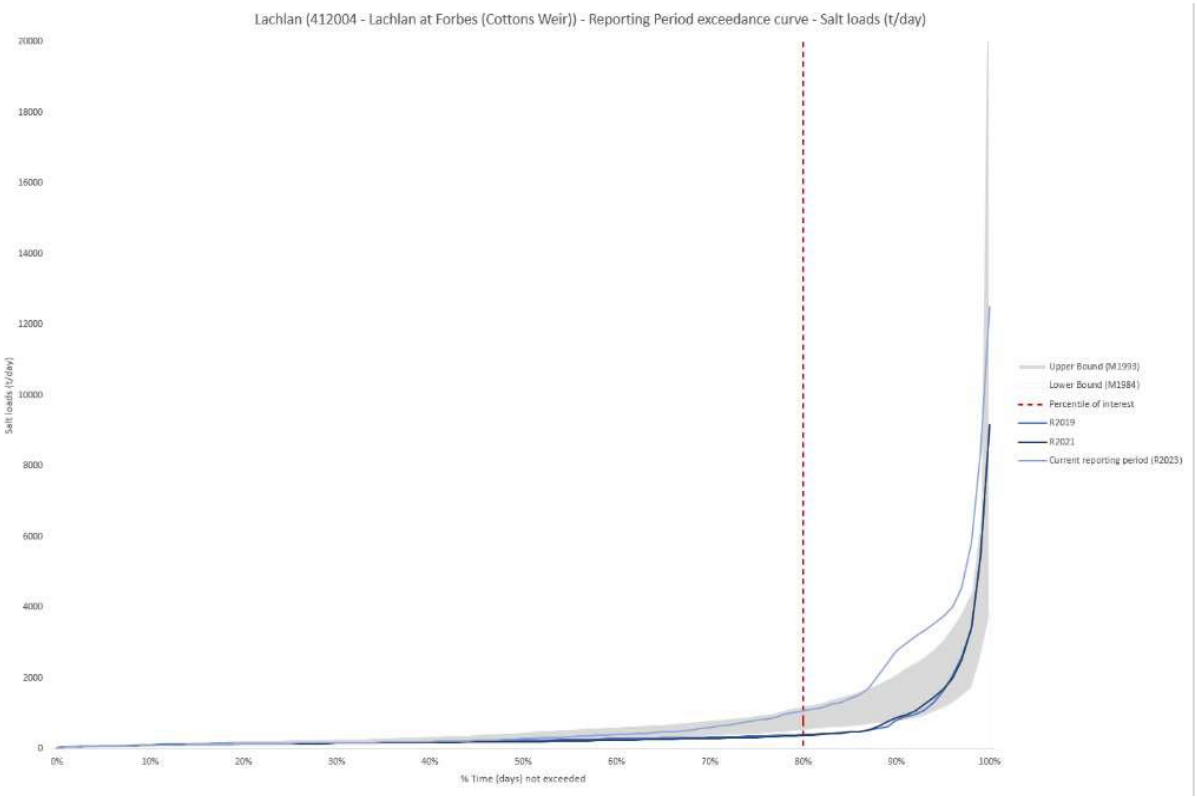

Paroo (424201A - Paroo at Cairwarro) - Reporting Period exceedance curve - Salt loads (t/day)
Upper Bound (M1993)
Lower Bound (M1981)
Percentile of interest
R2013
R2019
R2021
Current reporting period (R2023)
Salt loads (t/day)
% Time (days) not exceeded

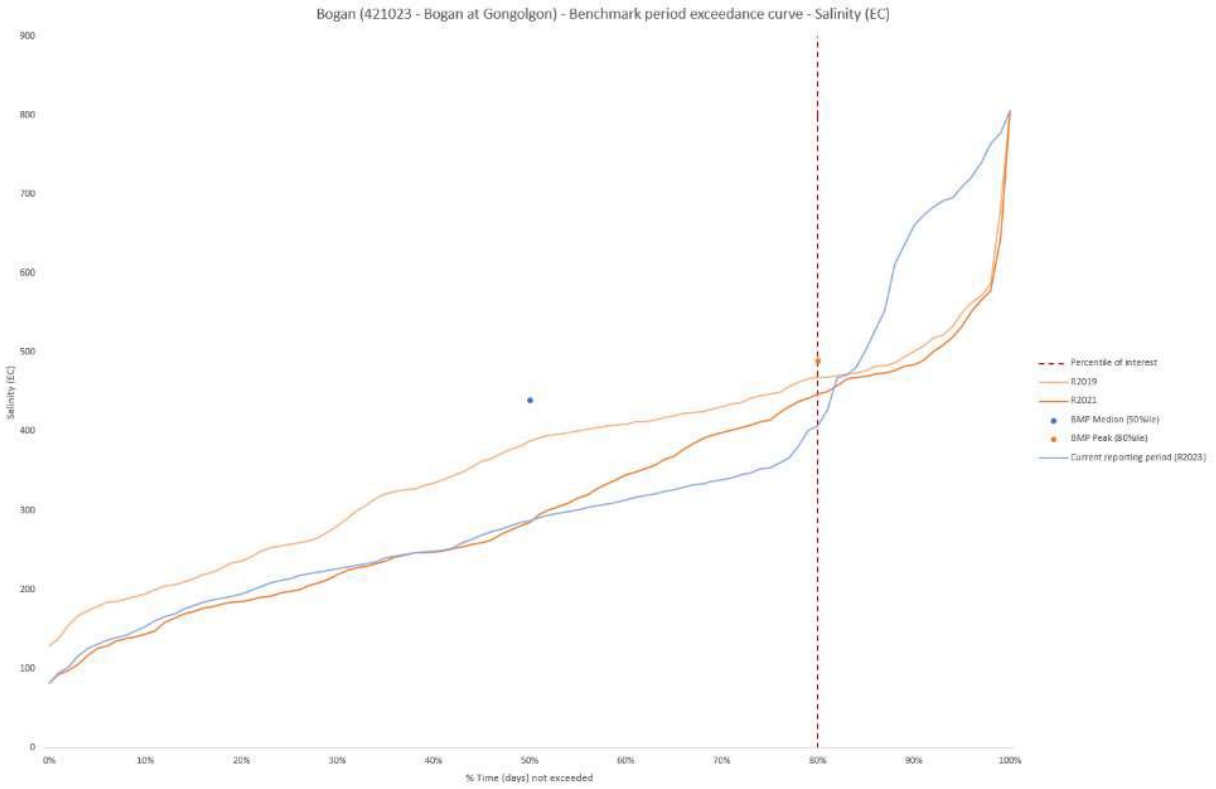
New South Wales

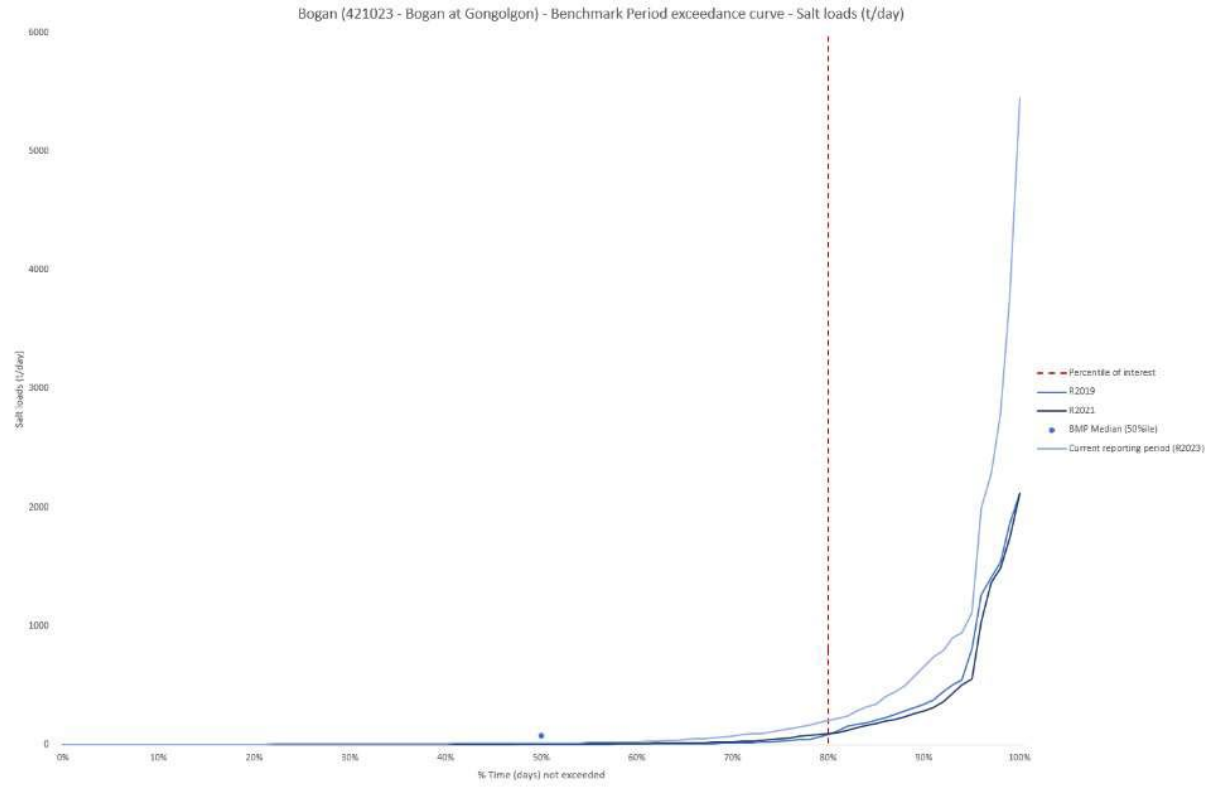


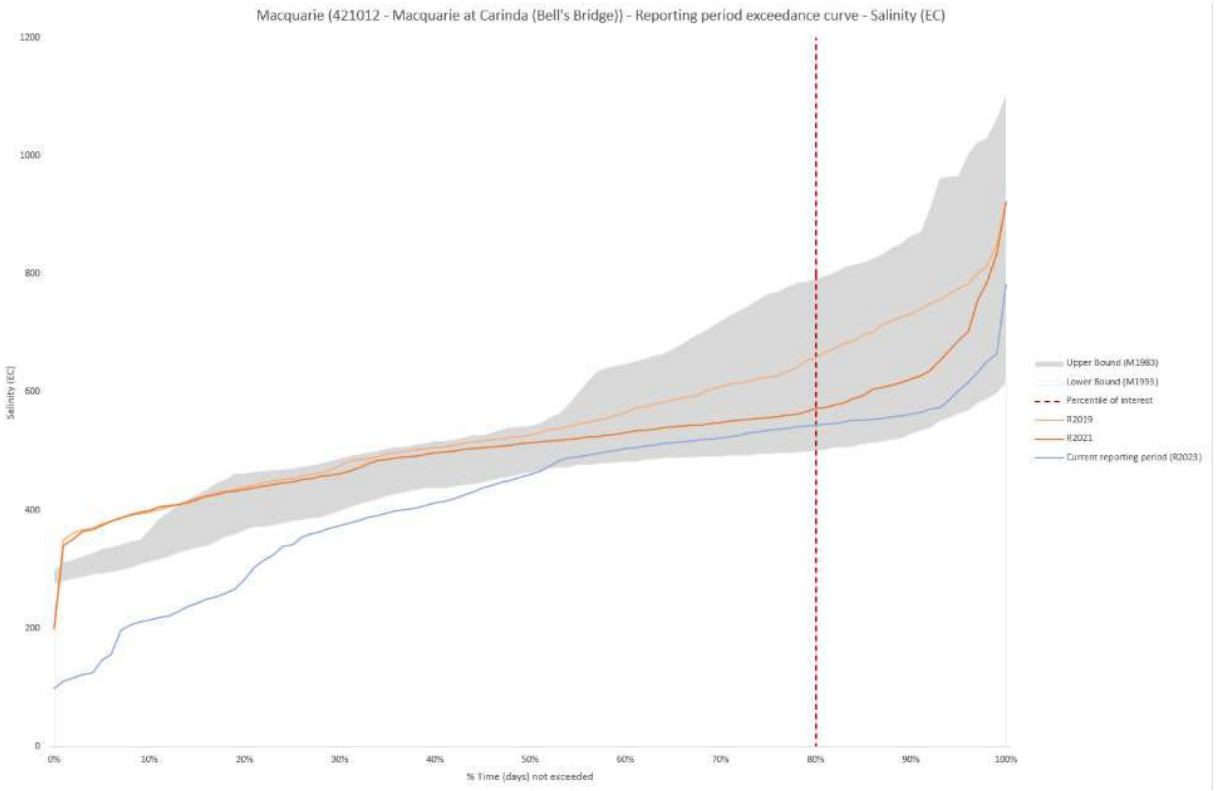


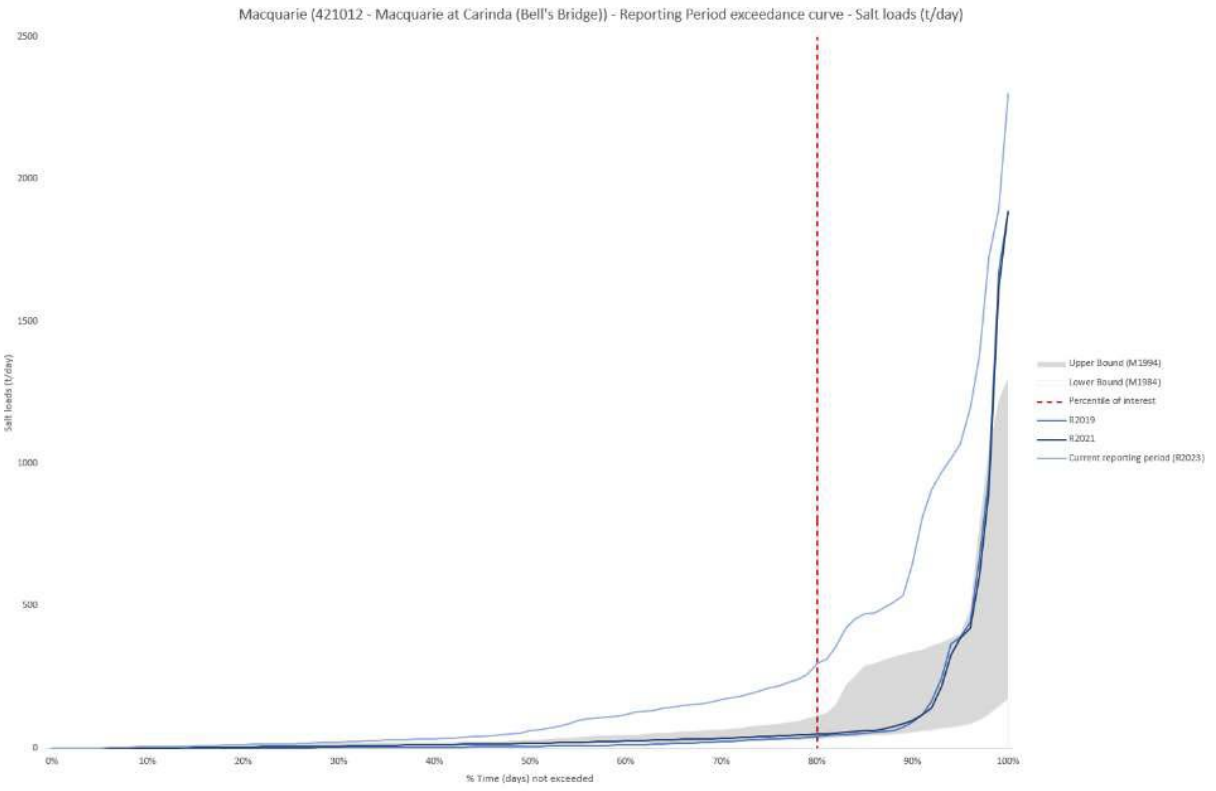

Lachlan (412004 - Lachlan at Forbes (Cottons Weir)) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Upper Bound (M1985)
Lower Bound (M1992)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

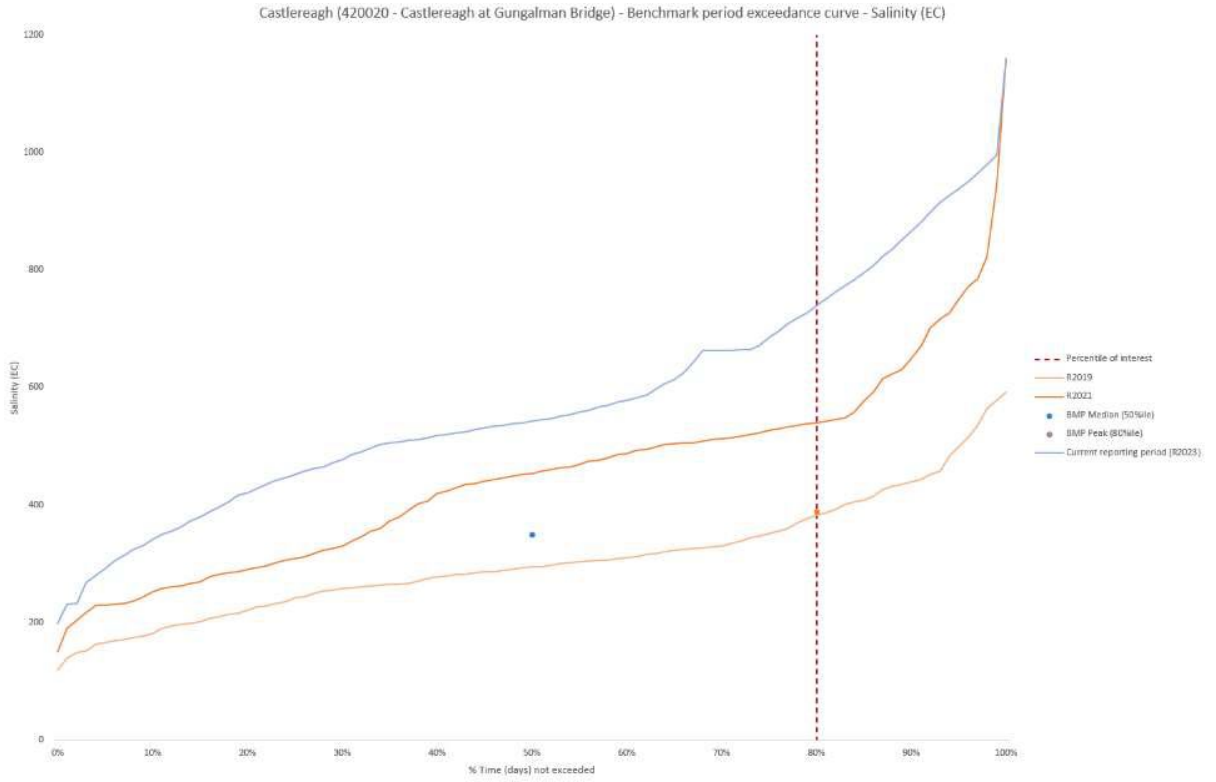

Lachlan (412004 - Lachlan at Forbes (Cottons Weir)) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Upper Bound (M1993)
Lower Bound (M1984)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

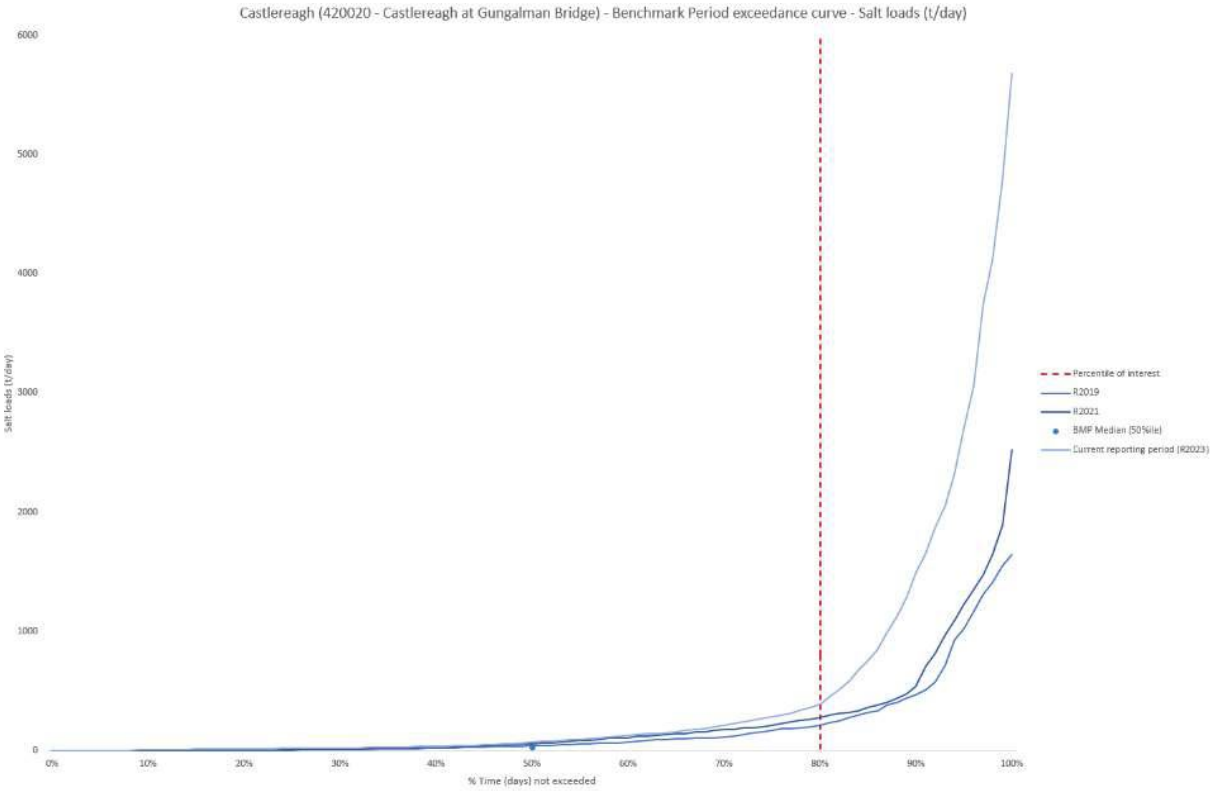

Bogan (421023 - Bogan at Gongolgon) - Benchmark period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Percentile of interest
R2019
R2021
BMP Median (50%ile)
BMP Peak (80%ile)
Current reporting period (R2023)

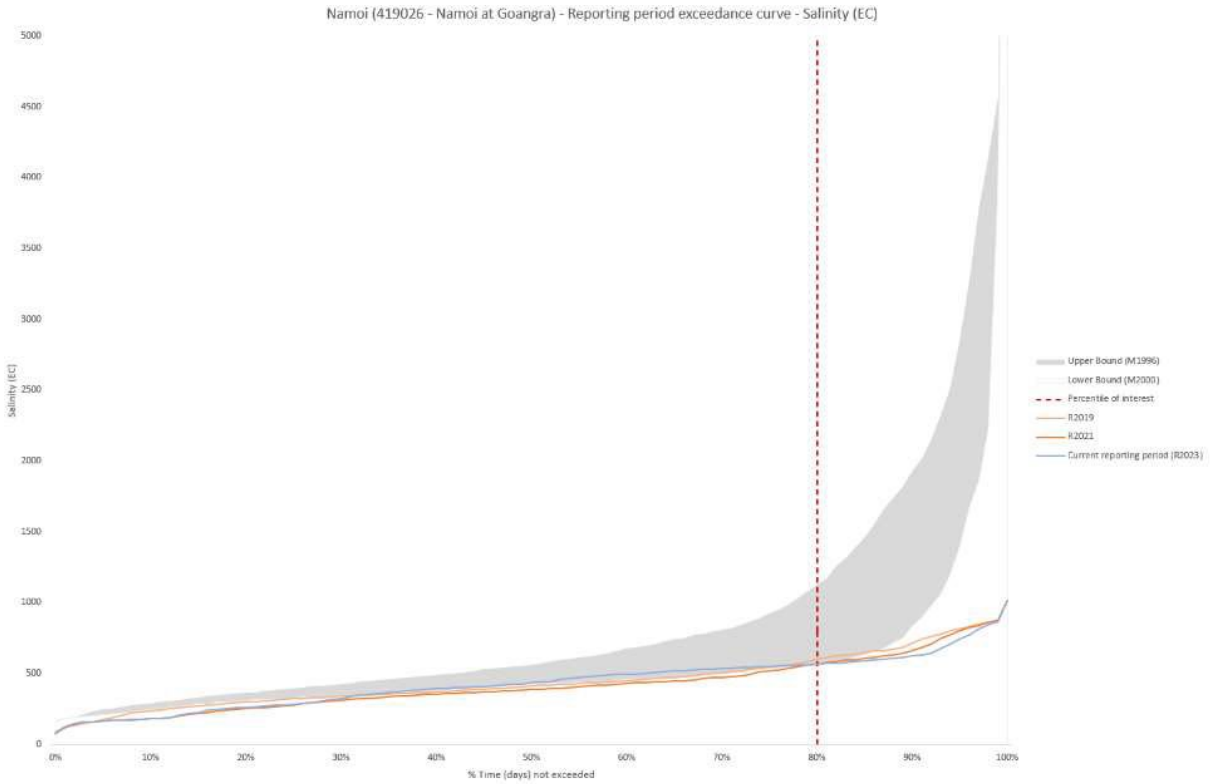

Bogan (421023 - Bogan at Gongolgon) - Benchmark Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Percentile of interest
R2019
R2021
BMP Median (50%ile)
Current reporting period (R2023)

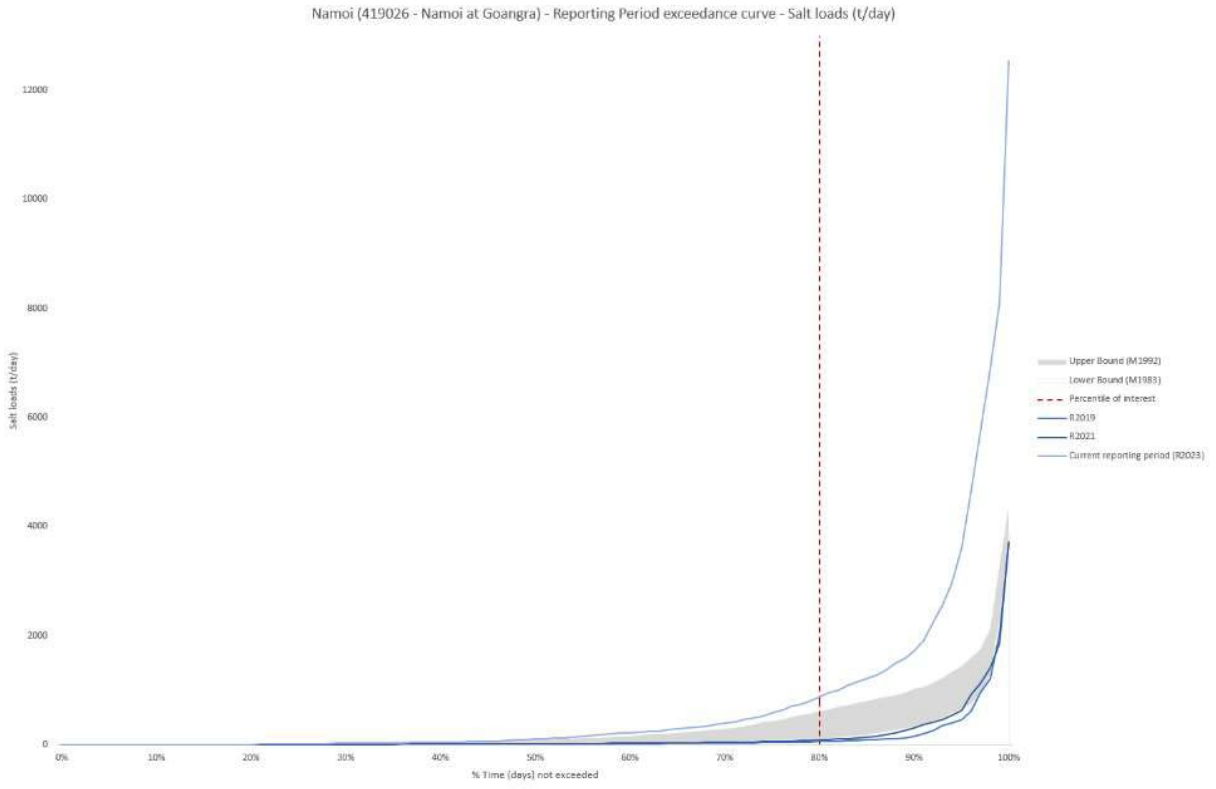

Macquarie (421012 - Macquarie at Carinda (Bell's Bridge)) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Upper Bound (M1983)
Lower Bound (M1993)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

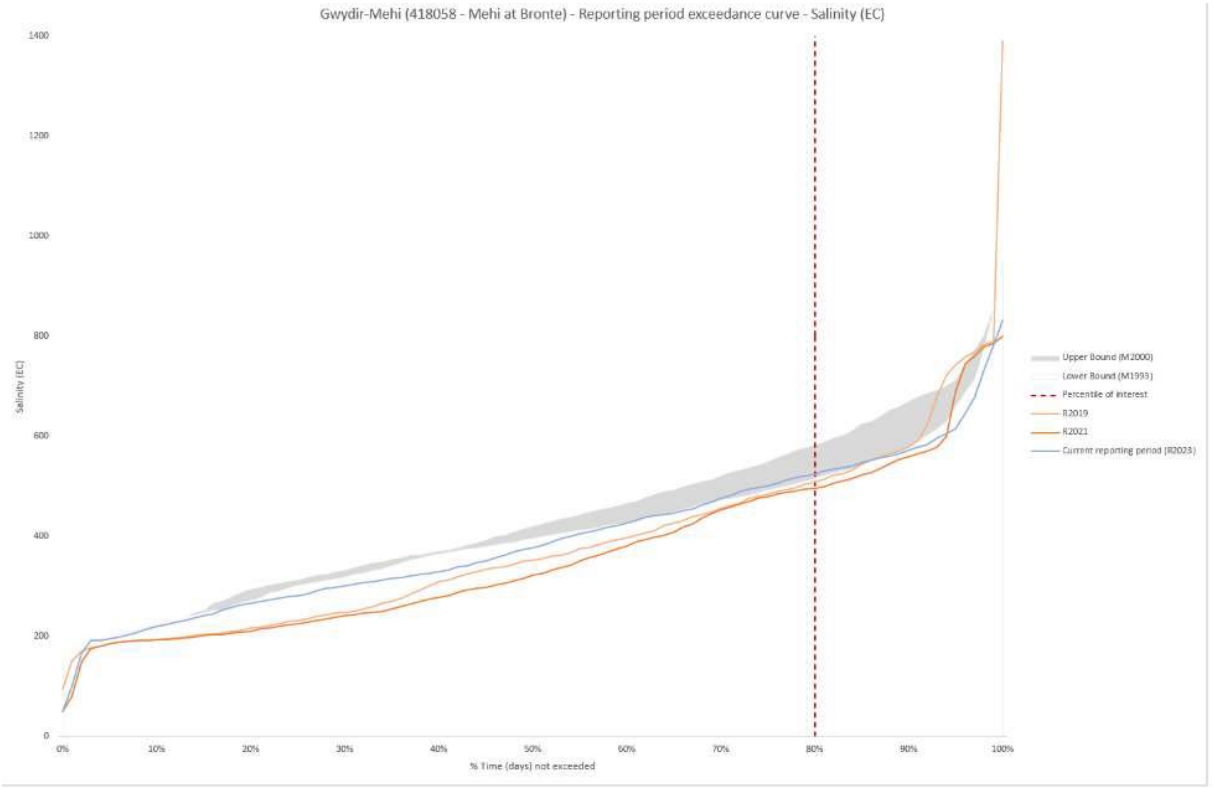

Macquarie (421012 - Macquarie at Carinda (Bell's Bridge)) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Upper Bound (M1994)
Lower Bound (M1984)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

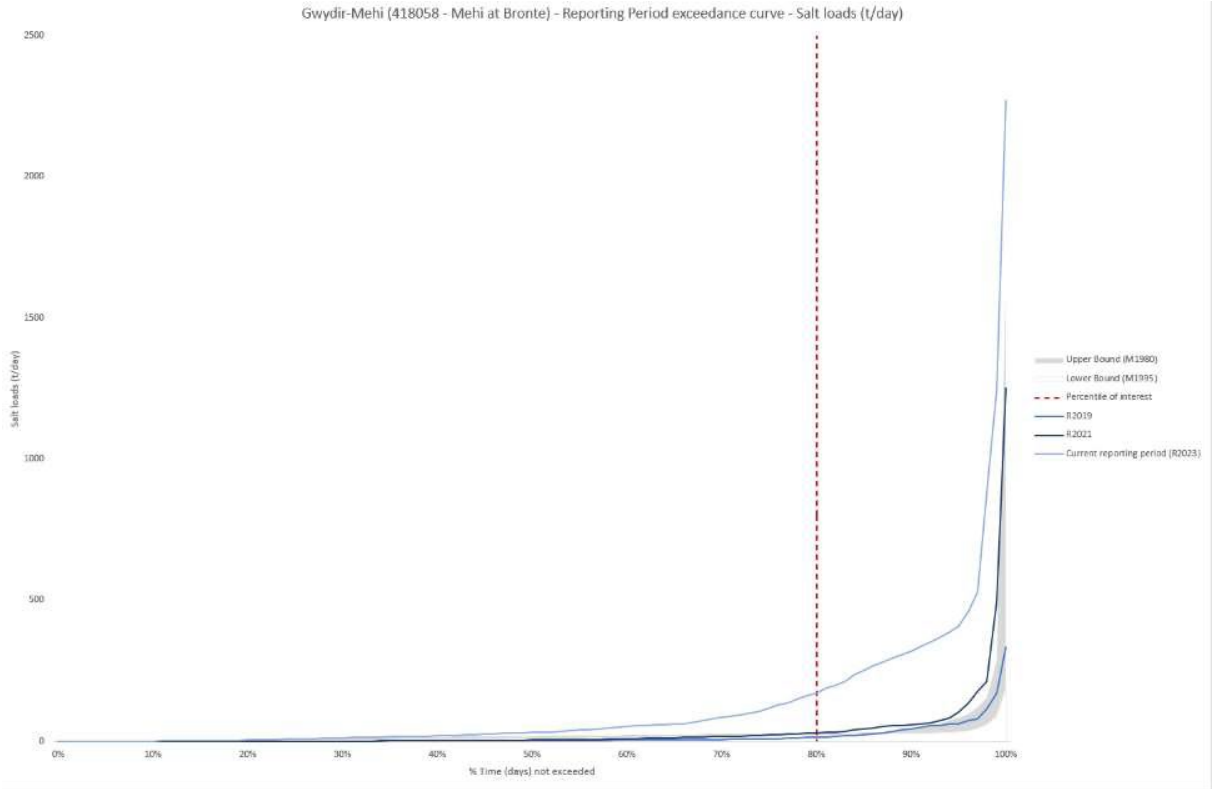

Castlereagh (420020 - Castlereagh at Gungalman Bridge) - Benchmark period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Percentile of interest
R2019
R2021
BMP Median (50%ile)
BMP Peak (80%ile)
Current reporting period (R2023)

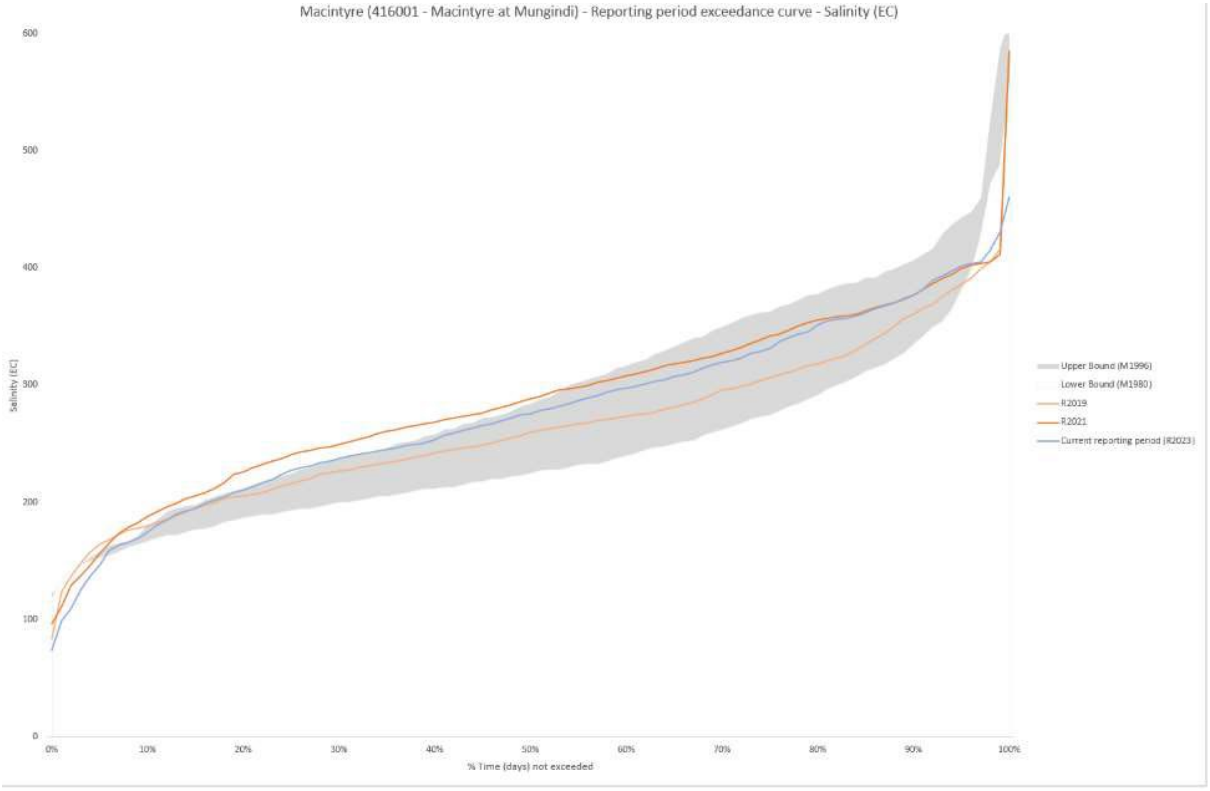

Castlereagh (420020 - Castlereagh at Gungalman Bridge) - Benchmark Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Percentile of interest
R2019
R2021
BMP Median (50%ile)
Current reporting period (R2023)

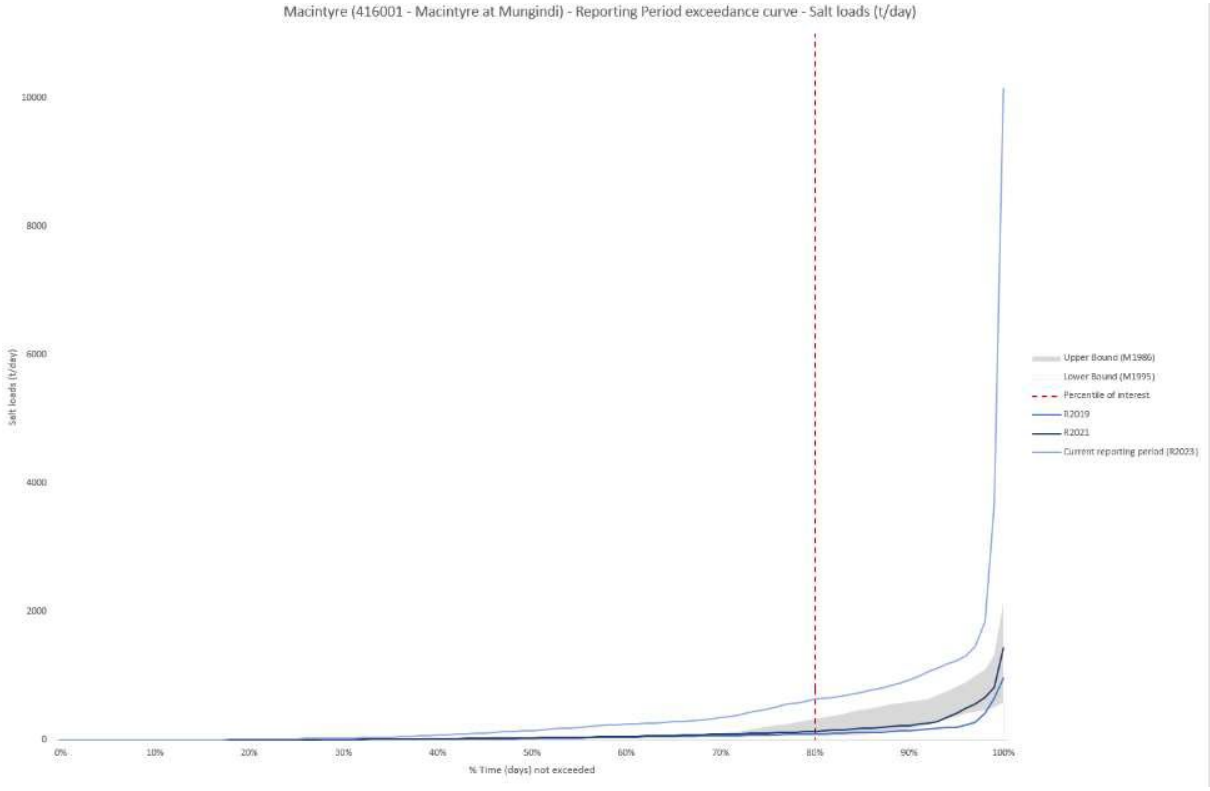

Namoi (419026 - Namoi at Goangra) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Upper Bound (M1996)
Lower Bound (M2000)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

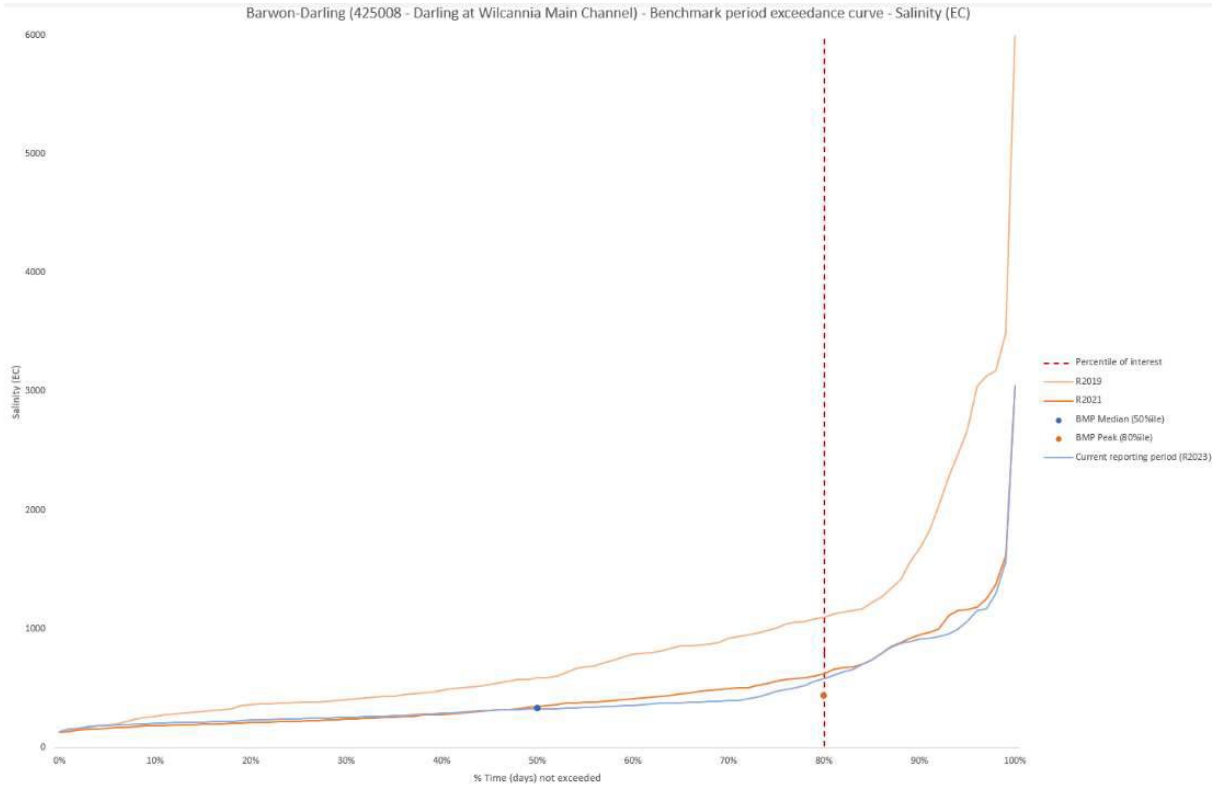

Namoi (419026 - Namoi at Goangra) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Upper Bound (M1992)
Lower Bound (M1983)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

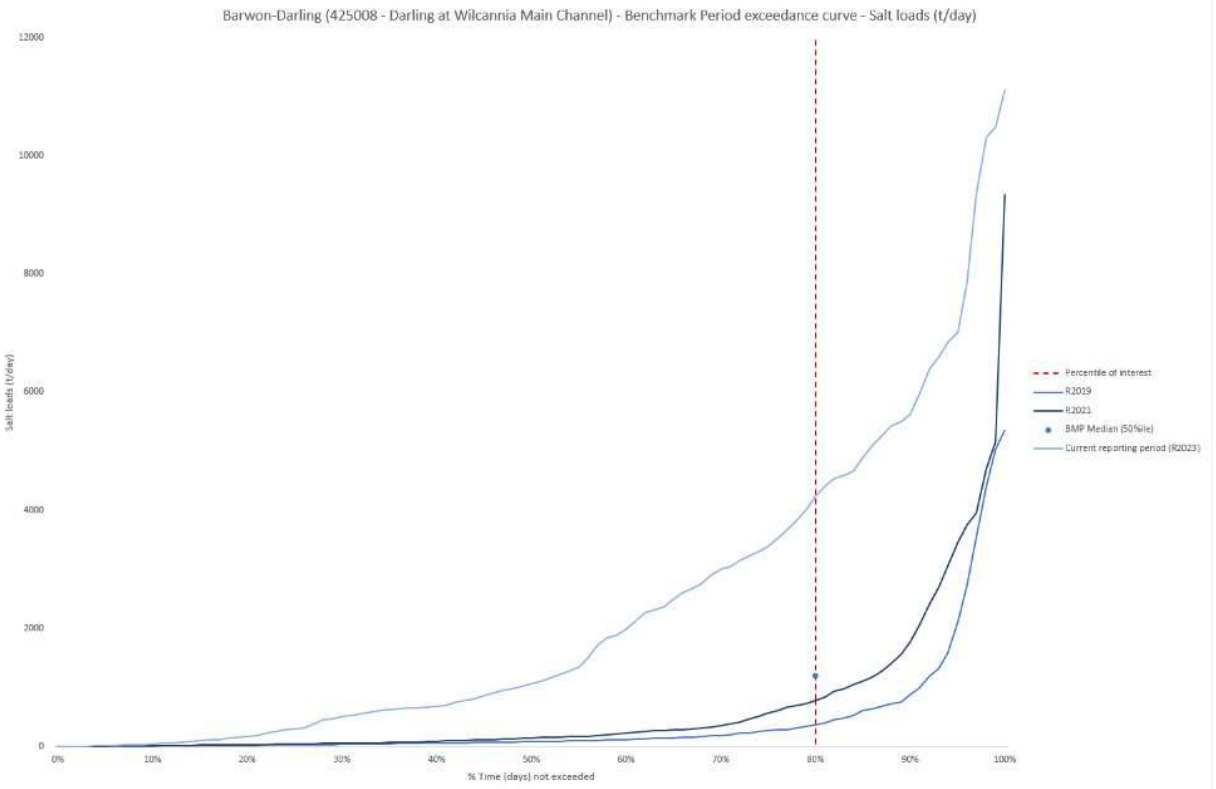

Gwydir-Mehi (418058 - Mehi at Bronte) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Upper Bound (M2000)
Lower Bound (M1993)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

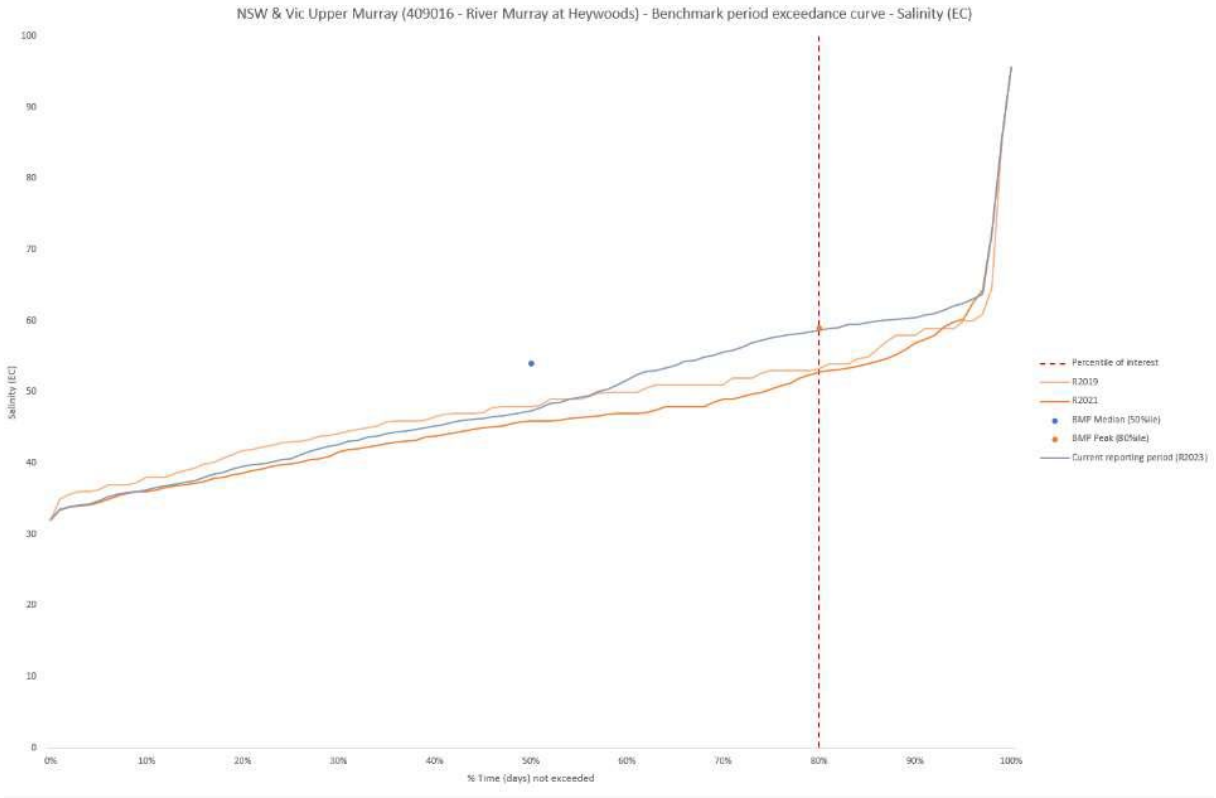

Gwydir-Mehi (418058 - Mehi at Bronte) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Upper Bound (M1980)
Lower Bound (M1995)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

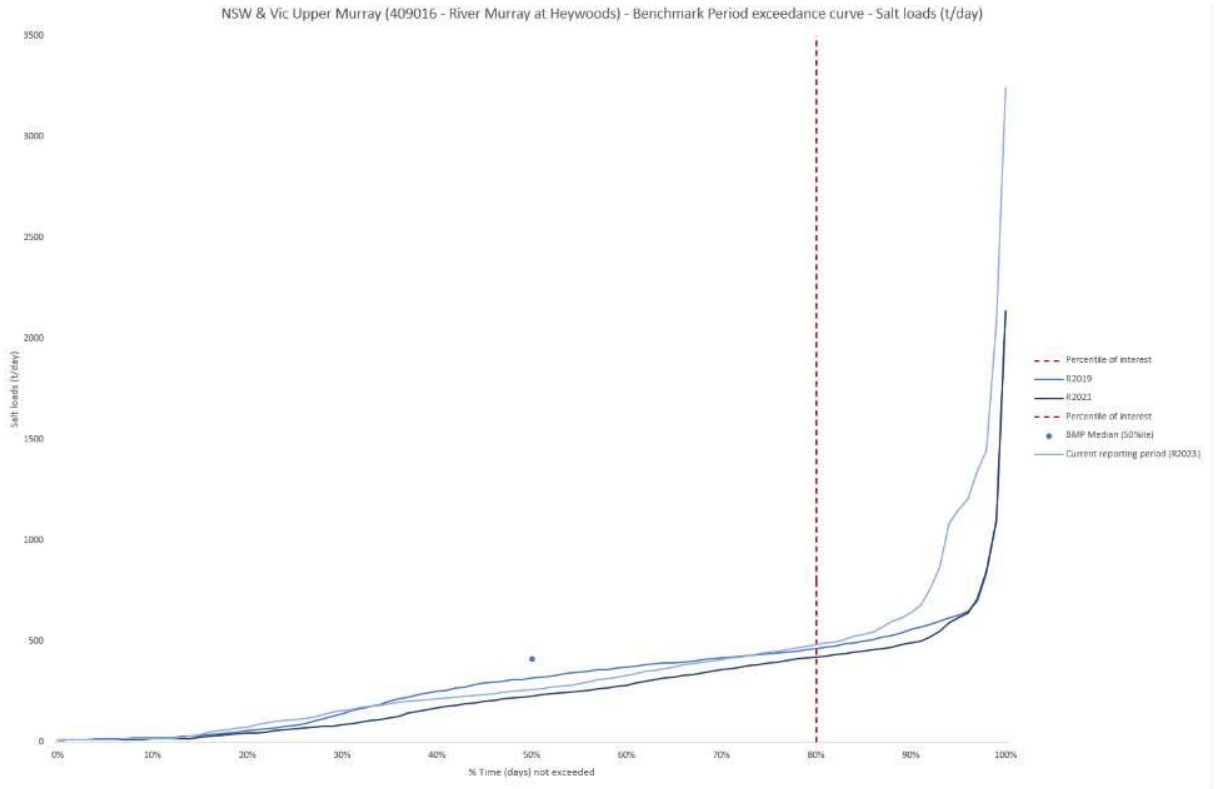

Macintyre (416001 - Macintyre at Mungindi) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Upper Bound (M1996)
Lower Bound (M1980)
R2019
R2021
Current reporting period (R2023)


Macintyre (416001 - Macintyre at Mungindi) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Upper Bound (M1986)
Lower Bound (M1995)
Percentile of interest
R2019
R2021
Current reporting period (R2023)

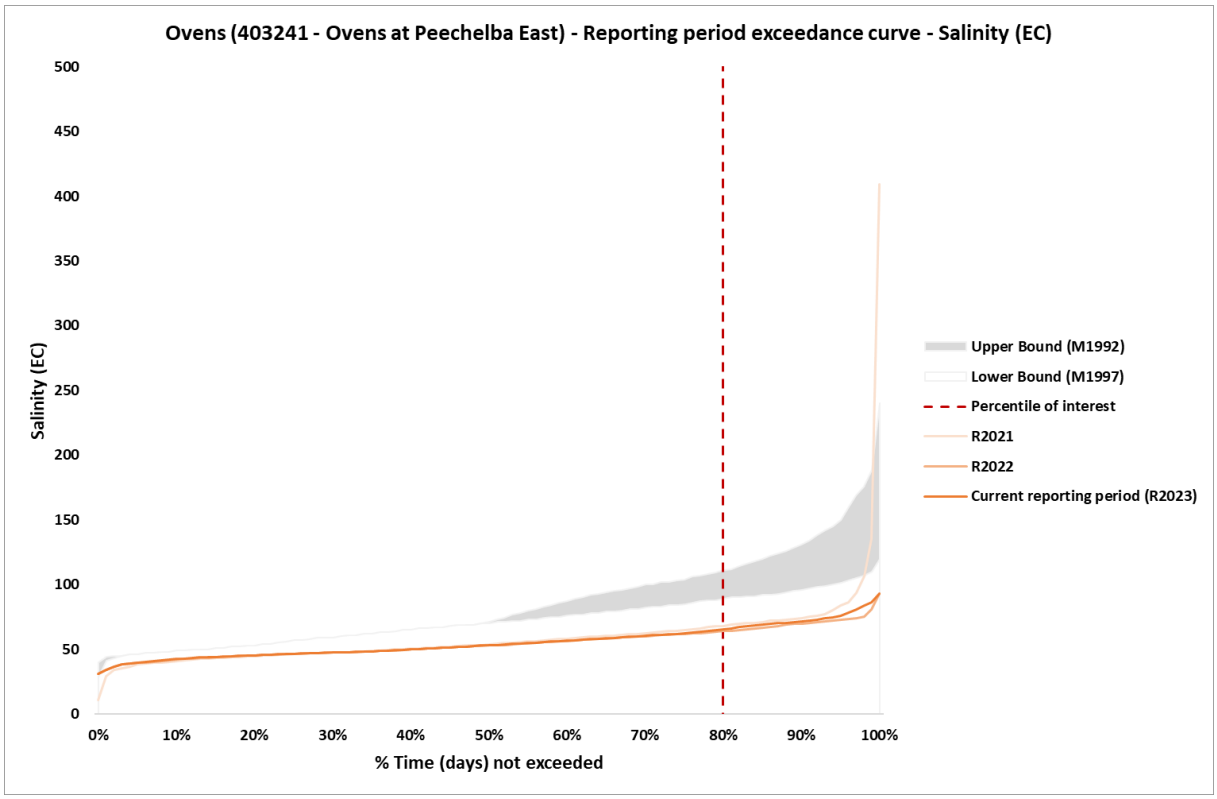

Barwon-Darling (425008 - Darling at Wilcannia Main Channel) - Benchmark period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Percentile of interest
R2019
R2021
BMP Median (50%ile)
BMP Peak (80%ile)
Current reporting period (R2023)

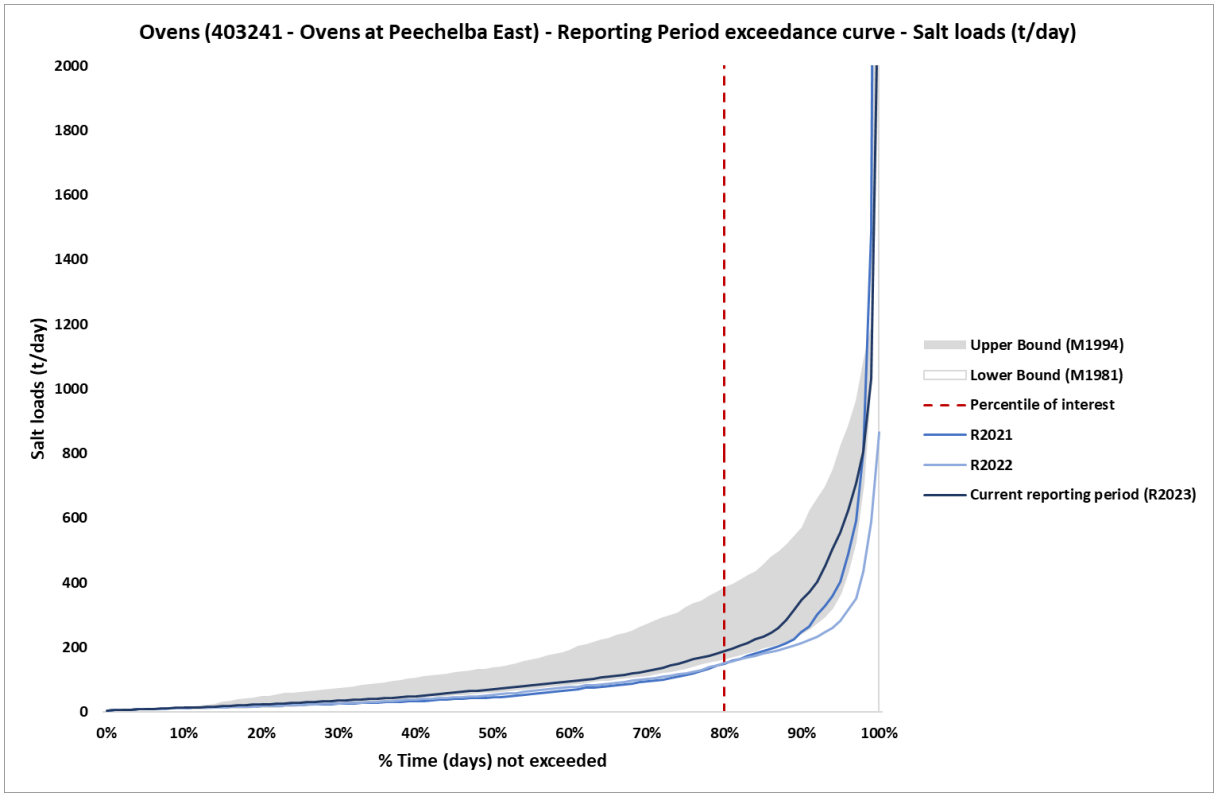

Barwon-Darling (425008 - Darling at Wilcannia Main Channel) - Benchmark Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Percentile of interest
R2019
R2021
BMP Median (50%ile)
Current reporting period (R2023)

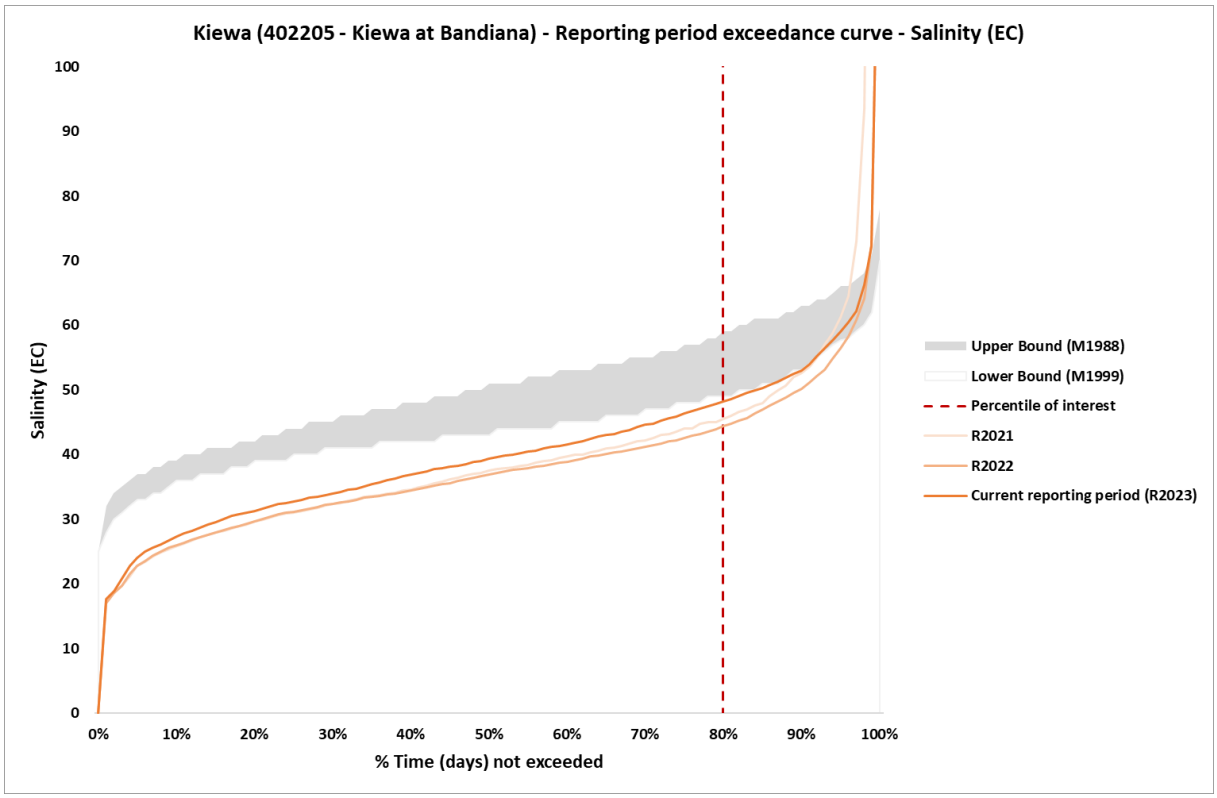

NSW & Vic Upper Murray (409016 - River Murray at Heywoods) - Benchmark period exceedance curve - Salinity (EC)
Salinity (EC)
% Time (days) not exceeded
Percentile of interest
R2019
R2021
BMP Median (50%ile)
BMP Peak (80%ile)
Current reporting period (R2023)

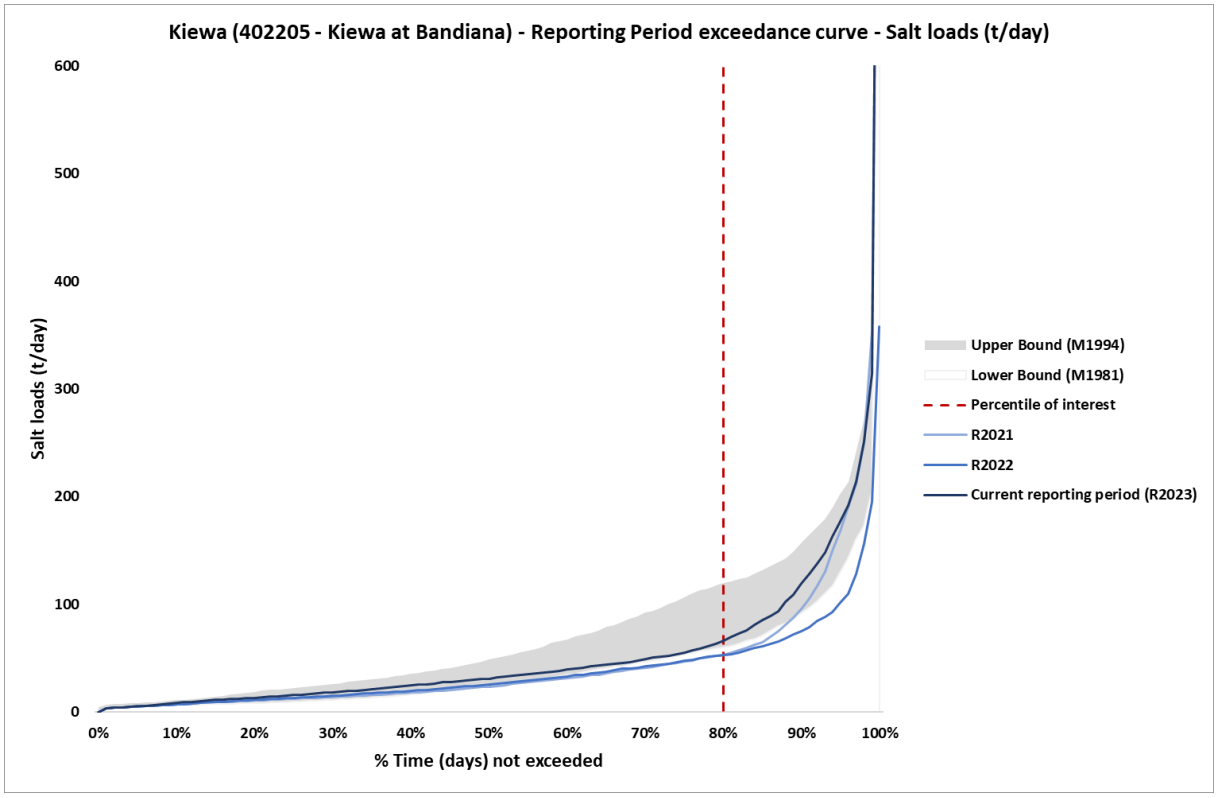

NSW & Vic Upper Murray (409016 - River Murray at Heywoods) - Benchmark Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
% Time (days) not exceeded
Percentile of interest
R2019
R2021
Percentile of interest
BMP Median (50%ile)
Current reporting period (R2023)

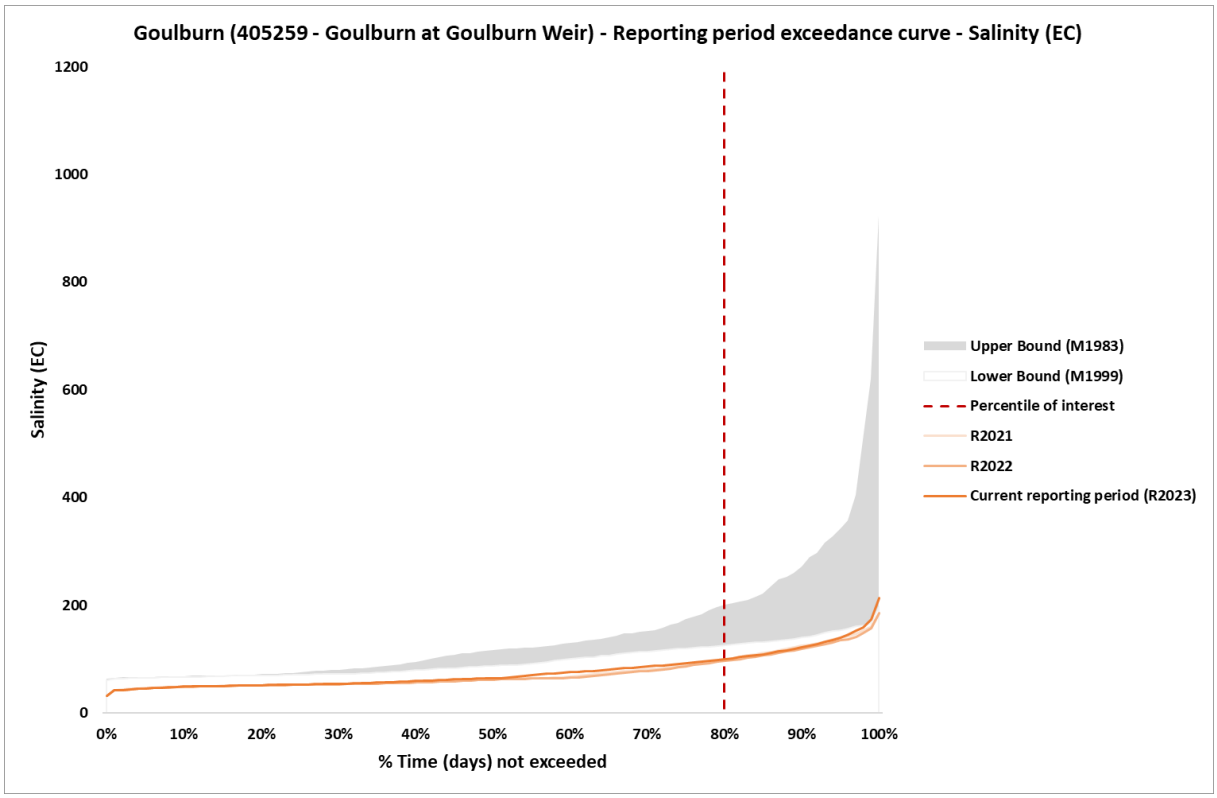
Victoria

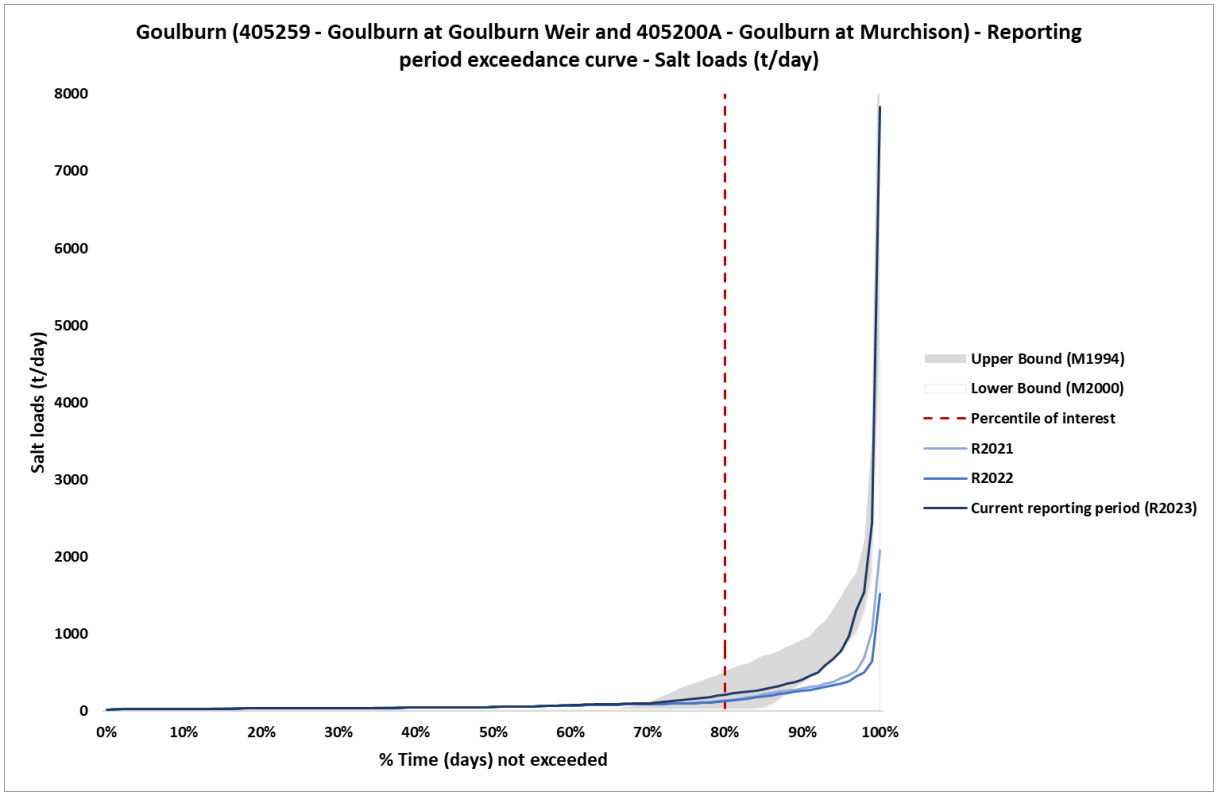

Ovens (403241 - Ovens at Peechelba East) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
500
450
400
350
300
250
200
150
100
50
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1992)
Lower Bound (M1997)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

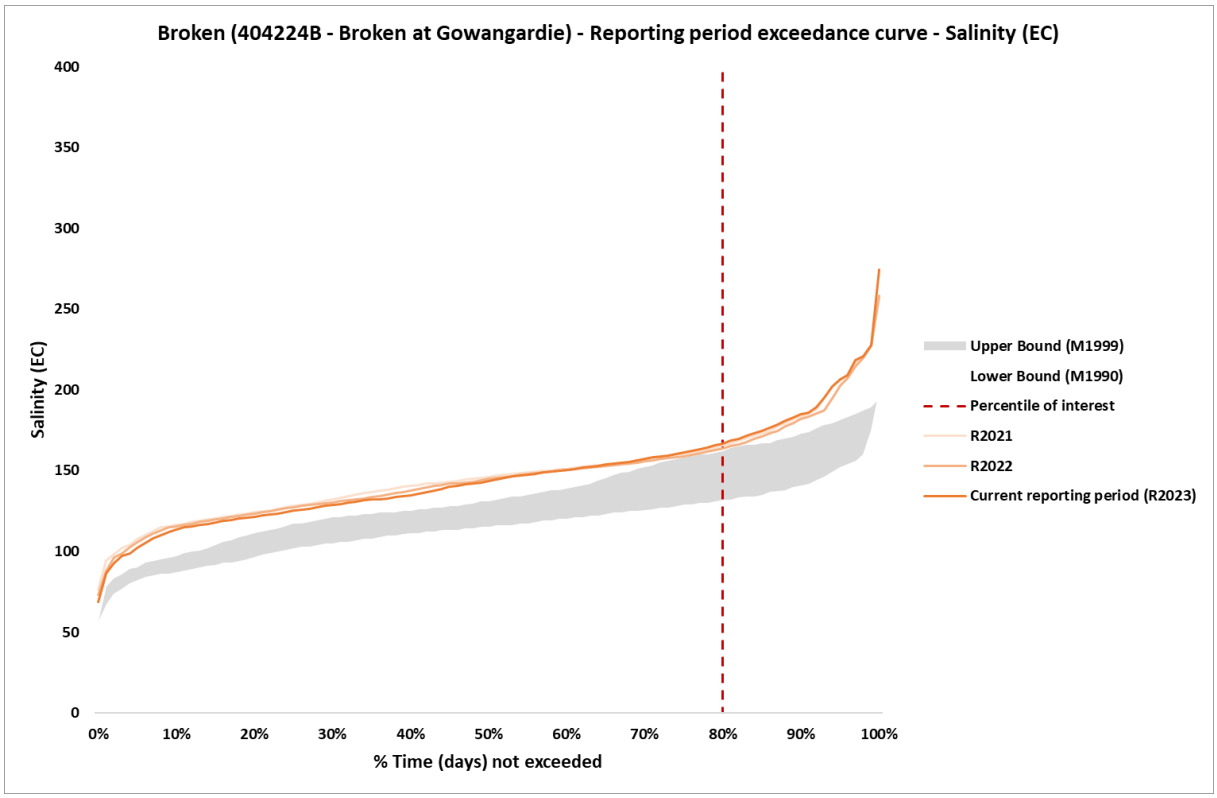

Ovens (403241 - Ovens at Peechelba East) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1994)
Lower Bound (M1981)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

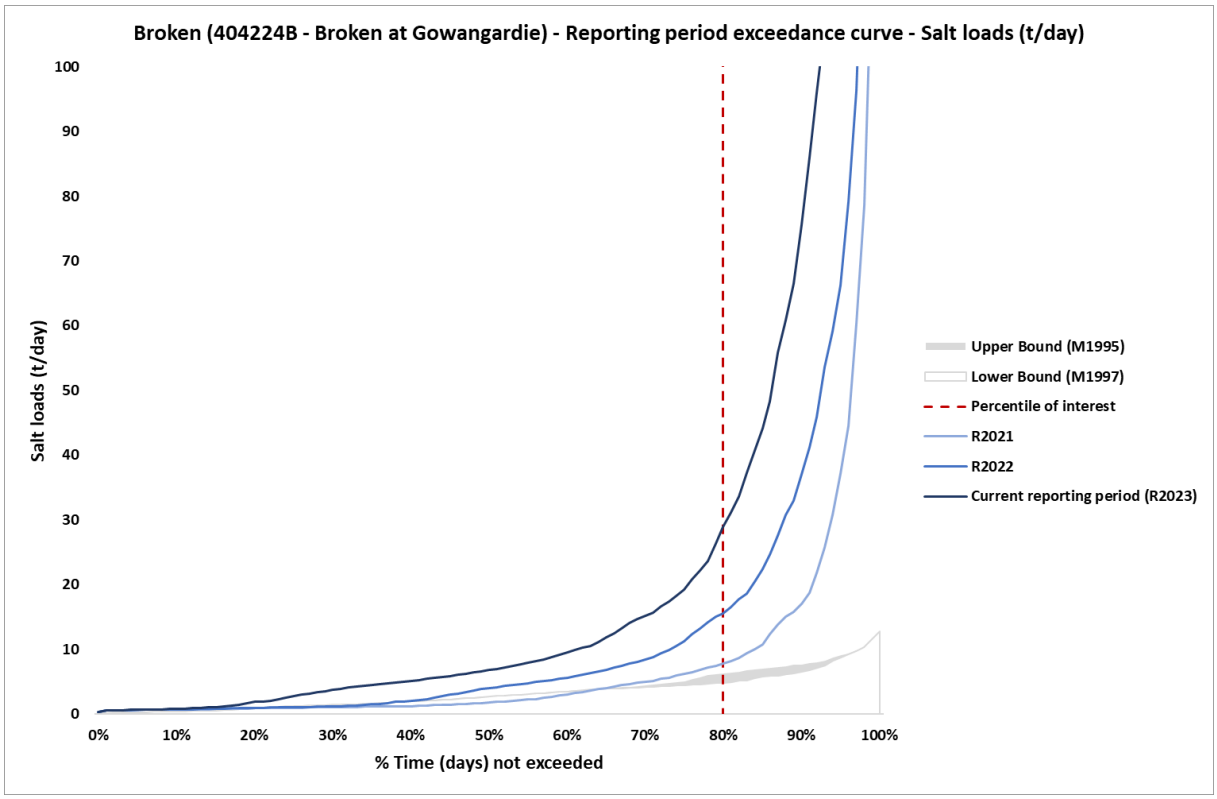

Kiewa (402205 - Kiewa at Bandiana) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
100
90
80
70
60
50
40
30
20
10
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1988)
Lower Bound (M1999)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

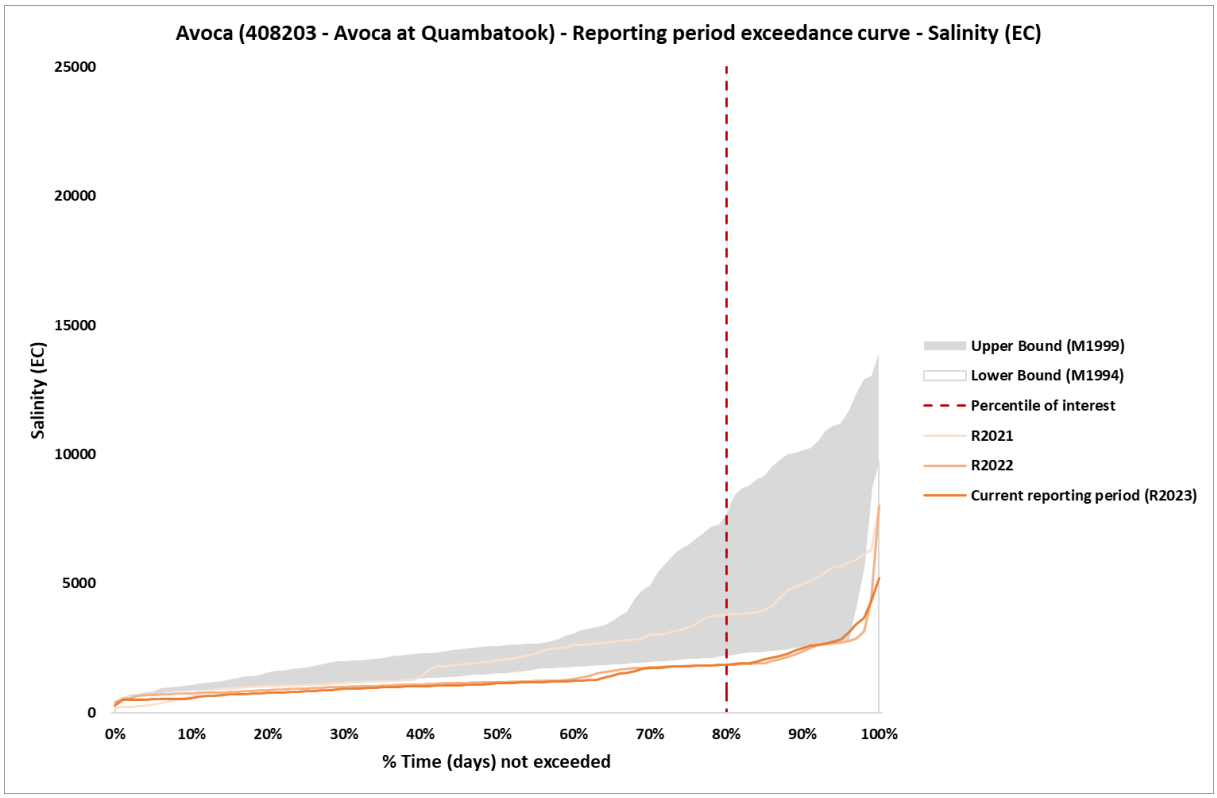

Kiewa (402205 - Kiewa at Bandiana) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
600
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1994)
Lower Bound (M1981)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

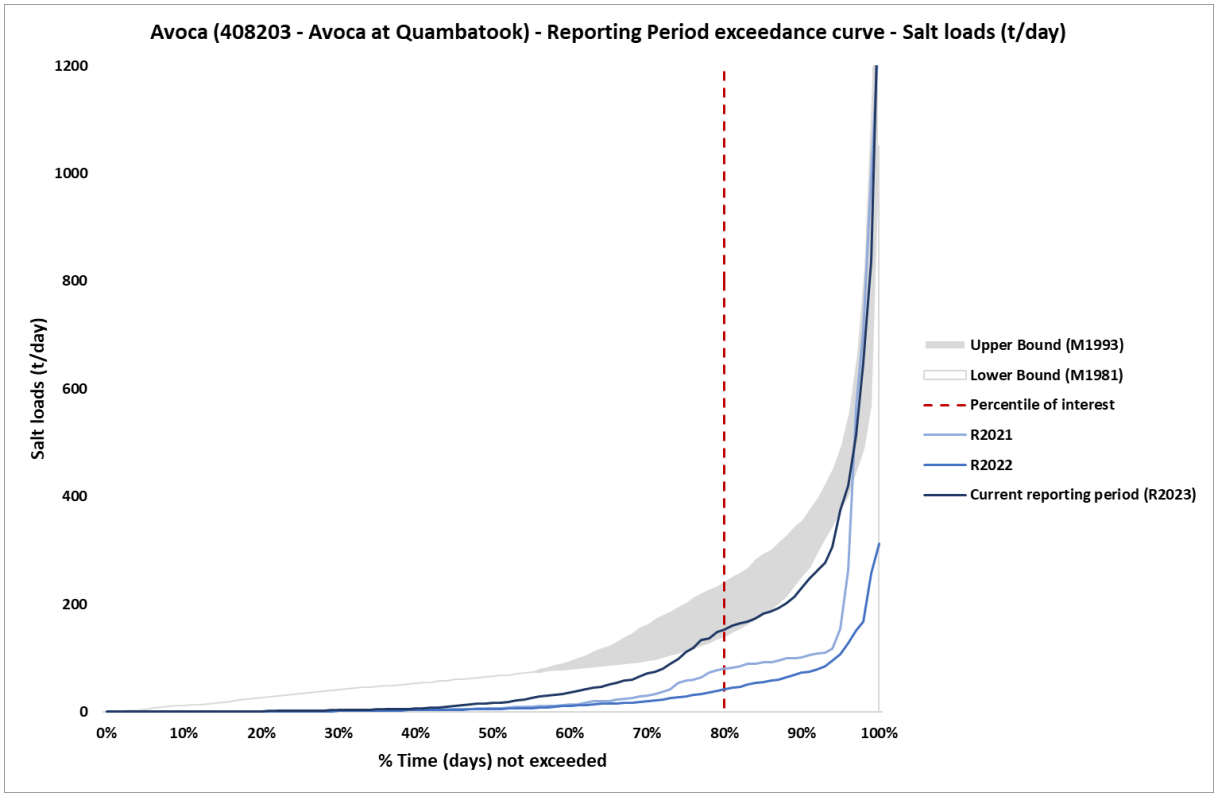

Goulburn (405259 - Goulburn at Goulburn Weir) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1983)
Lower Bound (M1999)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

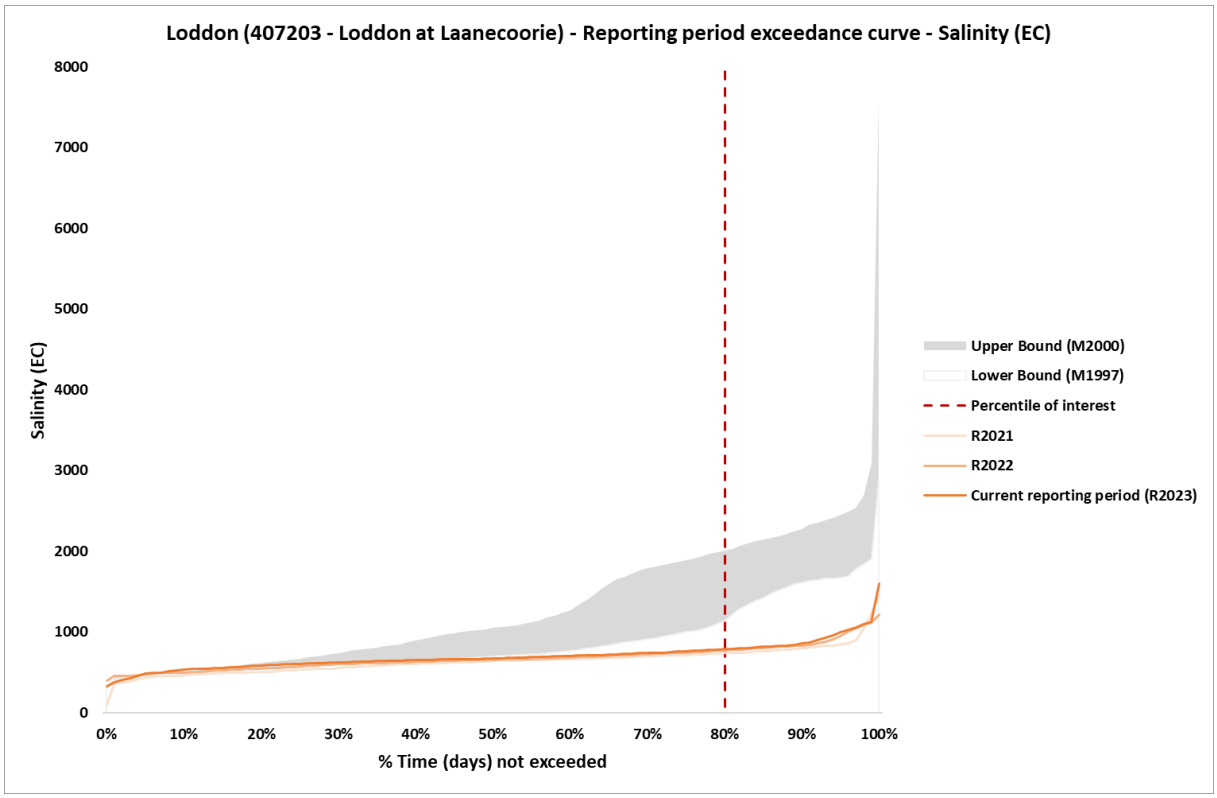

Goulburn (405259 - Goulburn at Goulburn Weir and 405200A - Goulburn at Murchison) - Reporting period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
8000
7000
6000
5000
4000
3000
2000
1000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1994)
Lower Bound (M2000)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

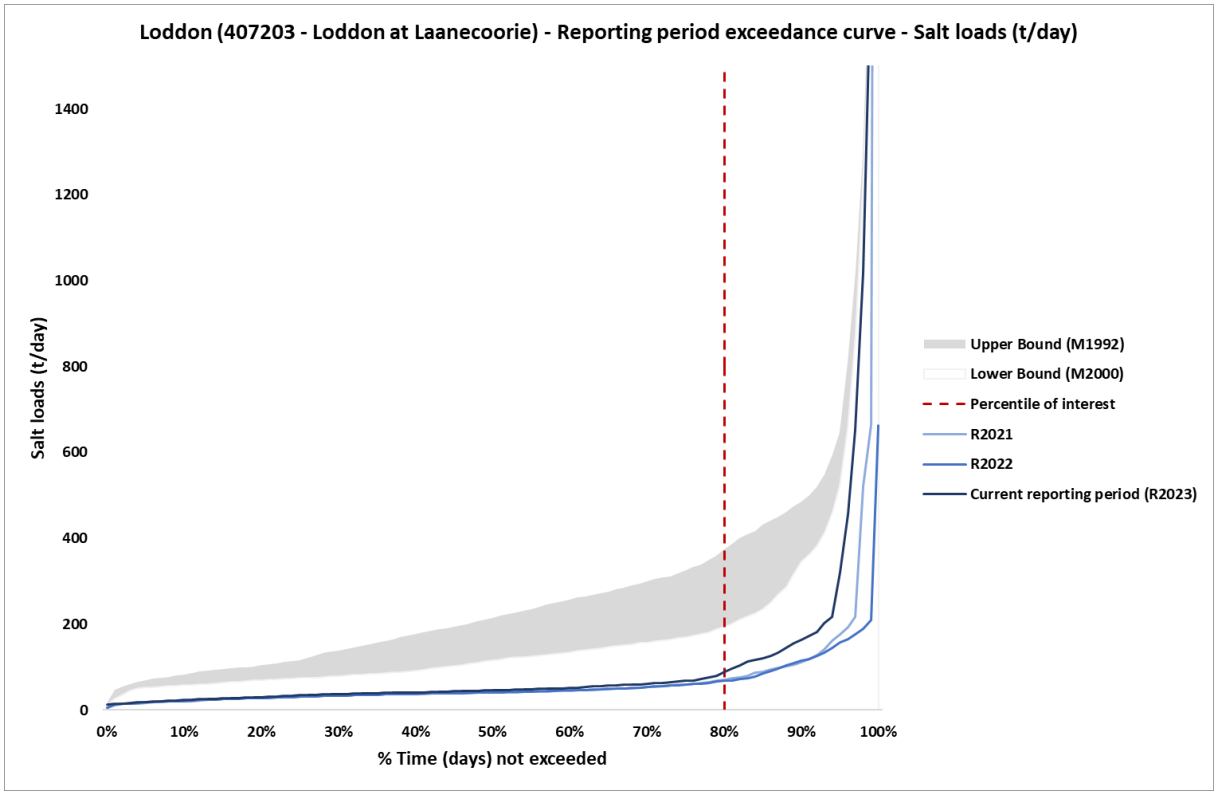

Broken (404224B - Broken at Gowangardie) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
400
350
300
250
200
150
100
50
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1999)
Lower Bound (M1990)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

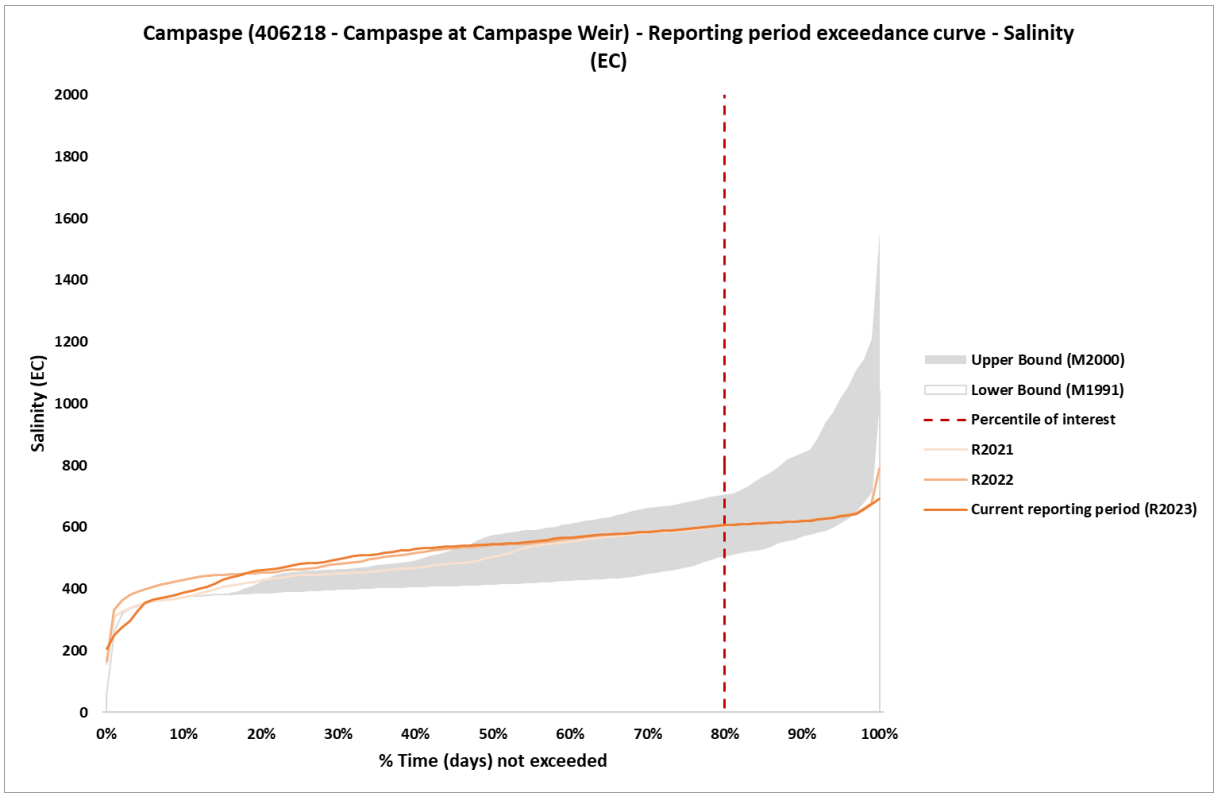

Broken (404224B - Broken at Gowangardie) - Reporting period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
100
90
80
70
60
50
40
30
20
10
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1995)
Lower Bound (M1997)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

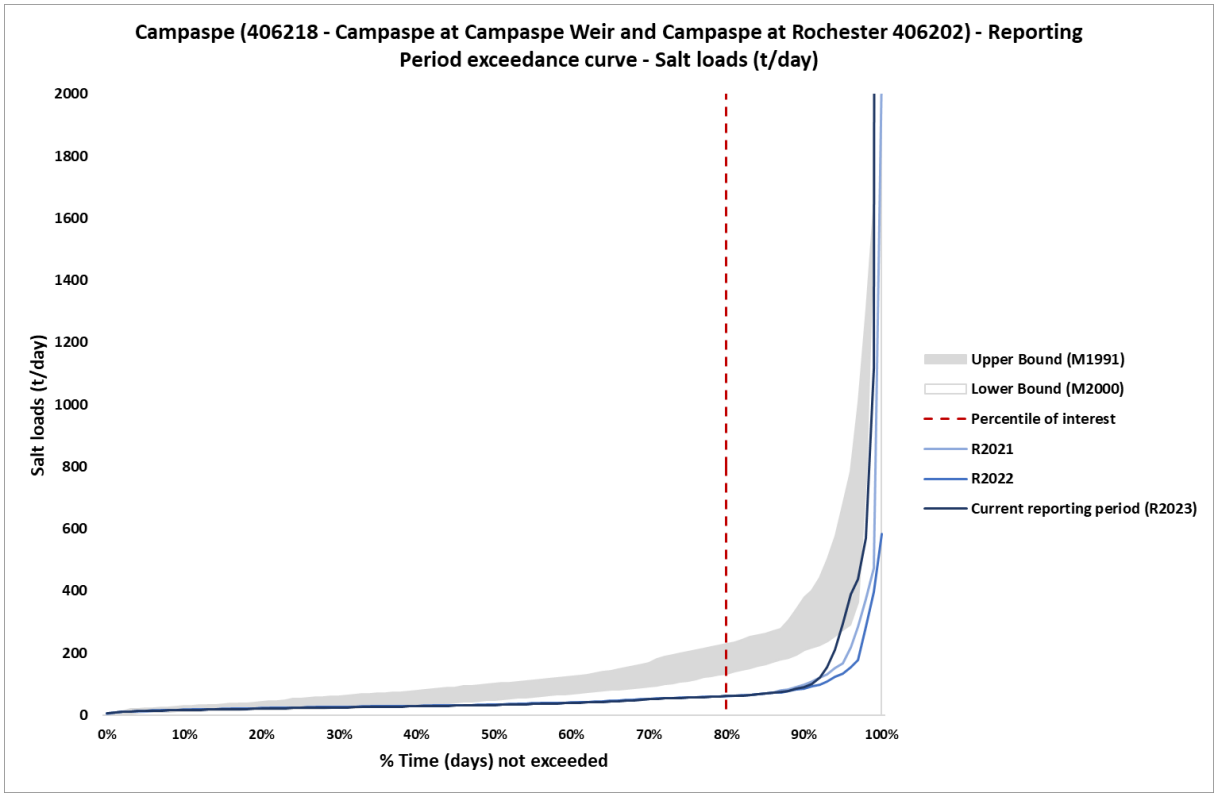

Avoca (408203 - Avoca at Quambatook) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
25000
20000
15000
10000
5000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1999)
Lower Bound (M1994)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

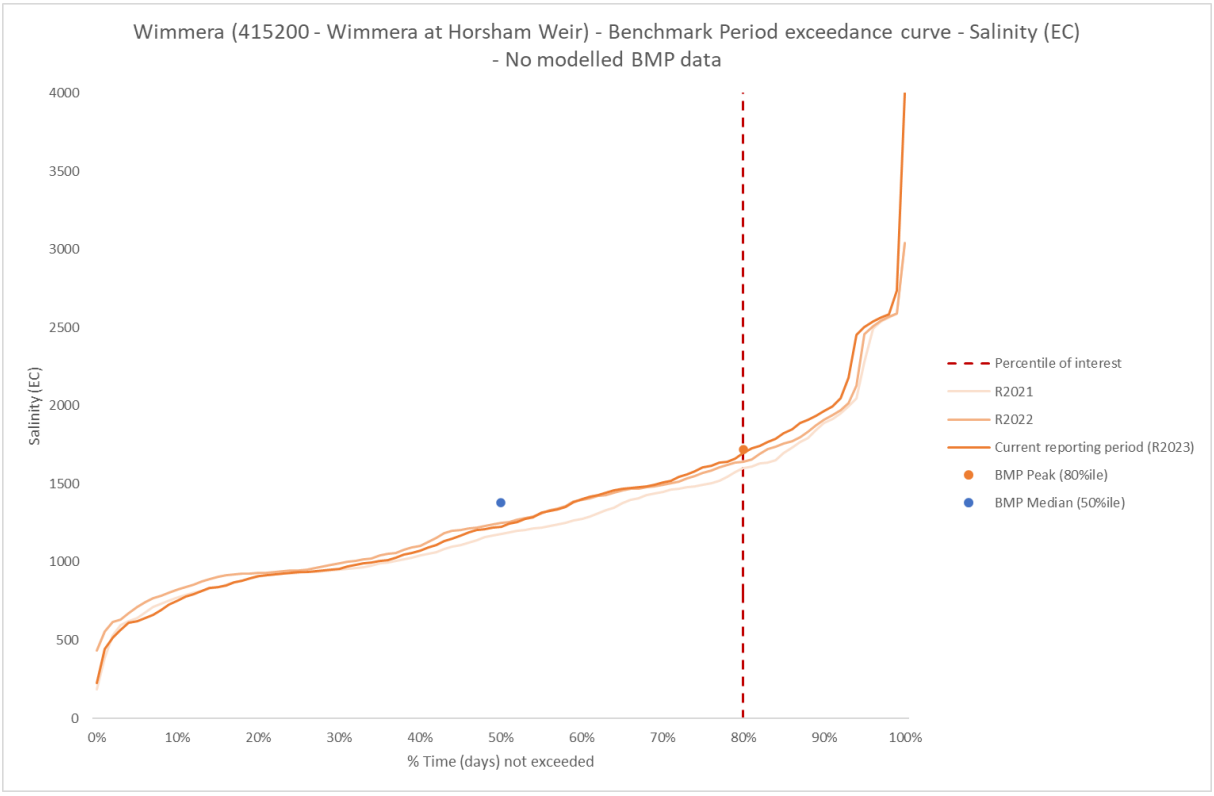

Avoca (408203 - Avoca at Quambatook) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1993)
Lower Bound (M1981)
Percentile of interest
R2021
R2022
Current reporting period (R2023)


Loddon (407203 - Loddon at Laanecoorie) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
8000
7000
6000
5000
4000
3000
2000
1000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M2000)
Lower Bound (M1997)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

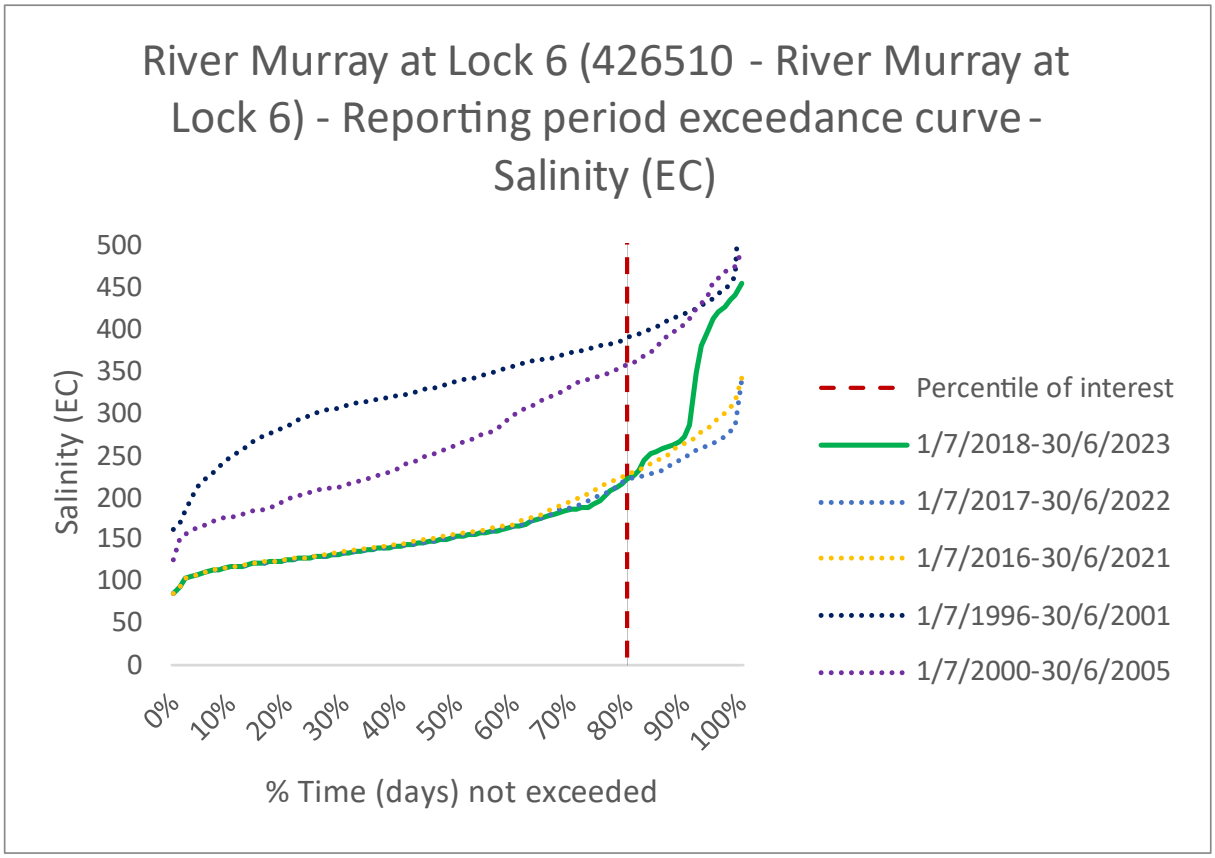

Loddon (407203 - Loddon at Laanecoorie) - Reporting period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
1400
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1992)
Lower Bound (M2000)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

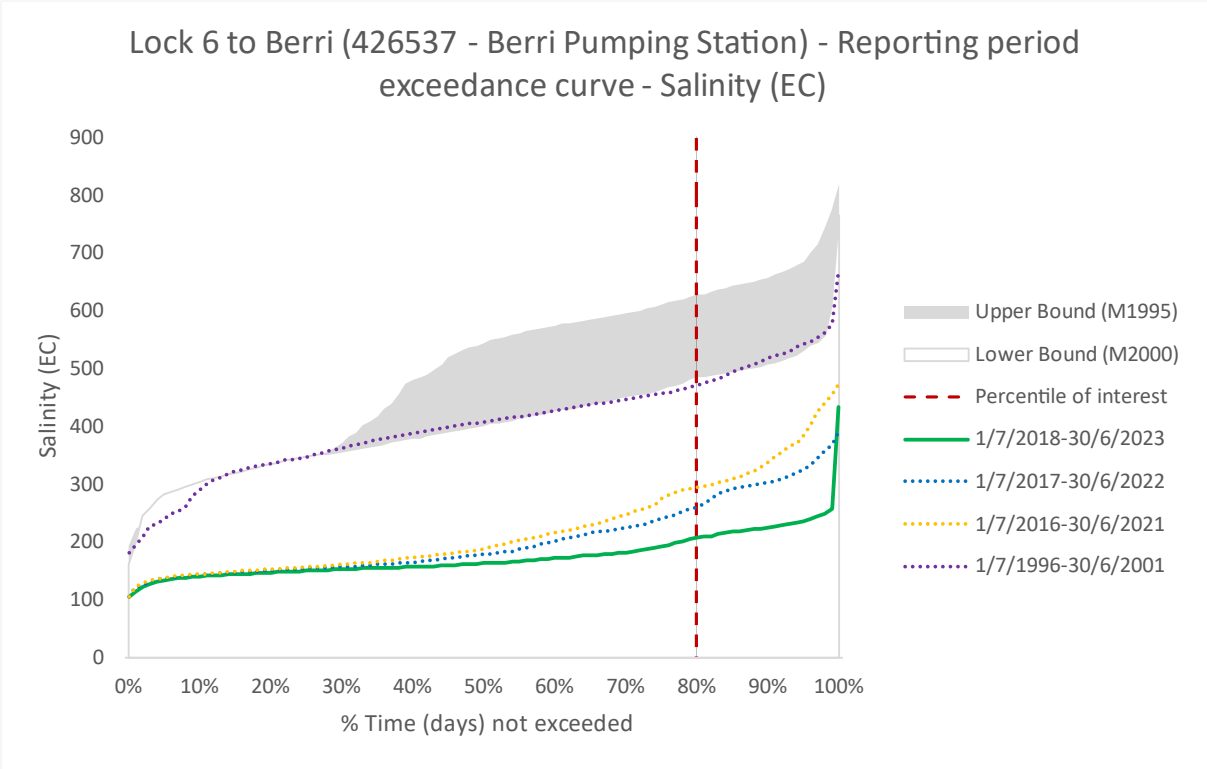

Campaspe (406218 - Campaspe at Campaspe Weir) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M2000)
Lower Bound (M1991)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

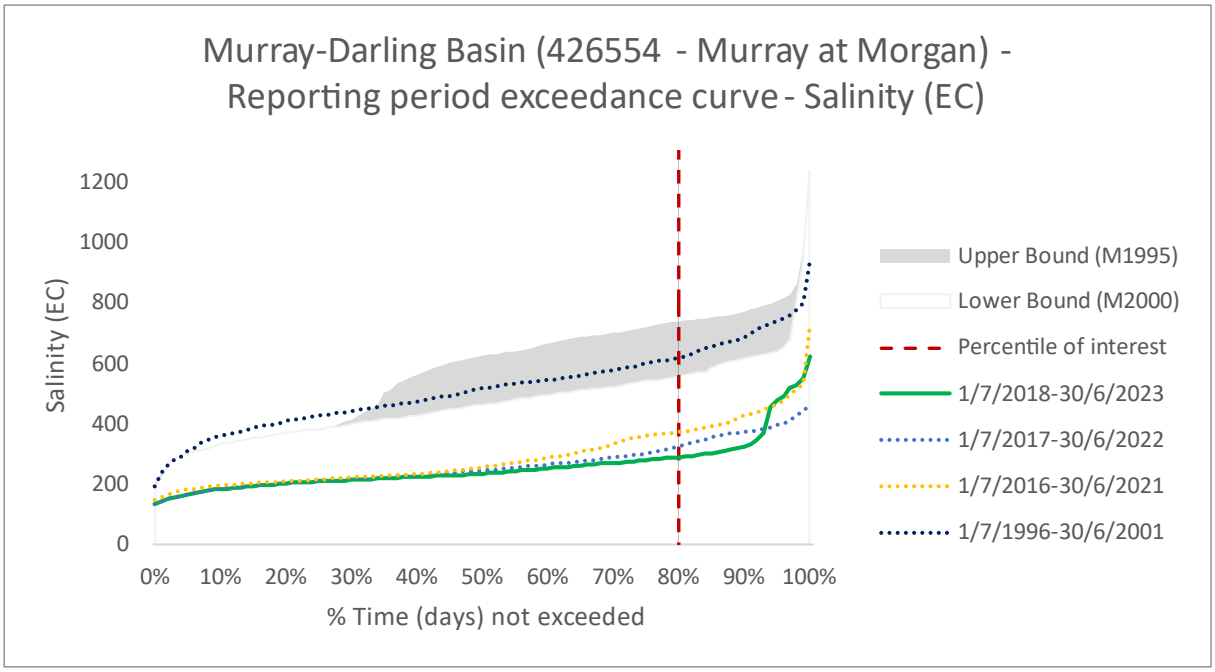

Campaspe (406218 - Campaspe at Campaspe Weir and Campaspe at Rochester 406202) - Reporting Period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1991)
Lower Bound (M2000)
Percentile of interest
R2021
R2022
Current reporting period (R2023)

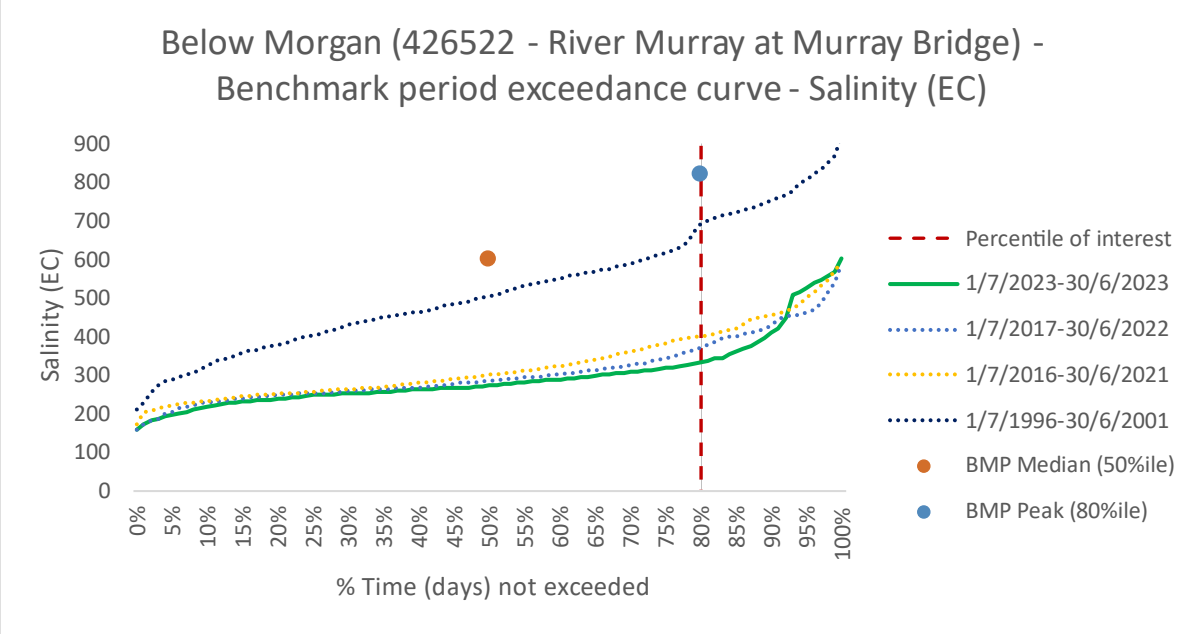

Wimmera (415200 - Wimmera at Horsham Weir) - Benchmark Period exceedance curve - Salinity (EC)
- No modelled BMP data
Salinity (EC)
4000
3500
3000
2500
2000
1500
1000
500
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Percentile of interest
R2021
R2022
Current reporting period (R2023)
BMP Peak (80%ile)
BMP Median (50%ile)

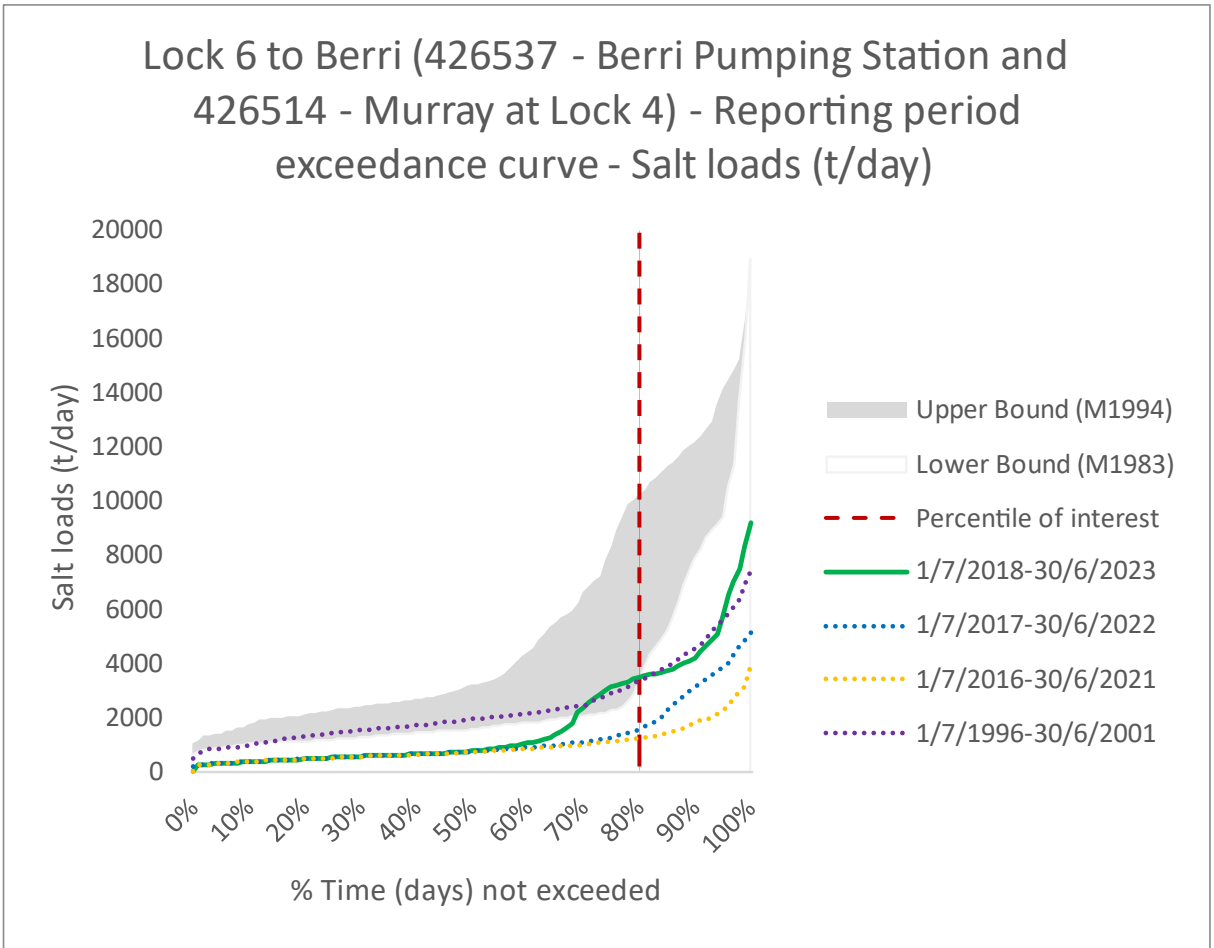
South Australia

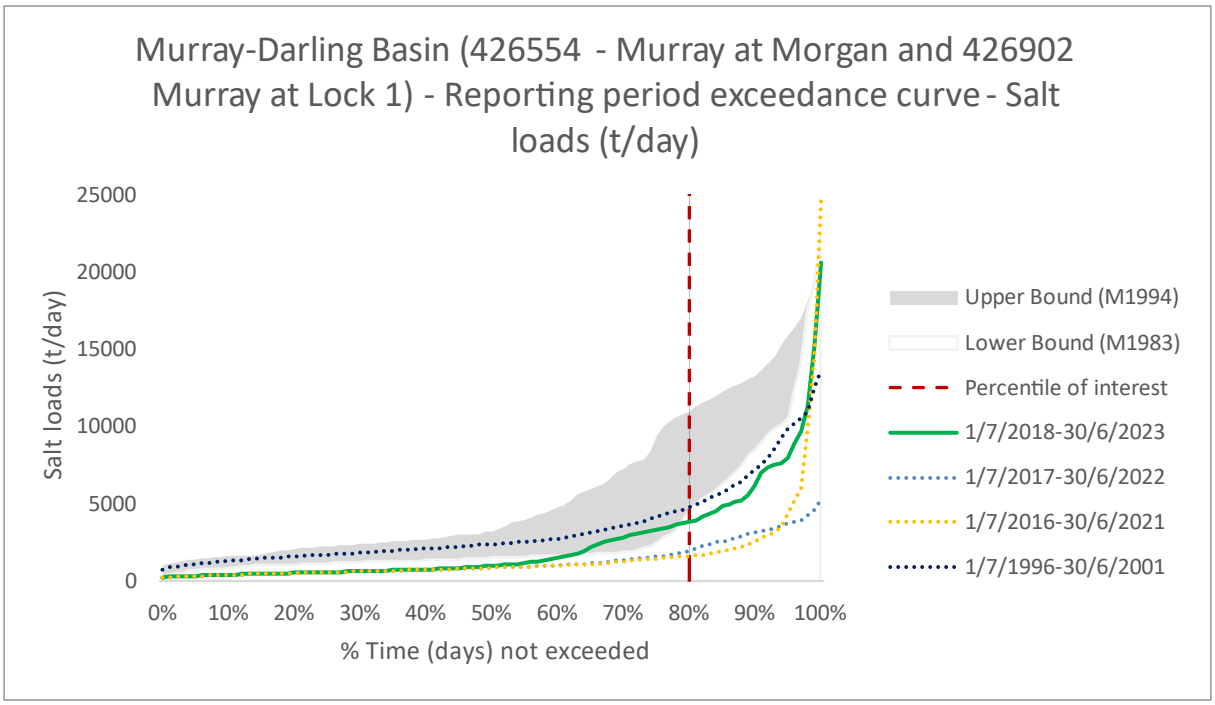



Lock 6 to Berri (426537 - Berri Pumping Station) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
900
800
700
600
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1995)
Lower Bound (M2000)
Percentile of interest
1/7/2018-30/6/2023
1/7/2017-30/6/2022
1/7/2016-30/6/2021
1/7/1996-30/6/2001


Murray-Darling Basin (426554 - Murray at Morgan) - Reporting period exceedance curve - Salinity (EC)
Salinity (EC)
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1995)
Lower Bound (M2000)
Percentile of interest
1/7/2018-30/6/2023
1/7/2017-30/6/2022
1/7/2016-30/6/2021
1/7/1996-30/6/2001


Below Morgan (426522 - River Murray at Murray Bridge) - Benchmark period exceedance curve - Salinity (EC)
Salinity (EC)
900
800
700
600
500
400
300
200
100
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
% Time (days) not exceeded
Percentile of interest
1/7/2023-30/6/2023
1/7/2017-30/6/2022
1/7/2016-30/6/2021
1/7/1996-30/6/2001
BMP Median (50%ile)
BMP Peak (80%ile)


Lock 6 to Berri (426537 - Berri Pumping Station and 426514 - Murray at Lock 4) - Reporting period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1994)
Lower Bound (M1983)
Percentile of interest
1/7/2018-30/6/2023
1/7/2017-30/6/2022
1/7/2016-30/6/2021
1/7/1996-30/6/2001


Murray-Darling Basin (426554 - Murray at Morgan and 426902 Murray at Lock 1) - Reporting period exceedance curve - Salt loads (t/day)
Salt loads (t/day)
25000
20000
15000
10000
5000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time (days) not exceeded
Upper Bound (M1994)
Lower Bound (M1983)
Percentile of interest
1/7/2018-30/6/2023
1/7/2017-30/6/2022
1/7/2016-30/6/2021
1/7/1996-30/6/2001

Appendix E – Comparison of in-stream salinity outcomes with long-term trends at EoVT sites

Under the BSM2030 strategy there is a continued requirement to monitor EoVT sites, however there is no longer a compliance requirement associated with achieving targets at these sites. Jurisdictions monitor flow and salinity for the nominated EoVT sites and also, where applicable, for the interpretation sites (sites for shared rivers or valleys that cross state boundaries).

Table 13 summarises the in-stream EC at each monitored site in the Basin. Records indicate the long-term 50th and 80th percentile EC values against baseline values. The length of the long-term record is also indicated.

In the southern connected system (refer Table 13 and Table 14), the 50th and 80th percentile salinities for 2021–22 and 2022–23 were generally comparable with or less than the mean baseline values. A full understanding of the variability in salinity outcomes with longer term trends requires a detailed analysis for the specific catchment - a process undertaken as part of the review of end-of-valley outcomes.

Estimates of salt load were calculated for records having both EC and flow data. Table 13 compares mean annual salt loads for 2021–22 and 2022–23, along with long-term mean annual loads against baseline values.

Table 12: Comparison of salinity data with long–term records for 2021–22 and 2022–23 (units: EC)

Site	AWRC Site Number	Length of record (years)[3]	50%ile Baseline	80%ile Baseline	Year	50%ile All data	80%ile All data
Basin target site							
River Murray at Morgan	426554	85	570	920	21/22	462	721
					22/23	461	718
South Australia							
Berri Pumping Station	426537	81	450	600	21/22	377	560
					22/23	376	558
River Murray at Murray Bridge [b]	4261162	89	600	820	21/22	484	731
					22/23	483	727
NSW/ Victoria shared							
River Murray at Lock 6 [c]	426510	61	380	470	21/22	314	438
					22/23	313	437
NSW							
Murrumbidgee R at Balranald Weir	410130	57	150	230	21/22	165	224
					22/23	167	225

[3] Length of record (Years) relates to the 2022–23 period. The 2021–22 period is less one year of the 'Length of record (Years) column

Site	AWRC Site Number	Length of record (years)[3]	50%ile Baseline	80%ile Baseline	Year	50%ile All data	80%ile All data
Lachlan R at Forbes (Cottons Weir)	412004	24	430	660	21/22	425	590
					22/23	425	590
Bogan R at Gongolgon	421023	23	440	490	21/22	352	523
					22/23	353	541
Macquarie R at Carinda (Bells Bridge)	421012	31	480	610	21/22[h]	545	664
					22/23	537	658
Castlereagh R at Gungalman Bridge	420020	22	350	390	21/22	539	864
					22/23	609	1037
Namoi R at Goangra	419026	31	440	650	21/22	401	553
					22/23	402	554
Mehi R at Bronte	418058	22	400	540	21/22	406	603
					22/23	406	601
Darling R at Wilcannia Main Channel	425008	58	330	440	21/22	382	552
					22/23	382	557
River Murray at Heywoods	409016	50	54	59	21/22	51	57
					22/23	51	57

Site	AWRC Site Number	Length of record (years)[3]	50%ile Baseline	80%ile Baseline	Year	50%ile All data	80%ile All data
River Murray at Red Cliffs	414204	56	310	390	21/22	267	364
					22/23	265	364
Victoria							
Wimmera R at Horsham Weir	415200	31	1380	1720	21/22	1170	1597
					22/23	1168	1591
Avoca R at Quambatook [d]	408203	37	2060	5290	21/22	1844	5600
					22/23	1797	5070
Loddon R at Laanecoorie	407203	15	750	1090	21/22	703	901
					22/23	702	890
Campaspe R at Campaspe Weir	406218	33	530	670	21/22	570	749
					22/23	564	744
Goulburn R at Goulburn Weir	405259	34	100	150	21/22	68	113
					22/23	69	113
Broken Ck at Casey's Weir [e]	404217	31	100	130	21/22	166	227
					22/23	164	224
Ovens R at Peechelba East	403241	44	72	100	21/22	60	83
					22/23	60	82

Site	AWRC Site Number	Length of record (years)[3]	50%ile Baseline	80%ile Baseline	Year	50%ile All data	80%ile All data
Kiewa R at Bandiana	402205	50	47	55	21/22	41	51
					22/23	41	51
River Murray at Heywoods	409016	50	54	59	21/22	51	57
					22/23	51	57
River Murray at Swan Hill	409204	56	270	380	21/22	196	323
					22/23	194	320
Queensland							
Barwon R at Mungindi [f]	416001	28	250	330	21/22	257	321
					22/23	258	323
Moonie R at Fenton	417204A	20	140	150	21/22	137	175
					22/23	137	177
Ballandool R at Hebel—Bollon Rd	422207A	21	170	210	21/22	201	298
					22/23	206	314
Bokhara R at Hebel	422209A	21	170	210	21/22	185	222
					22/23	188	231
Briarie Ck at Woolerbilla—Hebel Rd	422211A	20	150	280	21/22	240	317
					22/23	245	320

Site	AWRC Site Number	Length of record (years)[3]	50%ile Baseline	80%ile Baseline	Year	50%ile All data	80%ile All data
Culgoa R at Brenda [f]	422015	21	170	210	21/22	192	234
					22/23	196	246
Narran R at New Angledool [f]	422030	21	160	210	21/22	181	237
					22/23	186	250
Paroo R at Caiwarro	424201A	19	90	100	21/22	81	110
					22/23	80	111
Warrego R at Barringun No.2 [f]	423004	22	101	110	21/22	135	190
					22/23	132	186
Cuttaburra Ck at Turra [f]	423005	22	100	130	21/22	131	187
					22/23	130	184
ACT							
Murrumbidgee R at Hall's Crossing	410777	33	224	283	21/22	234	276
					22/23	234	274

a 95th percentile for BSM2030 target at Morgan
b Flow is not measured at this site
c Salinity measured at site A426510 (Murray @ Lock 6)
d Spot salinity data ends in Sep 2008 and continuous starts in Sep 2013
e Used salinity data for 404224 (Broken River at Gowangardie)
f Operated by New South Wales on behalf of Queensland
g Zero flow
h Limited data due to no or low flow conditions
i salinity from downstream gauging station

NA - data not available

Table 13: Comparison of salt load data with long–term records for 2021–22 and 2022–23

Site	AWRC Site Number	Length of record (years)[4]	Mean baseline salt load (t/y)	Year	Mean annual salt load (tonnes) All data
Basin target site					
River Murray at Morgan	426554	56	1,600,000	21/22	1,344,100
				22/23	1,367,700
South Australia					
Berri Pumping Station	426537	29	1,500,000	21/22	514,700
				22/23	536,000
River Murray at Murray Bridge [a]	426522	NA	1,600,000	21/22	NA
				22/23	NA
NSW/Victoria shared					
River Murray at Lock 6	426200	61	1,300,000	21/22	1,090,900
				22/23	1,093,900
NSW					

[4] Length of record (Years) relates to the 2022-23 period. The 2021–22 period is less one year of the 'Length of record (Years) column

Site	AWRC Site Number	Length of record (years)[4]	Mean baseline salt load (t/y)	Year	Mean annual salt load (tonnes) All data
Murrumbidgee R d/s Balranald Weir	410130	57	160,000	21/22	120,300
				22/23	130,100
Lachlan R at Forbes (Cottons Weir)	412004	24	250,000	21/22	136,600
				22/23	136,600
Bogan R at Gongolgon	421023	23	27,000	21/22	19,000
				22/23	31,400
Macquarie R at Carinda (Bells Bridge)	421012	31	23,000	21/22	24,800
				22/23	35,400
Castlereagh R at Gungalman Bridge	420020	22	9,000	21/22	65,200
				22/23	122,800
Namoi R at Goangra	419026	31	110,000	21/22	80,400
				22/23	99,200
Mehi R at Bronte	418058	22	7,000	21/22	8,700
				22/23	11,500
Darling R at Wilcannia Main Channel	425008	58	440,000	21/22	373,300
				22/23	392,600

Site	AWRC Site Number	Length of record (years)[4]	Mean baseline salt load (t/y)	Year	Mean annual salt load (tonnes) All data
River Murray at Heywoods	409016	50	150,000	21/22	125,600
				22/23	129,900
River Murray at Red Cliffs [b]	414204	40	1,100,000	21/22	1,236,400
				22/23	1,236,400
Victoria					
Wimmera R at Horsham Weir	415200	31	31,000	21/22	19,100
				22/23	21,600
Avoca R at Quambatook [c]	408203	37	37,000	21/22	28461
				22/23	34679
Loddon R at Laanecoorie	407203	15	88,000	21/22	28,500
				22/23	34,700
Campaspe R at Campaspe Weir [d]	406218	33	54,000	21/22	23800
				22/23	27000
Goulburn R at Goulburn Weir [e]	405259	34	166,000	21/22	48,400
				22/23	53,000
		31	15,000	21/22	2300

Site	AWRC Site Number	Length of record (years)[4]	Mean baseline salt load (t/y)	Year	Mean annual salt load (tonnes) All data
Broken R at Casey's Weir [f]	404217			22/23	3400
Ovens R at Peechelba East	403241	44	54,000	21/22	45,100
				22/23	47,800
Kiewa R at Bandiana	402205	50	19,000	21/22	16,200
				22/23	16,300
River Murray at Heywoods	409016	50	150,000	21/22	125,600
				22/23	129,900
River Murray at Swan Hill	409204	56	630,000	21/22	544,800
				22/23	546,700
Queensland					
Barwon R at Mungindi [g]	416001	28	50,000	21/22	52,800
				22/23	55,500
Moonie R at Fenton	417204A	20	8,700	21/22	17,600
				22/23	17,100
Ballandool R at Hebel—Bollon Rd	422207A	21	4,200	21/22	10,000
				22/23	10,400

Site	AWRC Site Number	Length of record (years)[4]	Mean baseline salt load (t/y)	Year	Mean annual salt load (tonnes) All data
Bokhara R at Hebel	422209A	21	5,000	21/22	11,900
				22/23	13,100
Briarie Ck at Woolerbilla—Hebel Rd	422211A	20	6,500	21/22	68,000
				22/23	67,700
Culgoa R at Brenda [g]	422015	21	29,000	21/22	66,400
				22/23	73,600
Narran R at New Angledool [g]	422030	21	10,000	21/22	26,800
				22/23	29,100
Paroo R at Caiwarro	424201A	19	24,000	21/22	27,600
				22/23	28,100
Warrego R at Barringun No.2 [g]	423004	22	4,800	21/22	31,900
				22/23	30,000
Cuttaburra Ck at Turra [g]	423005	22	5,500	21/22	25,700
				22/23	24,400
ACT					

Site	AWRC Site Number	Length of record (years)[4]	Mean baseline salt load (t/y)	Year	Mean annual salt load (tonnes) All data
Murrumbidgee R at Hall's Crossing	410777	33	32,700	21/22	69,700
				22/23	71,900

a Flow is not measured at this site
b Flow data stops in October 1994
c Spot salinity data ends in Sep 2008 and continuous starts in Sep 2013
d Used flow data for 406202C (Campaspe at Rochester)
e Used flow data for 405200A (Goulburn River at Murchison)
f Used salinity data for 404224B (Broken River at Gowangardie)
g Operated by New South Wales on behalf of Queensland
h Zero flow

NA = data not available

Salt load (t/d) = flow (ML/d) x salinity (EC) x 0.0006 except Queensland where the factor EC/TDS varies for each site

Appendix F – Operational processes

Table 14: BSMAP meetings between July 2021 and July 2023

Meeting Number	Date	Location
49	25 February 2021	Videoconference
50	19 May 2021	Videoconference
51	27 July 2021	Videoconference
52	29 September 2021	Videoconference
53	28 October 2021	Videoconference
54	22 February 2022	Videoconference
55	10 May 2022	Renmark, South Australia
56	4 August 2022	Videoconference
57	13 October 2022	Videoconference
58	8 November 2022	Videoconference
59	1 March 2023	Melbourne, Victoria
60	18 May 2023	Videoconference
61	18 July 2023	Videoconference

Table 15: BSMAP out-of-session papers for 2020–21 and 2022–23

Out-of-session number	Title	Confirmation Date
25	Basin Salinity Management 2030 (BSM2030) Reporting 2020	July 2020
26	Revised Basin Salinity Management Advisory Panel Terms of Reference	June 2021
27	Basin Salinity Management 2030 (BSM2030) Summary Report 2021–22	1 March 2023
28	Basin Salinity Management Advisory Panel workplan for 2023–24	7 April 2023

Table 16: Salt Interception Scheme Operators workshops 2021-22 & 2022-23

Meeting Number	Location	Date
21	Video Conference	11 August 2021
22	Video Conference	25 November 2021

Meeting Number	Location	Date
23	Video Conference	23 February 2022
24	Video Conference	25 May 2022
25	Mildura	21 September 2022
26	Video Conference	7 December 2022
27	Mildura	15 March 2023
28	Video Conference	29 June 2023

Appendix G – Executive summaries from Contracting Government reports

Disclaimer: Information contained in Appendix G was provided to the MDBA by each of the Contracting Governments as part of their BSM2030 reporting obligations. The executive summary from each State Contracting Governments comprehensive report and the Australian Governments annual report was extracted for inclusion in this appendix and reformatted to meet MDBA styles for consistency. The MDBA does not hold responsibility for the accuracy of data and information contained within Appendix G.

Executive Summary: Victoria's BSM2030 comprehensive report 2022–23

Victoria's Comprehensive Report 2023 presents Victoria's accountability and achievements in implementing the Basin Salinity Management 2030 (BSM2030) strategy in 2022–23 and includes select highlights from 2021–22.

The Department of Energy, Environment and Climate Action (DEECA) takes the lead on reporting Victoria's compliance under BSM2030, with support from the Goulburn Broken Catchment Management Authority (CMA), North Central CMA, North East CMA, Mallee CMA, Wimmera CMA and both Goulburn-Murray Water (GMW) and the Agriculture Victoria (AgVic).

Salinity Accountability Framework

Victoria reconfirmed its commitment to salinity management in the Murray–Darling Basin through Water for Victoria (2016). Water for Victoria is our long-term strategic plan for managing water resources in the context of climate change and a growing population.

Victoria remains compliant with Schedule B to the Murray–Darling Basin Agreement (Schedule 1 to the Water Act 2007). Victoria's net balance on the Murray–Darling Basin Salinity Register A as of September 2023 is -22.7 EC credits or $4.766 million/yr, which has been endorsed by the Basin Salinity Management Advisory Panel (BSMAP).

There was the following change to Victoria's Register A balance in 2022–23:

- A decrease of **1.3 EC** in the salinity credits for Victoria this consisting of a **0.9 EC** reduction to Victoria's share from the Joint Component of the Murtho Salt Interception Scheme (SIS) and 0.3 EC reduction to Changed MDBC River Operations 2000 to 2002, and 0.1EC minor shifts in the interpolated impacts of several accountable actions.
- No change in Victoria's salinity debits.

During the reporting period, Victoria led or supported work to assess new and existing accountable actions, including the Kerang Lakes/Swan Hill Salinity Management Plan, Victorian Mid Murray Storages (VMMS), Shepparton Irrigation Region (SIR) Land and Water Management Plan (LWMP), Tragowel Plains, Barr Creek Catchment, Pyramid Creek GIS, Church's Cut Decommissioning, and Reduced Irrigation Salinity Impact (RISI) Stage 1 and Stage 2.

Environmental watering activities such as the Victorian Murray Floodplain Restoration Project (VMFRP) are being incorporated into Victoria's accountability framework. In 2021, Victoria commissioned an assessment of current data and knowledge status for the nine sites that comprise the VMFRP to inform the priorities for future work to meet Schedule B to the Murray Darling Basin Agreement and the guiding principles of the BSM2030 strategy (RMCG, 2021). The report indicates three of the VMFRP sites will likely require detailed salinity assessments for consideration as new accountable actions.

Management of Salt Interception Schemes

The three Victorian salt interception schemes (SIS) (Barr Creek Drainage Diversion Scheme, Mildura-Merbein Salt Interception Scheme and Pyramid Creek Groundwater Interception Scheme) continued to be operated in accordance with their respective operating rules. As part of the trial of responsive SIS management implemented under BSM2030, Victoria continues to work with the Murray–Darling Basin Authority (MDBA), and the other jurisdictions, to refine the operation of the SIS Program in response to forecast river flow and salinity conditions. The Mildura-Merbein SIS is the only scheme located in Victoria

that is part of this trial.

A total of 108,472 tonnes of salt was diverted from the River Murray via Victoria's SISs in 2021–22, and 54,516 tonnes in 2022–23. The diverted salt from the River Murray in 2022–23 was much lower than previous years as a major flooding event in October 2022, caused significant damage to all three SISs which continued to impact their operation into 2023.

Salinity Management

Victoria continues to implement LWMPs in irrigation areas. LMWPs provide the strategic framework and key actions for natural resource management in Victoria via a regional partnership approach. In addition, CMAs have long-term Environmental Water Management Plans (EWMPs) to guide environmental watering activities across Victoria. EWMPs are developed under partnership arrangements with the community and government agencies, such as the Victorian and Commonwealth Environmental Water Holders and the MDBA which incorporate management of salinity impacts.

CMAs have also delivered a wide range of farm planning and on-farm works, including irrigation and dryland whole farm plans, upgrades to irrigation systems for water use efficiency and salinity benefits, as well as extension activities.

Salinity and salt loads at End-of-Valley-Target (EoVT) sites were monitored and evaluated over the reporting period for each Victorian valley for which an EoVT has been set. Salinity and salt load exceedance curves for Victorian EoVT sites are provided in this report, based on the improved EoVT reporting methodology.

Efficient Governance

The Efficient Governance section of this report explores work Victoria has taken to review its accountable actions, the ongoing status of its Basin-wide Core Salinity Monitoring Network (BSC Network), and Victoria's response to previous Independent Audit Group recommendations. During 2022–23, Victoria progressed works to inform improvements to the review and modelling of seven accountable actions.

Victoria's CMAs continued to support efficient Basin-wide governance of BSM2030 through monitoring which helps to support the assessment of salinity impacts and periodic reviews of Victoria's accountable actions. Victoria actively participates in the independent audit process, which tracks Basin-wide performance in implementing BSM2030 and identifies areas of improvement.

DEECA has worked closely with regional partners including CMAs, GMW and AgVic on the Victorian contribution to the BSC Network which identifies all surface and groundwater sites used to monitor and review Victorian accountable actions.

The Manual for Victoria's Salinity Accountability in the Murray–Darling Basin provides a strong framework which guides salinity managers in our state in meeting our obligations under Schedule B of the Murray–Darling Basin Agreement and other obligations under Victorian legislation, regulations, and policy.

Strategic Knowledge Improvement

DEECA, AgVic, GMW and the CMAs continued to increase state-wide capacity for managing salinity in the Murray–Darling Basin in the reporting period by progressing several research and investigation projects, including:

- Contemporary Salinity Risks of Victoria paper mapping out key governance, financial and physical risks faced by the salinity management program in Victoria, with a focus on Victoria's part in salinity management in the Murray–Darling Basin.
- Commenced developing a set of contextual narratives for Victorian EoVT sites. The contextual narratives will concisely capture key salinity processes, landscape characteristics, climate drivers and risks unique to each catchment in Victoria.
- North Central CMA prepared a draft guideline for assessing risks of salt mobilisation for proposals to water wetland and for the rehabilitation of wetlands and surface and groundwater interaction on the Gunbower forested floodplain to inform future VMFRP and The Living Murray salinity assessments.
- Mallee CMA has undertaken a hydrological review for threat assessment for Nangiloc–Colignan; developed a Mallee Bore Management Strategy; and completed an Acid Sulfate Soil hazard assessment and strategic management plan.
- AgVic continued to provide advice to agencies and the community on the management and avoidance of dryland salinity, rising groundwater levels, use of saline groundwater and extension to manage salinity risks from irrigation.

Community Engagement and Communication

Community engagement, extension and communication are central to the implementation of Victorian CMA Regional Catchment Strategies and subordinate strategies and plans, including Land and Water Management Plans and Waterway Strategies. Local ownership of the challenges and opportunities of salinity management has been a long-standing and successful approach in Victoria. Engagement with Traditional Owners and Aboriginal Victorians is increasingly being prioritised, with two-way communications focusing on sharing knowledge and understanding Aboriginal values and aspirations within landscapes impacted by salinity.

Many CMA boards use community-based advisory groups to gain community and expert input into projects and strategies, and to help inform communities, agencies, and land managers about natural resource management in the region. These groups are central to effective management of salinity in Victoria, particularly in irrigation areas.

CMAs, GMW and AgVic continued to engage with local communities to build knowledge of salinity threats and capacity to manage salinity. The wetter conditions led to increased concerns around waterlogging, elevated groundwater tables and land salinisation, which were supported through extension activities, watertable mapping, and field days.

Priorities for Future Work

Victoria will continue to implement BSM2030 in partnership with the MDBA and other jurisdictions. Key projects to complete include:

- Airborne Electro Magnetic Survey in the Victorian Mallee
- Engagement with Traditional Owners and Aboriginal Victorians on salinity issues with a focus on with knowledge sharing and supporting Aboriginal self-determination
- Preparation for the 2026 review of BSM2030
- Finalising contextual narratives of salinity risk for EoVT sites
- Renewal of the SIR LWMP

- Finalising the Integrated Accountable Action Model (IAAM) and applying the model to the Barr Creek and Tragowel Plains Accountable Action Reviews.

Victoria will also prioritise work on understanding and assessing potential new accountable actions including VMFRP, VMMS, SDLAM Projects and GMW Water Efficiency Project.

Victoria will continue to be a part of the trial for responsive management of the SIS and operate schemes within the state in accordance with the adaptive management approach until the conclusion of the trial in 2025.

Executive Summary: Queensland's BSM2030 comprehensive report 2022–23

This report has been compiled by the Department of Resources to report to the Murray–Darling Basin Ministerial Council on how Queensland is implementing Basin Salinity Management 2030 (BSM2030). It summarises Queensland's actions with respect to the key elements of BSM2030, includes information presented in the 2021–22 Annual Status Report, and provides information about stream flow and salt load at Queensland's ten End-of-Valley (EoV) reporting sites for the reporting period of July 2021 to June 2023. The Queensland Government has continued its commitment to implementing the objectives of BSM2030 and adhering to the guiding principles underpinning BSM2030.

As is typical for the catchments within the Queensland Murray–Darling Basin (QMDB), annual flows were highly variable within the two-year reporting period. Following a long dry period in the preceding years, significant amounts of rainfall and stream flow occurred between November 2021 to January 2022, with smaller flow events occurring through to December 2022 across the QMDB. This was the most significant groundwater recharge event in the eastern half of the QMDB since reporting began in 2000. However, following this period of increased flow, eight of the ten EoV sites have reported zero flow since early 2023.

Given this extreme disparity in flow, electrical conductivity (EC) levels and salt load were also variable, with some of the highest results recorded since reporting began in 2000. The variation in EC and salt load are to be expected as the large flow events preceded by dry/low flow conditions result in salt being flushed from the surrounding landscape into the streams and rivers.

The applicability and relevance of exceedance curves to the sites in the QMDB may require further investigation. It is unclear whether the exceedance curves (especially salt load) adequately capture the highly variable stream flow seen in most QDMB catchments. There have been previous discussions about implementing salinity and salt load targets under low and high flow conditions which may still prove useful.

Future priority work includes progressing the review of shallow groundwater in the lower Border Rivers alluvia, continuing work to identify long-term management options for coal seam gas brine and salt, finalising salinity risk assessment guidelines for Queensland, progressing the capture of landscape salinity data into publicly-accessible online platforms, and maintaining the existing resources and capacity within Queensland to continue contributing to BSM2030 tasks and reporting requirements.

Executive Summary: South Australia's BSM2030 comprehensive report 2022–23

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

South Australia's key achievements and outcomes during 2021–22 and 2022–23 are outlined below against each of the key elements of the BSM2030 strategy.

Salinity accountability framework

- South Australia remains compliant with Schedule B of the Murray–Darling Basin Agreement with a Salinity Register net credit balance of $8.332 million.
- The assessment of the South Australian Riverland Floodplain Integrated Infrastructure Program (SARFIIP) Pike and Katarapako accountable actions has been completed and entries have been included on the 2023 Salinity Register.

Management of salt interception schemes

- SIS located in South Australia diverted an estimated 271,971 tonnes of salt in 2021–22 and 229,962 tonnes in 2022–23.

Flow management

- Salinity levels remained below the target levels in 2021–22 and 2022–23 at all South Australian End-of-Valley Target sites and Basin Plan reporting sites other than Milang, which had a short exceedance above 1,000 EC.
- During 2021–22 and 2022–23 DEW considered the salinity and water quality risks associated with 60 separate requests to undertake environmental watering and river operations actions as part of the approval process.
- Murray–Darling Basin Authority (MDBA) modelling estimated that salt export from the Murray–Darling Basin over the 3-year period from July 2020 to June 2023, was 2.006 million tonnes per year.
- The Murray Mouth remained open 100 percent of the time due to dredging operations, scouring from high flows in 2022–23 and delivery of environmental water.

Salinity management in catchments

- South Australia continued to explore opportunities for long-term operational infrastructure to improve the ecological health of the Coorong South Lagoon and projects to sustain Riverland environments in consultation with community, First Nations and stakeholder groups.

Efficient governance

- The Morgan to Wellington and Pike-Murtho groundwater models were accredited by the MDBA and used to update existing salinity register entries.

Strategic knowledge improvement

- South Australia worked with the MDBA to undertake a project to improve the understanding of the water and salt balance in lower River Murray floodplains following inundation.
- South Australia completed a risk assessment of in-river salinity levels during the 2022–23 flood recession.

Community engagement and communication.

- DEW continues to publish weekly River Murray Flow Reports and a monthly Water Resources Update, which are distributed to over 1,000 recipients online.

Executive Summary: New South Wales' BSM2030 comprehensive report 2022–23

Salinity remains an issue in New South Wales (NSW) and requires ongoing management. NSW has continued to address the ongoing challenge of salinity through a variety of measures in 2021–22 and 2022–23. Outcomes and achievements for this period are listed in line with the eight key elements[5] of the Basin Salinity Management 2030 (BSM2030) Strategy.

Securing additional resources, coupled with a new endorsed program of works, has facilitated significant progress in conducting register reviews, evaluation of new accountable actions and processes to embody salinity assessment in the NSW water management framework.

Salinity Accountability Framework

NSW maintained a net credit balance on the Salinity Register in 2021–22 and 2022–23, in a continued commitment to Schedule B of the Murray–Darling Basin Agreement (the Agreement).

Five register reviews were completed as part of the upgrade of the Sunraysia model (EM2) upgrade including the benefit from the Lower Murray salt interception schemes (SIS) and the Reduced Irrigation Salinity Impact (RISI) actions. NSW also finalised the review for the Upper Darling SIS. Assessment for the combined Sunraysia Irrigation Development 1997-2006 and (provisional) 2007–2018 commenced, with significant progress made to deliver on phase 1 (investment case) and phase 2 (data inputs). Phase 3 (modelling) will be initiated during the next reporting period.

NSW also progressed preliminary investigations into several Basin Plan projects to determine whether they should be notified as accountable actions under the Schedule B of the Agreement, including the Yanco Creek Offtake Modernisation; Reconnecting River Country Program – Murrumbidgee River; Murray and Murrumbidgee National Parks; and, Lock 8 and 9 weir pool supply measure projects.

Management of Salt Interception Schemes (SIS)

The Joint Venture Salt Interception Schemes operational statistics declined during this reporting period with large-scale flooding impacting all sites and resulting in cessation of scheme operations for a large portion of the 2022–23 financial year. In total, 83,747 tonnes of salt was diverted from the Murray and Darling River systems in 2021–22 and 56,131 tonnes of salt in 2022–23.

In addition, DPE progressed two key initiatives during this reporting period:

- completion of an asset register and Asset Management Plan (2023) to assist with understanding future budget requirements and service delivery of the program
- a groundwater monitoring review completed by DPE hydrogeologists (2021) to ensure the SIS monitoring network remains fit-for-purpose. Several recommendations were made specific to each scheme.

Salinity Management in Catchments

DPE Water continued working with other government agencies on initiatives to support the delivery of BSM2030 tasks and objectives. Salinity management in catchments is supported by the development of salinity information and products to facilitate the delivery of NSW policy and

[5] Some key elements have been merged as per the Table of Contents provided in the BSM Procedure – Reporting.

intergovernmental agreements.

NSW maintains a high profile of work within catchments along with conducting programs of community engagement and communication with a wide variety of stakeholders across NSW. Activity has focussed on the Lachlan and Murrumbidgee catchments this reporting period in response to emerging dryland/catchment salinity.

Efficient Governance

There has been continued progress during the reporting period to ensure NSW's obligations as set out in BSM2030 are met, with a particular focus on reviewing the NSW BSM Program Plan, refocusing priorities and resourcing needs up until 2026. The BSM Steering Committee has provided valuable input and program oversight. NSW has continued to be an active member of the Basin Salinity Management Advisory Panel (BSMAP) and has provided assistance and support for the delivery of multiple interjurisdictional BSM2030 tasks.

Strategic Knowledge Improvement

NSW has pursued knowledge improvements during this reporting period, with respect to landscape management, salinity dynamics and processes. Key projects and innovations included the continuation of hydrogeological (HGL) mapping of very high and high salinity hazard landscapes, successful testing of modelled results versus known mapped sites, trialling EC trend analysis to detect change in catchments and applying new data to improve management in both the urban and regional context.

Community Engagement and Communication

Community engagement and communication activities continued during this reporting period, with a wide range of stakeholders participating in events. Salinity-related activities such as training, project support and field days were delivered across the state, supporting the knowledge and implementation of salinity management across NSW.

Future Priorities

NSW future priorities will build on the achievements in this period and continue to increase capacity to successfully implement and contribute to BSM2030 key tasks and objectives. Sourcing and securing appropriate skills and funding will continue to be a key priority.

Other key priorities include:

- the completion of high priority register reviews
- developing strategies and tools to manage the impact of irrigation development in Sunraysia
- region
- implementing and refining the preliminary salinity assessment procedure
- progressing the review of end of valley targets and catchment monitoring needs
- evaluating catchment salinity risk and needs analysis for catchment modelling
- NSW BSM2030 Comprehensive Report 2021–2022 to 2022–2023
- continued investment in salinity information to inform land and water management decisions.
- NSW will continue working with other Basin States and the Murray–Darling Basin Authority (MDBA)

- on key priorities to transition to Source and in preparation for the BSM2030 mid-term review.

Executive Summary: Australian Capital Territory's BSM2030 comprehensive report 2022–23

Introduction

The Murray–Darling Basin Ministerial Council approved the BSM2030 strategy in 2015 to deliver a strategic, cost-effective and streamlined program of coordinated salinity management for the Murray–Darling Basin to 2030. The BSM2030 strategy builds upon previous salinity management as part of the Salinity and Drainage Strategy (1988–2000) and the Basin Salinity Management Strategy (2001–2015). The Strategy maintains the pre-existing accountability framework and management arrangements.

This is the Australian Capital Territory's (ACT) fourth comprehensive report and covers implementation of the BSM2030 strategy in 2021–22 and 2022–23. The ACT's key achievements and outcomes over the past two years are outlined below against each of the relevant elements of the BSM2030 strategy, including the End-of-Valley salinity target. This report presents the results from this monitoring and the salt load entering, generated within, and leaving the ACT.

Throughout 2021–23, flow and salinity were monitored at the End-of-Valley Target site in the Murrumbidgee River at Halls Crossing and four reference sites. The flow monitoring results for the Basin Salinity Target, the ACT End of Valley Target and reference sites are presented in Tables 1 and 2 for the 2021–22 and 2022–23 water years respectively.

Salinity within the ACT remain a low risk to water quality as evident by the relatively low levels of salinity presented in this report.

Proposed or new accountable actions

The ACT proposes no accountable actions.

Outcomes and key achievements

ACT's outcomes and key achievements in implementing the BSM2030 strategy in 2021–23 include:

- ACT remained off the salinity register for the BSM2030 accountability framework.
- Salinity generated within the ACT does not result in exceedance of the relevant EoVT targets.

State Works or Measures

ACT does not have existing or proposed works or measures to report on for 2021–23.

The ACT is not involved in implementing any salinity mitigation works or actions under the BSM2030, located in the lower reaches of the Basin in South Australia, Victoria and NSW.

Summary of End-of-Valley Target Result

There is a direct correlation between annual flow (ML/y) and the salt load (t/y) transported throughout the catchments. The recorded salt load for 2021–22 and 2022–23 is within the bounds of the flow-salinity relationship.

In 2021–22 and 2022–23, above target salt load was recorded across the EoVT site and all reference sites. The total ACT salt load generated within the ACT for 2021–22 and 2022–23 were 70,592 and 83,382 tonnes respectively, above the total salt load target of 32,706 tonnes per year.

However, the above target salt loads for 2021–22 and 2022–23 are anticipated due to the high river flows observed, resultant from the above average rainfall recorded; 913 mm in 2021 and 893 mm for 2022. The average total annual rainfall for the ACT is 615 mm.

Some reference sites recorded below target EC levels however there is an increase in the mobilisation of salts across the landscape into the ACT and within the ACT associated with the increased river flows.

Assessing the salinity risk profile

Trends in salinity and salt load conditions across reference sites

The salt loads recorded at the EoVT site and reference sites were above the baseline for 2021–22 and 2022–23. However, these above target salt loads are anticipated due to the high river flows observed, resultant from the above average rainfall recorded and are within the bounds of the flow-salinity relationship.

The salt load from sewerage treatment plants (QSTP and LMWQCC) were above the baseline (1,780 and 12,753 t/year respectively) for 2021–22 and 2022–23 water years. However, salt loads from the QSTP remain consistently below baseline salt loads and within the bounds of the flow-salinity relationship. The salt loads measured at the Lower Molonglo Water Quality Control Centre is largely calcium bicarbonate and nitrate rather than sodium chloride. The high proportion of calcium reduces soil sodicity by reducing the sodium absorption ratio.

Risk of salinity to ecological assets within the ACT

The ACT Environmental Flow Guidelines are an instrument under the *Water Resources Act 2007* that set out the planned environmental water requirements needed to maintain ecological values of the Territory's lakes and waterways.

The Guidelines are reviewed every five years of operation to determine their effectiveness for supporting aquatic ecosystem health and protect water quality through maintaining base flows. The Guidelines are subject to review in 2023. Previous reviews in 2013 and 2017 have not identified salinity as a risk to riverine health. The ACT Water Resource Plan, made under the Water Act 2007 and Basin Plan, do not identify elevated levels of salinity as a risk for water quality.

Contribution to Murray Darling Basin salinity risk

The Total ACT Impacts salt load contributions to the Murray Darling Basin are historically and continue to be *low risk* to the catchment and Murray Darling Basin. The data presented on Total ACT impacts demonstrates salt loads are within the bounds of the flow-salinity relationship and there are relatively low levels of salinity in ACT waterways as recorded throughout the monitoring reference sites and EoVT site.

The ACT Environmental Flow Guidelines provide a positive contribution to the dilution of salts in the upper reaches of the Murrumbidgee River. Any management actions in the ACT on the volumes of

water and/or concentrations of salt are intercepted by Burrinjuck Dam in NSW and has no impact on salinity at the Morgan (SA) target site.

Efficient governance: Review of Register Models and Entries

Core Salinity Monitoring Network

The ACT nominated three sites for inclusion in the Basin-wide Core Salinity Monitoring Network in June 2017. There have been no changes to the list of ACT sites since that time.

The ACT salinity monitoring sites are:

- Murrumbidgee at Angle Crossing (Lobb's Hole) station 410761
- Molonglo at Oaks Estate station 410729
- Murrumbidgee at Halls Crossing station 410777

Salinity Register Model and Register Entries

The ACT does not have any salinity register entries in the BSM2030 accountability framework.

Community engagement and communication

The ACT Healthy Waterways project includes the construction of infrastructure–such as wetlands, ponds and rain gardens–as well as research trials, improvements to water monitoring practices, and the H2OK community education campaign.

Thirteen quality 'assets'–ponds, wetlands, rain gardens and channel restorations – will be delivered under Stage 2 by the end of 2023. These will reduce the amount of nutrients, sediment and pollutants entering our waterways. Improvements to water quality are designed to:

- enhance the amenity of our lakes, ponds, streams and rivers
- create opportunities for recreation
- boost economic activity associated with our lakes and ponds
- expand the habitat available for local native aquatic plants and animals
- contribute to reducing urban heat
- enhance appreciation of First Nations values associated with waterways and strengthen the connection of First Nations people to Country.

On top of innovative infrastructure projects, the current ACT Healthy Waterways program funds:

- Elements of the H2OK: Keeping our waterways healthy project, including The Leaf Collective
- Riparian restoration and soil conservation works
- Research and water quality monitoring projects
- Development of new modelling and reporting tools

Between 2023 and 2025, findings and lessons learned from these projects will be incorporated into catchment plans for Lake Tuggeranong, Lake Burley Griffin, Lake Ginninderra, Yerrabi pond, the Naas-Gudgenby River and possibly one other rural river. The catchment plans will outline options to

meet specific water quality targets or objectives for waterbodies. They will be developed with inputs from First Nations people and interested members of the community.

Priorities for Future Work

- Assessment of future climate impacts on water quality
- Work with NSW and MDBA to develop an upper Murrumbidgee River model in the Source platform under the integrated River Model Uplift project
- Work with MDBA to apply a risk-based approach to salinity reporting and implementation of the BSM Strategy
- Support the MDBA in the trial of responsive management to inform the BSM2030 strategy review in 2026.

Executive Summary: Australian Government's BSM2030 annual report 2022–23

The Australian Government did not provide a BSM2030 annual report for 2022–23.

Office locations – *First Nations Country*
Adelaide – *Kaurna Country*
Canberra – *Ngunnawal Country*
Goondiwindi – *Bigambul Country*
Griffith – *Wiradjuri Country*
Mildura – *Latji Latji Country*
Murray Bridge – *Ngarrindjeri Country*
Wodonga – *Dhudhuroa Country*

mdba.gov.au 1800 630 114 engagement@mdba.gov.au