South Australian River Murray Water for the Environment Report 2023-24

Government of South Australia

Department for Environment and Water

Acknowledgement of the Traditional Owners

The Department for Environment and Water acknowledges Traditional Owners of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respect to Aboriginal and Torres Strait Islander cultures and to Elders both past and present.

The First Nations of South Australia, the Aboriginal Traditional Owners, have occupied, enjoyed and managed their customary lands and waters since time immemorial and continue their deep cultural, social, environmental, spiritual and economic connection today. The Government of South Australia acknowledges and pays respect to the Traditional Owners and their Nations. The Government of South Australia also acknowledges and respects the rights, interests and obligations of Traditional Owners to speak and care for their Country – lands and waters – in accordance with their laws, customs, beliefs and traditions. In acknowledging this history and connection we also recognise the deep and irreversible damage and dislocation that Aboriginal and Torres Strait Islander people have experienced and continue to experience through European colonisation, settlement and displacement. Aboriginal Nations have advocated strongly for a healthier Murray–Darling Basin and just settlement of their land and water rights. This commitment led to a stronger Basin Plan for South Australians and asks us as a state government to better recognise Traditional Owner interests in our water resource management. The Department for Environment and Water seeks to enable partnerships with Aboriginal Nations built upon mutual respect and trust. We recognise the differences between Nations and their preferred approaches for engagement with Government and will work through these arrangements to support Traditional Owners to meet their customary rights and obligations in natural resource planning and implementation.

First Nations peoples should be aware that this publication may contain images of deceased persons or culturally sensitive material.

Acknowledgements

The South Australian River Murray Water for the Environment Report was prepared by staff in the Department for Environment and Water with contributions from the Murraylands and Riverland Landscape Board, Accolade Wines, Australian Landscape Trust and Renmark Irrigation Trust. A draft was provided to the Commonwealth Environmental Water Holder and The Living Murray Program, with their feedback improving the quality of the Report.

The following agencies and organisations are acknowledged for their important role in the management of water for the environment:

- Accolade Wines, Banrock Station
- Aquasave - Nature Glenelg Trust
- Australian Landscape Trust, Calperum Station
- Bio-R Oz
- BirdsSA
- Chowilla Community Reference Committee
- Commonwealth Environmental Water Holder
- Commonwealth Scientific and Industrial Research Organisation
- Coorong, Lower Lakes and Murray Mouth Community Advisory Panel
- Coorong, Lower Lakes and Murray Mouth Scientific Advisory Group
- First Peoples of the River Murray and Mallee Region
- Flinders University
- Gerard Country Ranger Team
- Investigator College
- Katarapko Community Advisory Panel
- Murray-Darling Basin Authority, including The Living Murray program
- Murraylands and Riverland Landscape Board
- New South Wales Department of Climate Change, Energy, the Environment and Water
- Ngarrindjeri Aboriginal Corporation
- Pike Community Reference Committee
- Raukkan Community Council
- Renmark Irrigation Trust
- River Murray and Mallee Aboriginal Corporation
- River Murray Channel and Floodplain Scientific Advisory Group
- SA Water
- South Australian Research and Development Institute
- The Conservation and Hunting Alliance of SA
- The University of Adelaide
- The Goolwa to Wellington Local Action Planning Association Inc.
- The Mannum Aboriginal Community Association Inc.
- The National Trust of SA (Overland Corner)
- The SA Regent Parrot Recovery Team
- Treasury Wine Estates
- Victorian Environmental Water Holder
- Wetland Habitats Trust

Cover image: Pied stilt (*Himantopus leucocephalus*) feeding at Lake Limbra, Chowilla Floodplain in June 2024. Credit: H Kieskamp.

Foreword

The 2023-24 water year was certainly unique. Following the largest flood experienced in the River Murray since 1956, and the high flows experienced over the preceding two years, the region had experienced extended inundation and the environmental benefits as a result were vast. The 2023-24 water year commenced with significant rainfall in the upper Murray in June 2023. This high rainfall extended unregulated flows to South Australia into late September 2023, taking the total duration of unregulated flow to 803 days (beginning July 2021). Importantly, 1,639 gigalitres of water for the environment was delivered to South Australia throughout the water year, with a large proportion delivered in spring through return flows from upstream watering actions and collaborative efforts with water holders. Further rainfall upstream led to two more unregulated flow events in October 2023 and January 2024, resulting in a total of 3,921 gigalitres of unregulated flows to South Australia in 2023-24 which supported environmental outcomes throughout the region and built on the benefits of the previous year's flood. Management actions in 2023-24 largely focused on maintaining and building on the benefits from the preceding year's flood.

Highlights of 2023-24 include:

- Prolonged elevated overbank and in-channel flows in spring, supporting the successful recruitment of flow-cued native fish
- Successful implementation of a Lake Victoria directed release in September and November, delivering approximately 95 gigalitres to maintain flow at the South Australian border above critical levels for estuarine conditions in the Coorong and to promote connectivity for native fish outcomes in the River channel
- A total of 5,187 gigalitres of water for the environment and unregulated flows was released from the barrages, contributing to salinity benefits in the Coorong
- A lowering of Lock 6 weir pool (outside of normal operating range) and the lowering of weir pools 1 to 5 (within normal operating range) to target improved velocity outcomes within the channel and to support drying of lower areas of the floodplain
- The reintroduction and persistence of Yarra pygmy perch to the Lower Lakes
- Management of over 60 permanent and ephemeral wetlands, providing important habitat for threatened species.

The management of water for the environment during periods of elevated flows is a significant focus area for the South Australian Government. Environmental water provides important opportunities to enhance flow and continue the recovery of the River Murray system in South Australia and across the Basin more broadly. Ongoing monitoring programs are essential for assessing the outcomes of the delivery of water for the environment. Monitoring results are fed back into the planning process and used to support future watering decisions as part of adaptive management.

Spiny flat-sedge and free-floating Lemna/Wolffia spp at Lake Limbra, Chowilla Floodplain. Credit: H Kieskamp.

Abbreviations

AHD	Australian Height Datum
AOO	Annual Operating Outlook
AWA	Aboriginal Waterway Assessment
BOM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CLLMM	Coorong, Lower Lakes and Murray Mouth. Also refers to the Lower Lakes, Coorong and Murray Mouth The Living Murray Icon Site.
DEW	Department for Environment and Water
EC	Electrical Conductivity
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
Flow-MER	CEWH's Monitoring, Evaluation and Research (Flow-MER) Program
GL	Gigalitres
HEW	Held Environmental Water
IPP	The Living Murray's Indigenous Partnerships Program
JAMBA	Japan-Australia Migratory Bird Agreement
MDBA	Murray–Darling Basin Authority
ML	Megalitre (a million litres)
NAC	Ngarrindjeri Aboriginal Corporation
NPW Act	*National Parks and Wildlife Act 1972*
QSA	Flow at the South Australian border
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RMIF	River Murray Increased Flow
SA River Murray LTWP	Long-Term Environmental Watering Plan for the South Australian River Murray
SCBEWC	Southern Connected Basin Environmental Watering Committee
TLM	The Living Murray Program
VEWH	Victorian Environmental Water Holder
YOY	Young of Year

River red gum seedlings at Brenda Park in July 2023. Credit: A Kriesl.

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Introduction and Purpose

The planning, delivery, monitoring, evaluation and reporting of water for the environment within the South Australian River Murray is coordinated by the Department for Environment and Water (DEW) in collaboration with First Nations, other government agencies, research organisations, non-government organisations and community groups.

The primary purpose of this report is to provide a complete and public record of all environmental watering actions, regardless of water holder or manager, undertaken in the South Australian River Murray region throughout the 2023-24 water year. The report is in addition to the reporting undertaken by DEW to meet the requirements of the Murray-Darling Basin Plan (Basin Plan). It also fulfils the South Australian Government's commitment to the Council of Australian Governments (COAG) to publish an annual report on the use of River Murray water for the environment in South Australia for public information sharing (National Water Initiative Policy Guidelines for Water Planning and Management; COAG, 2010).

Water for the environment delivered in 2023-24 was provided by a number of water holders including the South Australian Minister for Climate, Environment and Water, the Commonwealth Environmental Water Holder (CEWH), The Living Murray (TLM) program, the Victorian Environmental Water Holder (VEWH) and New South Wales Department of Climate Change, Energy, the Environment, and Water (NSW DCCEEW). Along with DEW, there are a number of other organisations also involved in delivering this water to sites located throughout the South Australian River Murray, particularly the Murraylands and Riverland Landscape Board, Renmark Irrigation Trust, Australian Landscape Trust and Accolade Wines.

Throughout this report, 'water for the environment' refers to *held environmental water*, which is water available under a water access right (e.g. water licence) for the purposes of achieving environmental outcomes. Environmental outcomes are also underpinned by *planned environmental water*, which is water protected via a plan or legislation, such as unregulated flows, that cannot be used for non-environmental purposes (unless in an emergency). Receiving planned environmental water is critically important to achieving environmental outcomes in South Australia. In 2023-24, a large volume of unregulated flow (planned environmental water) arrived in South Australia and supported environmental outcomes throughout the region.

This report provides a record of environmental watering activities along the South Australian River Murray during the 2023-24 water year and includes:

- an overview of river conditions in 2023-24
- a summary of the water for the environment actions undertaken, including sites and volumes
- key environmental observations and outcomes
- a list of reports that provide detailed information about monitoring and ecological outcomes.

Black-fronted dotterel (Charadrius melanops) at Little Hunchee wetland. Credit: C O'Brien.

Planning for Environmental Watering

The watering actions undertaken throughout the 2023-24 water year were identified in the 2023-24 Water for the Environment Annual Plan for the South Australian River Murray (2023-24 Annual Plan) (DEW, 2023) and guided by the Basin Annual Environmental Watering Priorities 2023-24 (MDBA, 2023), the Basin-Wide Environmental Watering Strategy (MDBA, 2019) and the Long-Term Environmental Watering Plan for the South Australian River Murray Water Resource Plan Area (DEW, 2020). These documents (available on the DEW website), together with site-based management plans, describe key ecological objectives and targets for environmental watering in South Australia.

The 2023-24 Annual Plan describes the planning process undertaken in the lead up to the water year. A scenario-based planning approach is used, which enables flexibility in the delivery of water for the environment depending on the flow conditions experienced. The scenarios used in planning for 2023-24 are shown in Figure 1.

All environmental water holders and site managers in the region were invited to participate in the planning process which benefits from the input of First Nations groups, scientific experts and community groups, including the Coorong, Lower Lakes and Murray Mouth (CLLMM) Community Advisory Panel, CLLMM Scientific Advisory Group, SA River Murray Channel and Floodplain Scientific Advisory Group, the Ngarrindjeri Aboriginal Corporation and the River Murray and Mallee Aboriginal Corporation.

The proposed watering actions were submitted to the MDBA Southern Connected Basin Environmental Watering Committee (SCBEWC) and the CEWH in early 2023 to inform decisions on the use of water for the environment in South Australia, as well as system-scale planning for the southern Murray-Darling Basin. Representatives from South Australia, as well as New South Wales, Victoria, the MDBA, the VEWH, the CEWH, Murray Lower Darling Rivers Indigenous Nations (MLDRIN) and the Commonwealth Government are members of SCBEWC[1].

Planning for Flexible Management

To facilitate the planning process, the MDBA provides annual operating outlooks (AOOs), which describe potential flow conditions under a range of climate scenarios (Figure 1). DEW and site managers plan for environmental watering actions based on these flow scenarios, as described in the 2023-24 Annual Plan (DEW, 2023). It should be noted that while these scenarios are useful for planning purposes, they are indicative only and may or may not reflect the conditions that occur.

Comparison of the actual flow to South Australia (without additional water for the environment) in 2023-24 indicates the 'moderate' and 'dry' planning scenarios were most representative of the conditions experienced throughout most of the water year (see dashed line in Figure 1).

More information on the actions planned for the 'moderate' and 'dry' scenarios, and an indication of which of these were achieved, is shown in Appendix A.

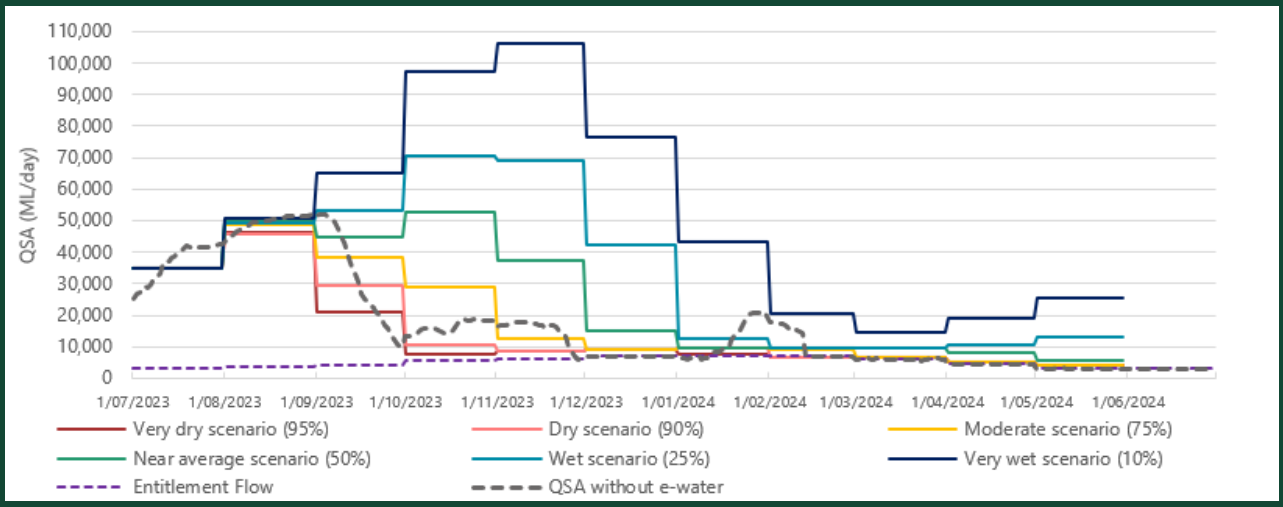


Figure 1. Actual flows to South Australia (QSA) in 2023-24 without water for the environment compared to planning scenarios.

[1] For more information regarding SCBEWC, refer to their annual reports.

Overview of Flow Conditions in 2023-24

Moderate conditions

2022-23: Very Wet
2021-22: Wet

7,453 GL total flow across the South Australian border

2022-23: 23,085 GL
2021-22: 9,134 GL

The 2023-24 water year saw warm and wet climatic conditions across the Murray-Darling Basin (BOM, 2024), following very wet conditions in 2022-23. Temperatures were generally very much above average across the Basin, with the highest on record experienced in isolated areas of the northern Basin (Figure 2). Rainfall was generally average across the Basin but highly variable, with some areas of the northern and southern Basin experiencing very much above average rainfall, and small areas in the southern Basin experiencing lowest on record (Figure 2). Overall, Basin inflows in 2023-24 were greater than the long-term median, although unsurprisingly less than half the volume recorded in 2022-23 (MDBA, 2024).

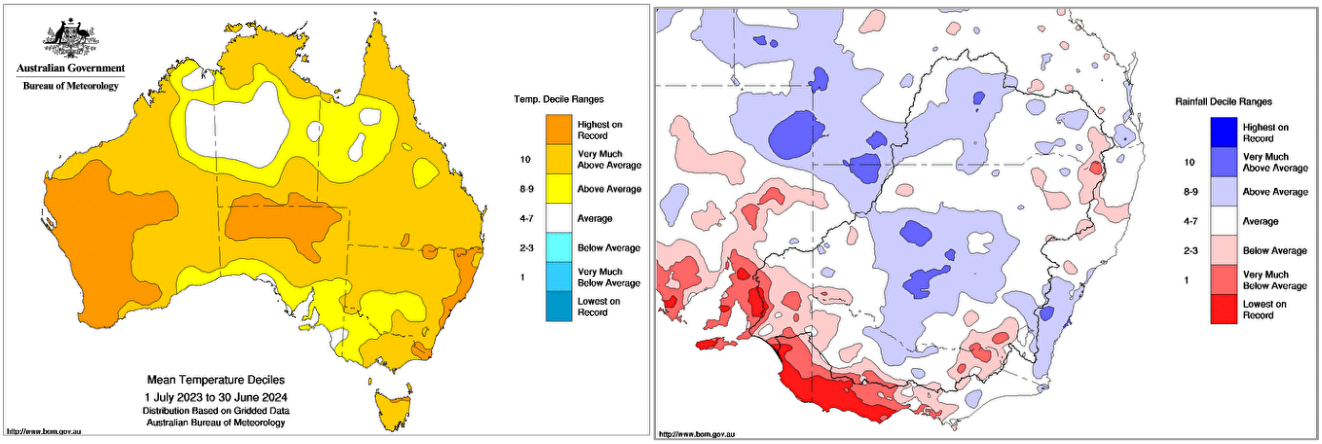


Figure 2. Australian mean temperature deciles (top) and Murray-Darling Basin rainfall deciles (bottom) 1 July 2023 to 30 June 2024. Source: Bureau of Meteorology.

Significant rainfall was experienced in the upper Murray in June 2023 which prolonged the delivery of unregulated flows to the South Australian border into the 2023-24 water year. Unregulated flows eventually ceased on 26 September 2023, for the first time since July 2021 (MDBA, 2024). However, this was short lived, as high rainfall across the upper Murray catchments in early October 2023 resulted in unregulated flows being declared again at the South Australian border from 11 October to 22 November 2023. Multiple rainfall events along the Murray in early January 2024 also resulted in another unregulated flow event being declared from 13 January to 12 February 2024.

Flows to South Australia remained above 20,000 megalitres per day (ML/d) for 166 days of the year (MDBA, 2024), including during the critical spring period. Flows exceeded 40,000 ML/d for much of the winter period and into spring, peaking on 4 September 2023 at 53,000 ML/day at the South Australian border (Figure 3).

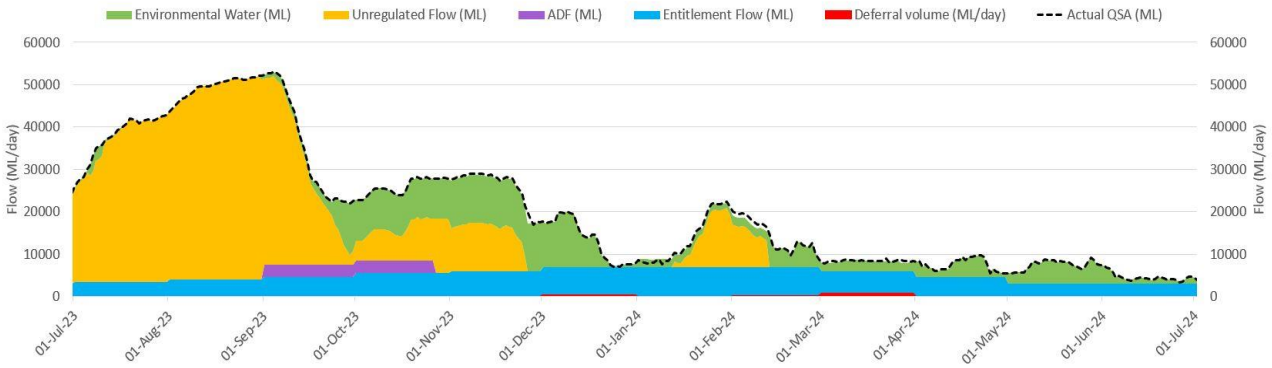


Figure 3. River Murray flows at the South Australian border (QSA) in megalitres per day (ML/day) during 2023-24.

Environmental Water Delivery

1,639 GL water for the environment

3,921 GL unregulated flow over 7 months

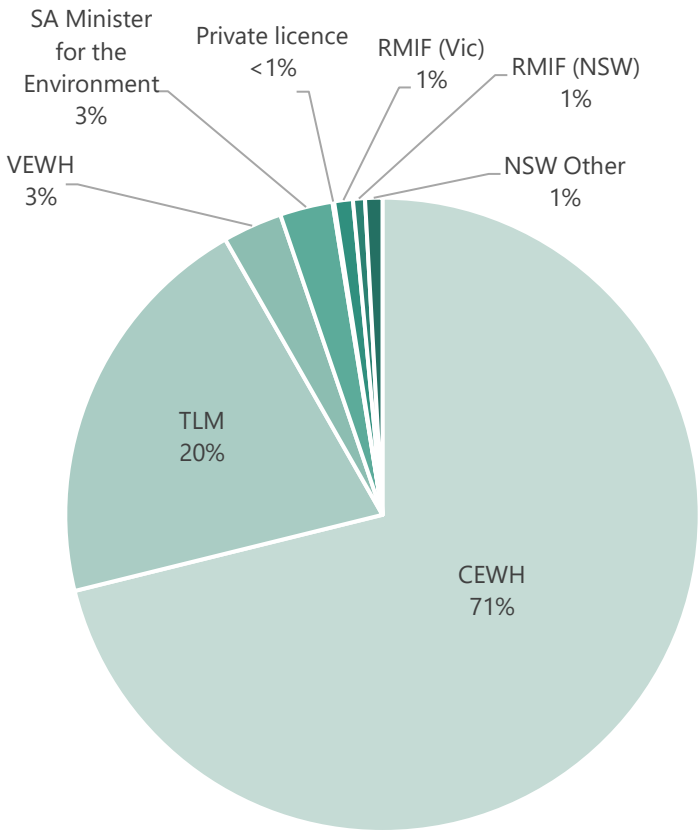
5,187 GL released out the barrages

7 GL pumped to wetlands and floodplains

3 managed floodplains underwent drying phases

6 weirs on the main channel manipulated

In total, approximately 1,639 GL of water for the environment was delivered to South Australia (Figure 4). The CEWH provided approximately 1,166 GL (including approximately 162 GL held on licences in South Australia) and TLM provided approximately 338 GL (including 45 GL held on licences in South Australia). South Australia also received approximately 90 GL of water for the environment in the form of VEWH, NSW DCCEEW and River Murray Increased Flow (RMIF) return flows from upstream environmental watering actions. Approximately 44 GL of water for the environment held in South Australia by the South Australian Minister for Climate, Environment and Water was also delivered. Environmental watering actions were also supported by a small volume of water for the environment held on a private licence and approximately 14 GL of consumptive water that was used for environmental outcomes in 2023-24 (Appendix B).



The majority of water for the environment (~1,594 GL or 98%) delivered to South Australia made its way along the length of the South Australian River Murray to the Lower Lakes and Coorong, providing ecological and water quality benefits throughout the system. The remaining 2% (38 GL) of managed environmental watering actions was shared between 60+ wetlands. A small number of wetlands were also managed using unregulated flows (Appendix B).

Figure 4. Proportion of water for the environment delivered to SA that was contributed by each water holder in 2023-24:

- *CEWH = Commonwealth Environmental Water Holder*
- *TLM = The Living Murray Program*
- *SA = SA Minister for Climate, Environment and Water*
- *VEWH = Victorian Environmental Water Holder*
- *RMIF = River Murray Increased Flow*
- *Private licence*
- *NSW Other*

*Poached egg daisy (*Polycalymma stuartii*) at Chowilla Floodplain. Credit: H Kieskamp.*

Outcomes of Water Delivery

To understand the ecological outcomes of the watering events undertaken within the South Australian River Murray, various monitoring programs have been implemented. Monitoring programs vary from a whole-of-Basin scale, such as CEWH's Monitoring, Evaluation and Research (Flow-MER) Program, to landscape scale such as the TLM Program condition and intervention monitoring, and to smaller site-scale programs funded variously by federal and state governments, and the Murraylands and Riverland Landscape Board.

The following section provides a summary of outcomes observed at key watering sites and the water for the environment and unregulated flows that supported these outcomes.

Southern bell frog (Litoria raniformis; Vulnerable under the EPBC Act 1999) at Chowilla Floodplain. Credit: H Kieskamp.

South Australian River Murray Channel and Floodplain

Several environmental watering events occurred across the South Australian River Murray Channel and Floodplain in 2023-24 including pumping to priority wetlands, lowering weir pools within normal operating ranges (Weir 6 was lowered below normal operating range) and optimising within channel flows at the floodplain anabranches. Floodplain regulator operations and weir pool raising were not pursued in 2023-24 due to the need for drying phases following the 2022-23 flood event. The outcomes of these watering actions, including the drying phases, are summarised in this section.

River Murray Channel Flows

Specific Ecological Objectives:

- Increase the availability of habitat with moderate-fast flowing water, particularly in spring
- Protect Murray cod habitat during their breeding season and support survival of larvae
- Promote successful breeding and survival of golden perch and silver perch larvae
- Vary water levels below the weirs to freshen groundwater and support native plant growth
- Reduce the rate of flow recession to ensure a better ecological response from sustained watering

Outcomes:

5,574,519 ML delivered (3,921,023 ML of this was unregulated flows)

>12,000 ha of floodplain watered

Site Water Manager: DEW

Source of water: CEWH, TLM, Vic RMIF, VEWH, NSW, SA Minister, unregulated flows

The 2023-24 water year commenced with unregulated flows declared at the South Australian border and flows peaking early in the year at ~53,000 ML/day on 4 September, inundating 12,000 hectares (ha) of the South Australian River Murray Channel and Floodplain. Following consultation with ecologists and scientific experts, the addition of water for the environment to the peak to inundate larger areas of floodplain was not pursued. The extensive and prolonged recent inundation, continued positive vegetation responses post-flood recession, the need for some areas of the floodplain to undergo further drying, and the potential negative effects of rewetting recently extensively flooded vegetation were the main factors influencing the decision to not boost flows in winter.

Water for the environment was delivered in late September 2023 via a directed release from Lake Victoria to slow the recession after the peak and maintain flows above 20,000 ML/day. Shortly following this, on 29 September 2023, unregulated flows ceased at the South Australian border, after a total of 803 days, which also resulted in a cessation of the directed release. This was short lived however, as unregulated flows re-commenced on 11 October 2023 for a further 43 days due to high rainfall in the upstream states. Throughout October to December 2023, water for the environment continued to be delivered via return flows from upstream watering actions and releases from Lake Victoria to maintain flows above 20,000 ML/day for velocity and fish outcomes. This included the successful delivery of water from Lake Victoria in early December 2023 in addition to return flows from upstream, which made it possible to maintain close to 20,000 ML/day under regulated conditions for approximately 14 days.

Preliminary results from the CEWH's FlowMER program show successful recruitment by golden perch (*Macquaria ambigua*) and silver perch (*Bidyanus bidyanus;* Endangered under the *EPBC Act 1999*) in 2023-24. These fish appear to have been spawned in the Lower Murray and mid-Murray, with golden perch spawning in early-mid November coinciding with flow to South Australia between 25,000 to 35,000 ML/day as a result of the unregulated flows, directed release from Lake Victoria, and return flows from upstream watering actions in the Murray, Goulburn and Murrumbidgee (Ye, et al., in prep.).

The remainder of the year saw water for the environment delivered to South Australia to elevate flows above entitlement primarily for CLLMM outcomes, with the exception of another small unregulated flow from late January to early February 2024, which resulted in a small peak of 22,428 ML/day. Many areas of floodplain have benefitted from a drying phase in 2023-24, with some experiencing lush understorey growth followed by the establishment of eucalypt seedlings.

Lush understorey at Plush's Bend

Following the 2022-23 flood and extended high flows experienced along the South Australian River Murray Channel and Floodplain from 2021 to 2023, many areas had been inundated for an unusually extended amount of time. As a result, vegetation, especially in littoral areas along the channel and lower lying areas of the floodplain, were beginning to show signs of stress and required a period of drying.

Following the flow peak in early spring 2023, flows at the South Australian border throughout summer averaged ~14,000 ML/day, which provided the River Murray Channel riparian edges and lower Floodplain a chance to dry out. Lush understorey vegetation quickly dominated the bare sediment that had been inundated during higher flows. This was followed by the establishment of stands of eucalypt seedlings in many areas.

Photographs taken at Plush's Bend, located ~5km downstream of Lock 5, provide an example of the the shift in vegetation condition post-flood and the benefits of a drying phase.

Top photo: Plush's Bend in October 2023 post-flood during spring water delivery when flows at the South Australian border were ~26,000 ML/day.

Middle photo: Lush understorey at Plush's Bend in February 2024 when flows at the South Australian border were ~18,000 ML/day.

Bottom photo: Abundant eucalypt seedlings at Plush's Bend in July 2024 when flows at the South Australian border were ~4,300 ML/day.

Chowilla Floodplain

3,975 ML delivered March – May 2024

360 ha watered

Site Water Manager: DEW

Source of water: TLM

Specific Ecological Objectives:

- Maintain and improve the condition of long-lived vegetation (i.e. river red gum, black box, river cooba and lignum)
- Support the ongoing growth of seedlings and saplings
- Optimising flow conditions by reinstating hydrodynamic diversity and lotic conditions
- Provide breeding refuge habitat for waterbirds, frogs and other biota
- Improve local soil moisture and support growth of understorey and aquatic vegetation
- Maintain or improve the diversity and abundance of key waterbird species

Outcomes:

The 2023-24 water year started with the majority of the large lakes and wetlands at Chowilla still holding some water post-flood. As flow increased in August and September 2023, low lying areas of the floodplain were inundated and most of the lakes and wetlands reconnected. The flow receded quickly in spring, and most sites were dry or nearly dry by late summer.

Between March and May 2024, 3,975 ML of water for the environment was delivered to Lake Limbra via pumping, inundating 360 ha. The objective of this water delivery was to provide habitat and food resources for waterbirds which were abundant during the summer surveys. The water also benefited fringing black box (*Eucalyptus largiflorens*) woodlands including large numbers of black box seedlings, along with sedges and other flood-responding vegetation.

At the five pool connected wetlands at Chowilla, a drying cycle was initiated in early summer 2023 as they had experienced an extended period of inundation during the preceding wetter years. This drying cycle aimed to achieve multiple ecological outcomes, including providing a dry period for river red gums (*Eucalyptus camaldulensis*), consolidating sediment in the wetland beds and removing concentrated populations of large common carp (*Cyprinus carpio*).

Waterbird abundances boomed within the large ephemeral Chowilla lakes as water levels drew down following the flood and were topped up by >50,000 ML/d flows, providing additional food and habitat resources. Coombool Swamp, which retained a large amount of water post-flood (but was not topped up during subsequent flows), provided a particularly fertile foraging ground for a huge variety and abundance of waterbirds. Surveys detected thousands of waterbirds in July and October 2023, and up to ~9,700 waterbirds were counted during December 2023. Several waterbird species utilised the large ephemeral lakes on Chowilla during 2023-24: 10 species of duck, including the state Rare (*NPW Act 1972*) Australasian shoveler (*Spatula rhynchotis*) and freckled duck (*Stictonetta naevosa)*; large waders including spoonbill, ibis,

Waterbirds at Gum Flat, Chowilla Floodplain. Credit: H Kieskamp.

egrets and herons; five species of migratory waders; medium sized waders; as well as a variety of terns, hens, lapwings, coots, kites, swans, gulls, grebes, plovers, cormorants, and more. Other highlights included >10 Baillon's crake (*Porzana pusilla*) and larger numbers of Australian spotted crake (*Porzana fluminea)* at Lake Littra, and several sightings of immature, white-bellied sea-eagles (*Haliaeetus leucogaster*; Endangered under the *NPW Act 1972*).

Waterbird monitoring was also undertaken during the environmental watering action at Lake Limbra. A total of 34 species were observed foraging in the shallow flats, inundated fringing sedges and deeper areas of the lake. Over 2,500 birds were consistently recorded during surveys, comprising deep-diving grebes, ducks and cormorants, large and small waders and fringe-dwelling species. All species of duck expected in the region utilised the lake, including four threatened species; the freckled duck, musk duck (*Bizuira lobata menziesi;* Rare under the *NPW Act 1972*), blue-billed duck (*Oxyura australis;* Rare under the *NPW Act* 1972) and Australasian shoveler.

Vegetation around the lake also benefited from the watering, with flowering mature black box trees, rewatering of flood germinants, and fresh, green lignum (*Muelenbeckia florulenta*) growth across the southern section. A dense band of native sedges emerged around the lake's edge, with other flood-responding grasses and forbs among them. Aquatic flora also emerged, with tiny free-floating species present in shallow water.

Bush bird refuge at Chowilla

Several threatened terrestrial bird species were observed utilising the abundant resources at Chowilla during spring, summer and autumn surveys, including the State Rare (*NPW Act 1972*) Little Friarbird (*Philemon citreogularis citreogularis*), Blue-faced Honeyeater (*Entomyzon cyanotis cyanotis*), Striped Honeyeater (*Plectorhyncha lanceolata*), Restless Flycatcher (*Myiagra inquieta*), and Peregrine Falcon (*Falco peregrinus macropus*). In addition, EPBC listed species were recorded, including the Endangered Pink Cockatoo (*Lophochroa leadbeateri leadbeateri*), and the Vulnerable Southern Whiteface (*Aphelocephala leucopsis*).

Restless flycatcher (*Myiagra inquieta*; Rare under the *NPW Act 1972*) at Chowilla Floodplain. Credit: H Kieskamp.

Throughout Chowilla, the good floodplain conditions typified by healthy flowering trees, emergent vegetation and abundant insect life provided a variety of feeding and breeding habitats for terrestrial birds. Surveys recorded more than 60 species, which is particularly high compared with previous years. Evidence of breeding on the floodplain included bluebonnets observed feeding young, and numerous young mobs of emus. Overall, species abundances and diversity were high on the floodplain with good conditions post-flood and subsequent high flows supporting an array of resources.

Fish surveys at the large ephemeral lakes found that generally total catches were lower compared with the previous two years. Despite this, moderate abundances of small-bodied fish were captured at all sites, with carp gudgeons the most abundant among native species.

Introduced species comprised around half of catch biomass and included common carp, goldfish (*Carassius auratus*) and oriental weatherloach (*Misgurnus anguillicaudatus*). However, common carp young-of-year were scarce, with most captured individuals measuring >10cm. Overall common carp abundances were also significantly lower compared to previous years. Goldfish abundances were higher than common carp at many sites, whilst oriental weatherloaches were in high abundances at Lake Littra.

Frogs appear to have had a very minimal breeding response at Chowilla in 2023-24, after major breeding in the previous two years. Some frog calling was detected in early spring, but overall call activity was low and decreased through spring. A total of six species of frog were identified in 2023-24 including the southern bell frog (*Litoria raniformis*; Vulnerable under the *EPBC Act 1999*).

Pike Floodplain

Management of all floodplain regulators within normal operating range to optimise flow

Increased abundances of Murray cod

Site Water Manager: DEW

Specific Ecological Objectives:

- Maintain and improve the condition of long-lived vegetation (i.e. river red gum and lignum)
- Provide diverse hydraulic conditions and complex habitats for flow dependent biota and processes
- Maintain water quality to support aquatic biota and normal biogeochemical processes
- Provide habitat conducive to supporting communities of riparian frogs
- Restore and maintain resilient populations for large-bodied native fish
- Establish and maintain a diverse plant community comprised of native flood-dependent and/or amphibious species

Outcomes:

Management actions at Pike Floodplain in 2023-24 focussed on supporting in-stream habitat under all water availability scenarios. The Pike Floodplain inlet and outlet regulators were managed within their normal operating range to optimise habitat for flow-dependent fauna and to protect water quality. This included fully opening minor regulators to connect Mundic Creek to the River Murray to support lateral connectivity when flows exceeded 40,000 ML/day in late July to August 2023.

The ecological condition monitoring data from Pike Floodplain indicated that there was no need to undertake managed inundation in 2023-24, because areas of the floodplain that could be influenced by operation of the environmental regulators were either meeting ecological targets or were likely to benefit from a drying phase. Temporary wetlands were still holding water and vegetation on the shedding floodplain was still responding to the 2022-23 flood. Understorey plants at low elevations were still completing their lifecycle, and there were small tree seedlings that could have been overtopped by a rise in water levels. Data from Autumn 2023 showed that tree condition continued to improve in response to the flood. Furthermore, groundwater levels were still receding from flood levels.

At higher elevations on the floodplain, eucalypt seedlings and some stands of floodplain trees could have benefitted from follow-up watering to improve their condition and resilience. However, spatial assessments indicated that the majority of those locations would be beyond the influence of the environmental regulators.

*Emus (*Dromaious novaehollandiae*) spotted at Pike Floodplain in November 2023. Credit: S Walters.*

Environmental Water Planning at Pike

A key factor in planning for a dry phase at Pike floodplain in 2023 was to avoid re-inundating native understorey plants in lower-lying locations that had not had time to emerge and complete their lifecycle after the flood recession. Monitoring results showed drying was beneficial, with the diversity of amphibious and flood-dependent species in temporary wetlands increasing between the 2023 and early 2024 surveys (Walters, 2024).

*Jerry jerry (*Ammania multiflora*) and other floodplain and amphibious species at Pike Floodplain. Credit: S Walters.*

Prolonged submergence of lignum was considered to have led to a decline in condition at some survey sites in early 2023 (Walters, 2024), and was another indicator informing the decision to not deliver environmental water to Pike Floodplain in 2023. Monitoring data subsequently showed that lignum condition improved over 2023 following a drying phase, with 77% of plants being assessed as in good condition in the early 2024 surveys (Walters, 2024).

Overall, black box tree condition had improved between autumn 2023 and 2024 and all of the river red gum transects met the ecological target for crown condition in 2024 (Wallace, 2024). Although there was an overall improvement in the condition of viable trees at floodplain scale, some tree death was recorded (Wallace, 2024).

Thirty-eight species of waterbird were recorded at Pike Floodplain from spring 2023 to autumn 2024 (Kieskamp, 2024). At the time of these surveys, wetlands still retained water from the flood and provided productive foraging mudflats. Furthermore, stands of lignum and the understorey plant community were in good condition providing diverse food resources and habitat. With the contraction of floodwaters, birdlife was no longer dispersed over a large area, resulting in some large numbers of birds congregating in refuge habitat such as Snake Wetland and Lagoon. Snake Wetland and Lagoon hosted a number of rare species (*National Parks and Wildlife Act, 1972*), including great crested grebe during summer, Australasian shovelers during summer and autumn, and musk ducks during autumn only (Kieskamp, 2024). Australian shelduck (*Tadorna tadornoides*), yellow-billed spoonbill (*Platalea flavipes*) and black-fronted dotterel (*Elseyornis melanops*) were observed breeding at Pike during spring (Kieskamp, 2024).

Woodland bird diversity reduced slightly, at 63 species, compared with the previous year, when 68 species were recorded. Observations of nesting or adult birds with dependent young, included wedge-tailed eagles (*Aquila audax*), grey butcherbirds (*Cracticus orquatus*), and dusky woodswallows (*Artamus cyanopterus*) (Kieskamp, 2024).

*A rainbow bee-eater (*Merops ornatus*) at Mundic Creek. Credit: S Walters.*

All riparian frog species typically recorded at Pike floodplain were detected in spring 2023. However, the highest activity was recorded early in the season, with calls declining through spring concurrent with cooler spells of weather and reducing water levels (Walters, 2023). This translated to very low detections of tadpoles for 2023.

A total of 2,960 fish were captured comprising 11 species (8 native and 3 non-native) in autumn 2024 condition monitoring. The most abundant native species was bony herring (*Nematalosa erebi*) at 58% of the catch, and the most abundant non-native species was common carp at 20% of the catch (Fredberg & Bice, 2024). Two species of conservation significance; Murray cod (*Maccullochella peelii*; Vulnerable under the *EPBC Act 1999*) and freshwater catfish (*Tandanus tandanus;* Protected under the *South Australian Fisheries Management Act 2007*) were sampled (Fredberg & Bice, 2024). Murray cod abundance has exhibited a positive trajectory from 2020–2022, and after suffering a slight decrease in 2023, their abundance improved again in 2024 (Fredberg & Bice, 2024).

Katarapko Floodplain

Management of Bank J floodplain regulator within normal operating range to optimise flow

2 fish species of conservation significance were sampled

Site Water Manager: DEW

Specific Ecological Objectives:

- Maintain and improve the condition of long-lived vegetation (i.e. river red gum, river cooba and lignum)
- Provide diverse hydraulic conditions and complex habitats for flow dependent biota and processes
- Improve local soil moisture and support growth of understorey and aquatic vegetation
- Provide habitat to support riparian frogs, native reptiles, mammals and woodland birds
- Restore and maintain resilient populations for large-bodied native fish and foraging generalists

Outcomes:

Similar to the Pike Floodplain, management actions at Katarapko Floodplain in 2023-24 focussed on supporting in-stream habitat under all water availability scenarios. Flows were maximised through Bank J to promote velocity within Eckerts Creek for flow dependent fauna in the anabranch.

The ecological condition monitoring data from Katarapko Floodplain indicated that environmental regulator operation was not required in 2023-24 due to the residual benefits of the 2022-23 flood event and extended periods of higher flows in early 2023-24. Elevated groundwater levels as a result of prolonged inundation were beginning to recede but had still not returned to pre-flood levels. Continuing to draw saline groundwater down outside of the root zone was one reason not to operate the floodplain regulators. Additionally, some low-lying vegetation was showing signs of stress as a result of prolonged inundation. For example, low-lying lignum sites had dropped in condition following spending several months underwater. Conversely, understorey condition monitoring sites showed a strong response to the flood with a high diversity of plant species, including six species of conservation significance. Letting understorey species set seed and complete a full life cycle was another driver for not undertaking any floodplain operations in 2023-24.

Tree condition monitoring continued to show an improvement as a result of the flood, particularly black box woodlands, including many areas at elevations beyond the reach of the floodplain infrastructure and environmental water.

Post-flood understorey vegetation response at Katarapko Floodplain. Credit: R Walsh.

Bird surveys undertaken in 2023-24 recorded 68 species of terrestrial birds utilising the Katarapko Floodplain. This was slightly lower than the preceding year, however 2022-23 was an exceptional year with the flood bringing additional species to the floodplain (72 species). Nevertheless, species diversity still remained much higher than the pre-flood year of 2021-22 (53 species). Monitoring observations in 2023-24 include 4 species regarded as uncommon or rare; Gilbert's whistler (*Pachycephala inornate:* Rare under the *NPW Act 1972*), regent parrot (*Polytelis anthopeplus*

monarchoides; Vulnerable under the *NPW Act 1972*), the south-eastern subspecies of the hooded robin (*Melanodryas cucullate cucullate*; Rare under the *NPW Act 1972*), and the nomadic diamond dove (*Geopelia cuneata*).

Twenty-nine species of waterbirds were also recorded at Katarapko in 2023-24, with many of these benefiting from the mudflats exposed by the receding floodwaters. Breeding of nankeen night heron (*Nycticorax caledonicus*) and Australasian darter (*Anhinga novaehollandiae novaehollandiae*; Rare under the *NPW Act 1972*) was recorded around Ngak Indau wetland.

Annual fish condition monitoring captured 1,956 individual fish comprising 11 species (8 native and 3 non-native). The most abundant native species were bony herring, and the most abundant non-native species were common carp. Two species of conservation significance were sampled: Murray cod and silver perch
(Fredberg & Bice, 2024).

Small-bodied fish sampling was conducted in the shallow margins of the Katarapko Floodplain. Native species comprised 81% of the catch, including carp gudgeon, unspecked hardyhead (*Crateocephalus fulvus*), Australian smelt (*Retropinna semoni*), Murray-Darling rainbowfish (*Melanotaenia fluviatalis*) and golden perch. Eastern gambusia (*Gambusia holbrooki*) and common carp were the main introduced species caught, although common carp numbers were far lower than the previous year.

Floodplain flora flourishes post-flood

The strong positive response in river red gum, black box and river cooba (*Acacia stenophylla*) tree condition following the 2022-23 flood was maintained into 2023-24 with tree condition sites all receiving similar scores to the previous year. There was a small increase in the number of black box sites that met the ecological target. However, a small number of tree deaths was also recorded with some uncertainty of the cause, although saline groundwater movement during flooding may have contributed.

Young eucalypt seedlings that germinated post-flood emerging from the understorey at Katarapko Floodplain. Credit: B Ibbotson.

Weirs 1, 2, 3, 4, 5 and 6 Reach

5 weirs lowered within normal operating ranges (Lock 6 was lowered outside of normal operating range)

424 ha exposed

Site Water Manager: DEW

Specific Ecological Objectives:

- Use weir pool manipulation and wetland management to support wetland drying regimes
- Support hydraulic diversity and lotic conditions (>0.2 m/s) across the whole weir pool during a spring pulse
- Reduce the proportion of the weir reach with slow/still water to reduce the risk of algal blooms
- Export salt from the floodplain to the channel (and ultimately out the Murray Mouth) resulting in freshening of groundwater
- Drying and consolidating sediments inundated during the 2022-23 flood
- Export elevated groundwater from the floodplain to the River following the 2022-23 flood

Outcomes:

During the spring pulse in October and December 2023, when flows were >20,000 ML/day, weirs 1 to 5 were lowered within normal operating range and weir 6 underwent a lowering outside of normal operating range. Weirs 1, 2 and 3 were lowered by 0.10 m, 0.08 m and 0.03 m, respectively, with 1 and 2 maintaining this height for 57 days and Weir 3 for 61 days. Weirs 4 and 5 were lowered by 0.04 m and 0.10 m respectively and maintained at this height for 57 days. Weir 6 was lowered outside of normal operating range, to 0.16 m for 41 days for the second time, to support the drying of the floodplain following the 2022-23 flood.

The lowering events exposed an additional 424 ha of riparian fringe and wetlands and contributed to the drying of the floodplain after the significant period of inundation experienced during the 2022-23 flood. Lowering weirs also supported the recruitment of many young seedlings on the floodplain and reduced wetland habitat for the introduced common carp, which were observed in very large numbers during the flood. Monitoring results showed very few juvenile common carp were captured at wetland sites in 2023-24.

Tadpole surveys at Devlins Pound in November 2023. Credit: C O'Brien.

Waterbirds were monitored at 29 sites in all 6 weir pools, over an area of 1,224 ha. These sites supported approximately 6,167 waterbirds, including 43 different species. Of these 43 species recorded, observations of endangered and rare species including the Australasian bittern (*Botaurus poiciloptilus;* Endangered under the *NPW Act 1972*), the musk duck, Australasian darter, intermediate egret (*Ardea intermedia plumifera*: Rare under the *NPW Act 1972*), great crested grebe (*Podiceps cristatus australis*: Rare under the *NPW Act 1972*), and spotless crake (*Zapornia tabuensis tabuensis*: Rare under the *NPW Act 1972*) were made. In addition, the common greenshank (*Tringa nebularia*; Endangered under the *EPBC Act 1999*) and sharp-tailed sandpiper (*Calidris acuminata*; Vulnerable under the *EPBC Act 1999*) were observed, as well as two other listed migratory birds (*EPBC Act 1999*) including the caspian tern (*Hydroprogne caspia*) and crested tern (*Thalasseus bergii*).

Across all weir pools, the health of river red gum and black box trees improved slightly, with no tree loss recorded. Although in low numbers, 7 species of frogs were heard calling at the majority of the 23 monitoring sites, including the nationally threatened southern bell frog at one site. Tadpoles were captured in very low numbers at 4 of 17 sites surveyed.

Great crested tern adult feeding its juvenile at Namoi wetland in October 2023. Credit: C O'Brien.

Martins Bend wetland refilling in March 2024. Credit: A Kriesl.

Wetlands

39,687 ML used
467 ML of this was unregulated flows

66 wetland sites managed

The delivery of water for the environment and management of wetland sites along the South Australian River Murray was facilitated by various organisations and water holders, including the Murraylands and Riverland Landscape Board, DEW, Accolade Wines, Renmark Irrigation Trust and Australian Landscape Trust. A full list of the wetland sites watered in 2023-24 is presented in Appendix C and D. This section outlines the ecological outcomes observed during the delivery of water to both managed pool-connected wetlands and ephemeral wetlands in 2023-24.

Pool-connected Wetlands

32,784 ML used[1]

Site Water Managers: DEW, Murraylands and Riverland Landscape Board, Accolade Wines, Australian Landscape Trust

In 2023-24, 52 pool-connected wetlands across 40 wetland complexes were managed by various organisations, including DEW, the Murraylands and Riverland Landscape Board, Accolade Wines, and Australian Landscape Trust.

Wetland infrastructure was managed to increase water level variability, including undertaking partial or complete dry phases at wetland sites. Following the 2022-23 flood, a number of pool-connected wetlands were closed to initiate drying phases to remove carp, consolidate sediments and promote growth of fringing vegetation. After the long period of saturated soils, drying phases also contributed to improved river red gum condition, observed as reduced yellowing and increased canopy growth, by drying sediments for short periods and oxygenating the upper root zone. Germination of floodplain eucalypts following the flood was prolific in some areas, and these saplings continue to survive in many areas, most notably at Loveday/Mussels Complex where dense clusters of saplings now stand. Options are being investigated as to how these stands can be supported with future water management.

A noticeable yellowing of lignum shrublands and river red gum seedlings was observed at several sites lower down the elevation gradient of the floodplain. It is uncertain if this was due to prolonged flooding, a potential redistribution of salts within the unsaturated zone or both. Conversely, black box located higher on the floodplain showed significant recovery following the flood and substantial canopy growth, most notably at Beldora, Pyap and Morgan.

Native sedges and herbs colonised the wetland fringes with the receding water levels. Three-corner rush favoured the drying wetland bed at Martins Bend, and spiny flat sedge (*Cyperus gymnocaulos*) that were sitting dormant on the fringes of Brenda Park wetland had significant growth. Wetlands refilled following a drying phase in 2023-24 provided vegetated areas that were ideal shelter for breeding frogs, e.g. Martin's Bend where six species, including the nationally vulnerable southern bell frog, were heard calling from inundated three-corner rushes.

Following the drying and wetting phases at Hart and Ramco Lagoons, high abundances of waterbirds were also regularly sighted foraging on aquatic plants and algae that germinated following the removal of carp. Black swans (*Cygnus atratus*) often dominated the counts and many dabbling duck species, including the Australasian shoveler were also observed.

[1] This volume included 12 ML of privately held All Purpose Consumptive (Class 8) water for Paiwalla wetland, 1,232 ML of All Purpose Consumptive (Class 3) water held by the SA Minister for Climate, Environment and Water for Loveday Basins (North and South) and 314 ML of privately held All Purpose Consumptive water held by Accolade Wines for Banrock Station.

Martin's Bend wetland filling in March 2024. Credit: A Kriesl.

Ephemeral Wetlands

6,903 ML delivered[2,3] (467 ML of this was unregulated flows)

Site Water Managers: DEW, Murraylands and Riverland Landscape Board, Australian Landscape Trust, Renmark Irrigation Trust

Source of water: SA, CEWH, TLM, unregulated flows

In 2023-24, 14 ephemeral wetlands[2] received water for the environment, including 1 wetland in the Lower Lakes region. Management of ephemeral wetlands was undertaken by 4 organisations; DEW, the Murraylands and Riverland Landscape Board, Renmark Irrigation Trust and Australian Landscape Trust. Below is a summary of the key ecological outcomes observed by each organisation at their ephemeral wetland sites.

Murraylands and Riverland Landscape Board

Water for the environment was delivered via pumping or gravity to a total of 9 ephemeral wetlands managed by the Murraylands and Riverland Landscape Board in 2023-24, inundating 505 hectares.

Monitoring observations and survey data showed wetlands responded variably to the drier conditions following the 2022-23 flood and subsequent unregulated flows. A record-breaking dry autumn and elevated groundwater and soil salinity likely contributed to the rapid decline in tree health in several wetlands including Molo Flat and Murbpook, while other wetlands retained floodwater for long periods. In some instances, poor tree health, particularly in dense stands of younger trees, was a result of the impacts of prolonged inundation. The key objective for sites where marked decline in tree health was observed was to prevent loss of long-lived vegetation.

The threatened species that were supported at environmental watering sites include the state Rare (*NPW Act 1972*) spiny lignum (*Muehlenbeckia horrida*), often seen in large patches, and the nationally threatened southern bell frog, in particular at Overland Corner Lignum Basin, where successful recruitment to juvenile frog stage was detected. Regent parrots were also supported at a number of sites where watered wetland areas were within or directly adjacent to nesting tree zones, or within significant flyaways and loafing areas. Water for the environment delivered at Berri Evaporation Basin supported nationally threatened Murray hardyhead (*Craterocephalus fluviatilis*; Endangered under the *EPBC Act 1999*), with approximately 20 fish captured during fish surveys in good pre-breeding condition. Carp and salinity management following the 2022-23 flood resulted in the establishment of extensive salt-tolerant aquatic plant growth and clear water within ideal salinity thresholds for the Murray hardyhead. Increased diversity and extent of aquatic, emergent and fringing vegetation was also observed at Overland Corner following watering.

Regent parrot at Murbpook Lagoon. Credit: A Kriesl.

[2] This number and volume is inclusive of Berri Evaporation Basin, Bookmark Creek and Disher Creek which are not ephemeral wetlands.

[3] This volume included 121 ML of All Purpose Consumptive (Class 3) water held by the SA Minister for Climate, Environment and Water pumped to Tolderol Game Reserve Wetlands for environmental outcomes.

Black fronted dotterel at Warrego Street wetland in April 2024. Credit: T Daniell

Renmark Irrigation Trust

Water for the environment was pumped to 3 temporary wetlands by Renmark Irrigation Trust in 2023-24; Nelwart Street, Twentysixth Street and Warrego Street. Noticeable differences were observed in vegetation cover, with greater growth observed post-flood at sites that had regularly received water for the environment compared to sites that had only received the floodwater.

During watering, lignum and trees were observed to have been in good condition and flowering, with trees also producing new tip growth. A number of species of conservation significance were observed at RIT watering sites, including the southern bell frog, at least 4 individual blue-faced honeyeaters (*Entomyzon cyanotis cyanotis*; Rare under the *NPW Act 1972*), a large group of white-winged chough (*Corcorax melanorhamphos*; Rare under the *NPW Act 1972*), and spiny lignum. A negative impact of the flood also saw the growth of declared weeds such as golden dodder (*Cuscuta campestris*) and noogoora burr (*Xanthium strumarium*).

Warrego Street wetland in April 2024 during environmental watering. Credit: T Daniell.

Pelicans (Pelecanus conspicillatus) flying over the Coorong in December 2023. Credit: J Kruger.

Coorong, Lower Lakes and Murray Mouth

5,433,572 ML delivered to the CLLMM
3,826,683 ML of this was unregulated flows

142,500 ha watered

5,187,355 ML released out the barrages
3,484,826 ML of this was unregulated flows

Lake Level Management and Barrage Releases

Ecological Objectives:

- Promote successful migration and recruitment of diadromous fish species in the Lower Lakes and Coorong
- Maintain or improve aquatic and littoral vegetation in the Lower Lakes
- Maximise fish passage connectivity between the Lower Lakes and Coorong
- Support aquatic habitat by establishing and maintaining variable salinity regimes in the Murray Mouth Estuary and North and South Lagoons.
- Maintain or improve waterbird populations in the Lower Lakes, Coorong and Murray Mouth
- Restore resilient populations of black bream and greenback flounder in the Coorong
- Maintain or improve mudflat invertebrate communities
- Maintain or improve *Ruppia tuberosa* colonisation and reproduction

Outcomes:

Approximately 5,187,355 ML of water was released out of the barrages in 2023-24, including water for the environment and unregulated flows. The proportion of flow through each of the barrages throughout the water year was Goolwa 25.8%, Mundoo 12.9%, Boundary Creek 0.6%, Ewe Island 20.2% and Tauwitchere 40.5%. Actual water delivery closely followed planned delivery in 2023-24. In most months, more water was delivered from water holders than was requested, however, less was delivered in December 2023 and January 2024 than requested.

For the CLLMM Icon Site, water for the environment is planned and delivered as per the requirements of the SA CEWH/DEW water delivery schedule, and in alignment with system scale watering events, the CLLMM SCBEWC proposal and decisions on water use made by SCBEWC. CLLMM TLM staff meet regularly with CEWH staff to ensure that operations and water delivery align with the watering schedule and the agreed objectives and outcomes.

Black swans on the Coorong in December 2023. Credit: J Kruger.

In September and November 2023, Lake Victoria directed releases were implemented in two periods, to keep flow at the South Australian border above critical levels for Coorong aquatic plant outcomes, and for flow-cued channel fish recruitment and estuarine conditions in the Coorong. The majority of the environmental water delivered in spring and summer 2023-24 to the CLLMM was directed to the Coorong via Tauwitchere barrage to provide suitable habitat for estuarine fish, invertebrates and waterbirds.

Southern pygmy perch, Mundoo Island. Credit: S Wedderburn.

From December 2023 onwards, delivery switched to direct trade, with a current upper volume between December and June set at 150 GL (due to water availability and delivery constraints). This water was delivered to protect water levels in the Lower Lakes over summer and autumn, and to continue barrage flows and connectivity to the Coorong. A small unregulated flow event arrived at the CLLMM in late January/early February, increasing barrage flow volumes and lake levels.

Recruitment of black bream

In autumn 2024 a black bream (*Acanthopagrus butcheri*) recruitment event was detected during the annual Coorong fish monitoring program. Hundreds of baby black bream were sampled in the northern Coorong, with the recruitment likely a result of small, managed flow releases from Goolwa barrage during summer. Analysis of daily growth rings of the otoliths (ear bones) of these fish confirmed spawn dates in January and February 2024.

Baby black bream in the northern Coorong in March 2024. Credit: SARDI.

In the Lower Lakes, seasonal water level fluctuation was managed to a maximum of around 0.83 m AHD in early summer 2023 and a minimum of 0.6 m AHD in autumn 2024. This was to protect threatened fish, frog and waterbird habitat in Lower Lakes wetlands. An exciting reintroduction of Yarra pygmy perch (*Nannoperca obscura*; Endangered under the *EPBC Act 1999*), to the Lower Lakes also occurred in December 2023 and monitoring results showed they were persisting in the habitat they were reintroduced to. Southern pygmy perch (*Nannoperca australis*; Vulnerable under the *EPBC Act 1999*) also responded well and aquatic vegetation continued to be in good condition in the Lower Lakes in 2023-24.

Evidence of thukabi (turtle) recruitment was evident at Tolderol and Watulunga.

At the Lower Murray barrages, all fishways were operated year-round, with attractant flow directed next to fishways when there was sufficient available volume. This continuous connectivity between freshwater and estuarine environments contributed to the detection of thousands of young-of-year congolli moving upstream from the Coorong to Lake Alexandrina via barrage fishways in spring 2023. Adult female congolli (*Pseudaphritis urvilii*) migration was also tracked from the South East drainage network, through the Coorong to the Murray Mouth and ocean to breed, displaying the importance of connectivity between different waterways.

In the Coorong, monitoring results suggested bivalves and polychaete worms continued to expand into the southern Coorong, likely due to freshening from the 2022-23 flood and continued unregulated flows and delivery of water for the environment in 2023-24. Almost 275,000 waterbirds were recorded using the Coorong and Lower Lakes in the annual summer census in early 2024. While many species were in greater abundance than the previous year, the majority of species, particularly shorebirds, were still below long-term median values. Summer delivery of water for the environment is needed to support critical mudflat habitat and submergent plant communities.

Lamprey on the move

During winter 2023, 11 pouched lamprey (*Geotria australis*) were trapped and tagged moving upstream through barrage fishways. Unregulated flows delivered through the Murray Mouth to the ocean during winter likely provided cues for adult lamprey migration.

Pouched lamprey caught in winter 2023. Credit: SARDI.

Abundant Coorong invertebrates in December 2023. Credit: J Kruger.

Partnering with First Nations

9 tours on country

7 Aboriginal Waterway Assessments (AWAs)

12 workshops

Over **590** hours of First Peoples support with monitoring

DEW and partner organisations involved in delivering water for the environment in South Australia acknowledge and pay respect to the First Nations of the Murray–Darling Basin, who have a deep cultural, social, environmental, spiritual, and economic connection to their lands and waters. DEW and partner organisations work with members of the River Murray and Mallee Aboriginal Corporation (RMMAC); the prescribed body corporate of the First Peoples of the River Murray and Mallee Region (FPRMMR), the Ngarrindjeri Aboriginal Corporation (NAC); the prescribed body corporate of the Ngarrindjeri People, and First Nations of the South East to ensure cultural priorities and local knowledge are incorporated into environmental watering programs. DEW Chowilla staff also engage with the Barkindji Maraura Elders Committee (BMEC) who represent the Maraura Nation, in collaboration with NSW DPIE staff responsible for site management at Kulcurna (the NSW part of the Chowilla floodplain). Many groups are directly involved with operating water management infrastructure such as regulating structures and pumps and collecting monitoring data to support decision-making.

Ngarrindjeri Led Thukabi Monitoring in the Lower Murray

The great success of the thukabi (turtle) monitoring project co-developed by The NAC and The University of Adelaide in 2022-23, led to it being funded again in 2023-24. With the increased level of community interest, and additional funding from the MRLB, the monitoring effort was able to be expanded from 10 to 16 sites.

The project aim was to assess the abundance, condition and recruitment of thukabi in the Lower Murray. Thukabi numbers in 2023-24 significantly increased from the previous year with a total of 240 individuals caught, consisting of 145 short-necked, 89 eastern long-necked and 6 broad-shelled thukabi. This monitoring occurred on the tail of the second highest flood in South Australia since 1956 but whether this had an influence remains inconclusive.

Craig Sumner and Chase Rigney retrieving thukabi nets. Credit: S Wedderburn.

The MDBA's The Living Murray's Indigenous Partnerships Program (TLM IPP) ensures First Nations knowledge and cultural values can be incorporated into icon site management, supporting the employment of Indigenous Facilitators at the Chowilla and CLLMM Icon Sites, and broader engagement with local community members to support The Living Murray's watering programs.

The NAC Yarluwar-Ruwe Project Coordinator met with DEW staff on a weekly basis throughout the year to discuss consultation on First Nation water interests and watering actions for the CLLMM. The Yarluwar-Ruwe Project Coordinator also organised the kungari (swan) egg collection workshop at Narrung in September 2023 and the initial workshop for the development of a Ngarrindjeri Seasonal Calendar in May 2024 with Ngarrindjeri community members.

The Ngarrindjeri community were also consulted on the CLLMM 2024-25 annual watering proposal via a workshop at Raukkan that was organised by the NAC and DEW and involved the Murraylands and Riverland Landscape Board and Hills and Fleurieu Landscape Board. Discussions focused on planning and delivery of water for the environment to smaller Lower Lakes wetlands undertaken by the landscape boards, but also more broadly on the larger bulk water delivered

via the River Murray channel to the CLLMM. Cultural values from the Yarning Circles Summary Report were a valuable source of information and were built on through this engagement process.

The NAC and Ngarrindjeri community continue to assist DEW and The University of Adelaide with threatened fish, thukabi (turtle) and kaltuwari (yabby) monitoring in the Lower Lakes. The Ngarrindjeri Thukabi Monitoring Project received 2nd prize in the SA Citizen Science Awards 2024. Ngarrindjeri community members also participated in the release of captive-bred Yarra pygmy perch into Lake Alexandrina.

A collaborative effort with Nature Glenelg trust, MRLB, NAC and DEW to reintroduce Yarra pygmy perch at Kumarangk/Hindmarsh Island in December 2023. Credit: MRLB

DEW staff consulted the First Peoples of the River Murray and Mallee Region (FPRMMR), Ngarrindjeri community and First Nations of the South East on their input to the revised River Murray Long-Term Watering Plan.

Chowilla Floodplain staff regularly liaise with the FPRMMR and Maraura Nation to discuss plans for water for the environment and to gain input on cultural perspectives and priorities. Updates were provided throughout the year regarding outcomes from watering actions and flood responses at First Peoples Working Group Meetings, On Country meetings, tours, and workshops and via email. Chowilla Floodplain staff and the RMMAC Project Officer met weekly to provide updates and progress on projects, engagement and monitoring. Specific activities with the FPRMMR included bi-monthly meetings to provide regular updates on monitoring and site activities and to gain the First Peoples input to projects and planning.

Workshops and tours were also held with RMMAC in mid-April to discuss the ecological condition of the Katarapko and Pike floodplains and potential options for management. RMMAC were supportive of managing for in-stream values and not undertaking managed inundations in 2023. The RMMAC Rangers provided significant support in the delivery of ecological monitoring at all three floodplains between spring 2023 to autumn 2024. This included more than 590 hours of assisting floodplain ecologists with frog call, tadpole, turtle and small-bodied fish, lignum and understorey vegetation condition surveys. The learning, knowledge and skills being shared between the Rangers and DEW ecologists continues to be of great value for the management of the floodplains.

The Murraylands and Riverland Landscape Board also attend FPRMM working group and RMMAC Ranger team meetings, providing updates and discussing ideas. In June 2024, the Murraylands and Riverland Landscape Board held a wetland tour with 20 First Peoples attendees visiting five wetland complexes selected by the RMMAC working group members. The tour outcomes included the discovery of new cultural sites for future investigation, site nominations for Aboriginal Waterway Assessments, and invaluable feedback and input into the Murraylands and Riverland Landscape Board watering program.

Aboriginal Waterway Assessments (AWAs)

Aboriginal Waterway Assessments (AWA) continue to be an important means of connecting to Country for the FPRMMR, allowing for the sharing of information and knowledge about many sites and gaining Traditional Owner perspectives. AWAs were undertaken at F1 wetland within Pike Floodplain in November 2023, Coppermine Waterhole in October 2023, at Lake Limbra in March and May 2024, Overland Corner in August 2023, Gerard in October 2023, Beldora Complex in May 2024, and at Murtho Flats in February 2024.

AWA at Coppermine Waterhole, Chowilla Floodplain in October 2023. Credit: H Kieskamp.

Communications and Engagement

7 community tours on-site

presentations given at **16** forums / workshops

5 videos produced for YouTube

>80 social media posts

3 television segments and **5** radio interviews

Water for the environment managers in South Australia strive to maintain community input and engagement throughout the water year. Planning annual delivery of water for the environment starts early and involves workshops with environmental water holders, scientific experts, First Nations, non-government organisations and river operators. These workshops consider the water resource forecast for the year ahead, facilitating discussions around what watering events may be possible and aiding in the development of watering proposals aimed to meet site specific and basin-wide targets.

Many decisions on real-time delivery of water for the environment during spring and summer were driven by consultation with South Australia's E-Flows Reference Group. These fortnightly meetings included presentations from the DEW Water Delivery team and input from a range of site managers and scientists regarding flow to South Australia and potential associated use of water for the environment to enhance ecological outcomes. DEW TLM staff also attended fortnightly QSA planning meetings and other operational meetings to work with water holders and river operators to identify opportunities for enhanced water delivery and to process trades and water orders in a timely manner.

Further community and non-government organisation consultation took place during the development of watering proposals for all major watering actions. For the Chowilla Floodplain Icon Site, River Murray channel, Pike and Katarapko Floodplains, and CLLMM Icon Site, there are established reference groups and/or science advisory groups with an in-depth knowledge of the region, its infrastructure and ecological processes. These groups provided valuable input to help plan for the delivery of water for the environment in 2023-24. Additionally, site tours, meetings and presentations were undertaken with various stakeholders to gain feedback on proposed actions and to share information about the outcomes of environmental water delivery. One-on-one conversations with landholders and industry representatives were also undertaken.

Community consultation and engagement continued throughout the water year from the initial planning phase and through the spring- summer peak season for delivery of water for the environment. Methods of communication and engagement included radio (5 interviews) and television segments (3 segments), print media and website articles (6 articles), social media posts (>80 posts), weekly River Murray flow reports, multiple weekly stakeholder and public notifications during operations, the development of videos (5 videos), and presentations to various interest groups (16 forums). Seven tours involving a diverse range of stakeholders were undertaken on the Chowilla floodplain and within the Coorong, Lower Lakes and Murray Mouth region.

Regular updates on the outcomes of water delivery were posted on the River Murray SA Facebook page (55 posts) and Murraylands and Riverland Facebook page (15 posts). A number of media releases and videos were also produced by DEW (or DEW staff contributed to content), and can be found at the following links:

- Department for Environment and Water - Community involvement
- Department for Environment and Water – Fish and bird species to benefit from River Murray environmental water releases

- Benefits of summer floods to the Coorong and Lower Lakes Channel 7 NEWS – Video | Facebook
- Flood – boost for the environment of the SA Murray Channel 7 NEWS Video | Facebook

Non-government organisations were also actively involved in community engagement, with Renmark Irrigation Trust, Accolade Wines, and Australian Landscape Trust (Calperum Station) promoting the importance of water for the environment through mainstream and social media.

Celebrating 20 years of The Living Murray Program

Traditional Owners, scientists, government and key community members got together to attend and celebrate 20 years of The Living Murray Program. Celebration events were held at the Coorong, Lower Lakes and Murray Mouth Icon Site in February 2024 and the Chowilla Icon Site in April 2024.

Both events comprised of an evening where TLM scientists and water managers presented on the data collected through the long-term monitoring program and discussed the key learnings and how these have translated to improved water delivery and management. First Peoples representatives welcomed attendees and presented on Traditional Owner involvement in the program over 20 years to both events, including a dance performance at the Chowilla event. The Chowilla event was held in Renmark with almost 100 people attending, and the CLLMM event at the newly opened CLLMM Research Centre in Goolwa where a wide range of people with an involvement in The Living Murray as well as community members and landholders attended. The following day at both events, tours of the Chowilla Floodplain and the barrages were held for icon site community advisory panels / reference group members, Traditional Owners and staff.

Tour of the barrages to celebrate 20-years of the TLM program at the CLLMM Icon Site in February 2024.

Monitoring

A number of monitoring programs aim to capture the ecological responses to water for the environment along the South Australian River Murray. These include:

- Condition and intervention monitoring at the Chowilla Floodplain and Lower Lakes, Coorong and Murray Mouth Icon Sites through the MDBA's TLM Program
- Condition and intervention monitoring associated with weir pool manipulation and Pike and Katarapko floodplain regulator operations coordinated by DEW
- CEWH's Flow-MER Program, which collects data along the South Australian River Murray Channel.
- Monitoring of selected South Australian River Murray wetlands and floodplain areas by the Murraylands and Riverland Landscape Board
- Monitoring by non-government organisations

Monitoring reports are produced for many of these projects (Appendix E), with many available on the CEWH Flow-MER and MDBA websites.

An extensive network of real-time surface water monitoring stations that measure a range of parameters including water level, salinity, dissolved oxygen and water temperature are found throughout the South Australian River Murray, Lower Lakes and Coorong and are operated and maintained by DEW. The data generated is critical for water managers to inform decisions on environmental flow delivery and the operation of infrastructure. Surface water monitoring data can be accessed at the Water Data SA website.

Bird surveys at Chowilla Floodplain in January 2024. Credit: A Kriesl.

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Appendix A

Water for the Environment Actions Planned for 2023-24

Table 1a and 1b: Summary of water for the environment actions proposed under the dry and moderate water resource scenarios in the 2023-24 Annual Plan

1a. Dry conditions

Site	Proposed Action	Status for 2023-24
CLLMM	Environmental return flows from spring multisite event released on the back of the unregulated peak, targeting 17,000 to 19,000 ML/d at the South Australian border for a duration of 3 months from October to December.	**Achieved**, due to sufficient River Murray flows through spring and a directed release from Lake Victoria.
	Summer/autumn direct trade add 1-3 GL/d to SA entitlement to maintain lake levels ≥0.6 m AHD and barrage flows under low inflow scenarios, particularly in autumn 2024.	**Achieved**
Channel and Floodplain	Target flows at the South Australian border ≥20,000 ML/d for 30 days + ≥18,000 ML/d for an additional 30 days in mid to late spring/early summer.	**Achieved**
	Enhance unregulated flow at the South Australian border ≥50,000 ML/d for 20 days + recession rate of <1,000 ML/d.	**Not pursued**, due to positive responses post-flood and need for some areas of the floodplain to undergo further drying.
Weir Pool Manipulation	Lowering of locks 1 to 6 during September to December.	**Achieved**
Chowilla Floodplain	No floodplain operations proposed. Pumping of up to 5 wetlands in spring or autumn. Manage inflows via Pipeclay Creek and Slaney Creek weirs.	**Achieved**
Pike Floodplain	No floodplain operations proposed. Manage inflows via Margaret Dowling and Deep Creek regulators and manage flow splits through Tanyaca and Pike regulators.	**Achieved**
Katarapko Floodplain	No floodplain operations proposed. Manage inflows via Bank J and manage flow through Log Crossing and South Arm regulators.	**Achieved**
Ephemeral Wetlands	Potential pumping to up to 15 priority wetlands along the River Murray.	**Achieved**

1b. Moderate conditions

Site	Proposed Action	Status for 2023-24
CLLMM	Spring directed release from Lake Victoria to ensure ~38,000 ML/d at the South Australian border to maintain high spring barrage flows to the Coorong.	**Partially achieved** due to prolonged elevated flows. A directed release helped to maintain flows >20,000 ML/d through spring.
	Environmental water return flows from spring multisite event released on the back of the unregulated peak, adding up to 9,000 ML/d at the South Australian border for a duration of three months from October to December.	**Achieved**
	Summer/autumn direct trade AND autumn return flows add additional 1,000-3,000 ML/d to South Australian entitlement to ensure minimum lake levels ≥0.6 m AHD.	**Partially achieved**
Channel and Floodplain	Target flows at the South Australian border ≥20,000 ML/d for 30 days + ≥18,000 ML/d for an additional 30 days in mid to late spring/early summer.	**Achieved**
	Target flows at the South Australian border ≥59,000 ML/d for 20 days + recession rate <1,000 ML/d in mid to late winter	**Not Pursued,** due to positive responses post-flood and need for some areas of the floodplain to undergo further drying.
Weir Pool Manipulation	Lowering of locks 1 to 6 during September to December.	**Achieved**
Chowilla Floodplain	No floodplain operations proposed. Pumping of up to 5 wetlands in spring or autumn. Manage inflows via Pipeclay Creek and Slaney Creek weirs.	**Achieved**
Pike Floodplain	No floodplain operations proposed. Manage inflows via Margaret Dowling and Deep Creek regulators and manage flow splits through Tanyaca and Pike regulators.	**Achieved**
Katarapko Floodplain	No floodplain operations proposed. Manage inflows via Bank J and manage flow through Log Crossing and South Arm regulators.	**Achieved**
Ephemeral Wetlands	Potential pumping to up to 15 priority wetlands along the River Murray.	**Achieved**

Appendix B

Environmental Watering Actions Undertaken in 2023-24

Table 2: Volume of water for the environment delivered across the South Australian River Murray region from different water holders (e.g. Commonwealth Environmental Water Holder (CEWH), The Living Murray (TLM), South Australian Minister for Climate, Environment and Water (SA), Victorian Environmental Water Holder (VEWH), River Murray Increased Flow (RMIF) and private holdings in SA (Private) in 2023-24.

Watering Action/ Location	Held environmental water						Other SA-held water used for environmental outcomes	Unregulated flows	Total volume (ML)
	CEWH	TLM	VEWH	Victorian RMIF	NSW RMIF / Other	SA (incl. privately held)			
CLLMM	1,158,504	332,910	49,560	15,054	24,437	13,509	12,913	3,826,684[3]	5,433,572[4]
Pike Floodplain / Lock 5	-	-	-	-	-	300	-	-	300
Managed pool-connected wetlands (Appendix C)	-	-	-	-	-	31,539	1,245	-	32,784
Pumped wetlands (Appendix D)[5]	2,172	3,975	-	-	-	167	122	467	6,903
TOTAL	**1,160,676**	**336,885**	**49,560**	**15,054**	**24,437**	**45,515**	**14,280**	**3,827,151**	**5,473,559**

[3] Transmission losses of 93,872 ML were applied against the unregulated flows between the South Australian border and Wellington (refer the Policy for Application of Losses to Environmental Water for more information)

[4] Transmission losses of 7,088 ML were applied against the held environmental water (HEW) between the South Australian border and Wellington (refer the Policy for Application of Losses to Environmental Water for more information)

[5] Includes Bookmark Creek, Disher Creek and Berri Evaporation Basin which are gravity-fed rather than pumped.

Appendix C

Managed Pool-Connected Wetlands

Table 3: Pool-connected wetland complexes managed in 2023-24 by Accolade Wines, SA Department for Environment and Water (DEW), Murraylands and Riverland Landscape Board (MRLB), and Australian Landscape Trust (ALT). Includes 52 wetlands across 40 wetland complexes.

Wetland Complexes	Actions	Manager
Banrock Wetland	Filled in spring, commenced dry in summer	Accolade Wines
Big Bend	Commenced dry in summer	MRLB
Brenda Park	Commenced dry in summer	MRLB
Causeway Wetland Complex	Connected to the River all year	MRLB
Devon Downs South	Connected to the River all year	MRLB
Hart Lagoon	Commenced dry in summer, filled in winter	MRLB
Irwin Flat	Connected to the River all year	MRLB
Kroehn's Landing	Connected to the River all year	MRLB
Lake Merreti	Commenced dry in autumn	ALT
Lake Woolpolool	Commenced dry in summer	ALT
Loveday Basins	Connected to the River all year	DEW
Loveday Mussels Lagoons	Connected to the River all year	MRLB
Martin Bend	Commenced dry in summer, filled in autumn	MRLB
Morgan Conservation Park	Commenced dry in summer	MRLB
Morgans' Lower Murray	Connected to the River all year	MRLB
Murbko South	Connected to the River all year	MRLB
Murbpook Lagoon	Connected to the River all year	MRLB
Narrung	Commenced dry in summer	MRLB
Nelwart	Connected to the River all year	MRLB
Ngak Indau	Commenced dry in spring	DEW
Nigra Creek/ Schillers Lagoon	Connected to the River all year	MRLB
North Caurnamont	Filled in winter, commenced dry in summer	MRLB
North Purnong	Connected to the River all year	MRLB
Paiwalla	Commenced dry in spring	MRLB
Pilby Complex	Filled in winter, commenced dry in summer[6]	DEW
Pipeclay Billabong	Filled in winter, commenced dry in summer	DEW
Pyap Horseshoe	Commenced dry in summer	MRLB
Ramco Lagoon	Commenced dry in summer, filled in autumn	MRLB
Reedy Creek	Connected to the River all year	MRLB
Riverglades	Connected to the River all year	MRLB
Silver Lea	Connected to the River all year	MRLB
Slaney Billabong	Filled in winter, commenced dry in summer	DEW
Spectacle Lakes /Beldora	Commenced dry in summer	MRLB
Sugar Shack Complex	Commenced dry in summer	MRLB
Sweeney's Lagoon	Connected to the River all year	MRLB
Teal Flat Complex	Teal Flat commenced dry in summer, Teal Flat Hut remained dry all year	MRLB
Teringie	Commenced dry in summer	MRLB
Waltowa	Filled in spring, commenced dry in autumn	MRLB
Wongulla Lagoon	Connected to the River all year	MRLB
Yatco Complex	Yatco North connected to the River all year, Yatco South commenced dry in autumn	MRLB

[6] Lock 6 depression filled again in autumn

Appendix D

Pumped Wetlands

Table 4: Volume of water for the environment and unregulated flows delivered to a total of 14 wetlands by the SA Department for Environment and Water (DEW), Murraylands and Riverland Landscape Board (MRLB), and Renmark Irrigation Trust (RIT) in the South Australian River Murray region in 2023-24.

Watering Action/ Location	Volume (ML)	Manager
Lock 6 to Lock 7		
Lake Limbra	3,975	DEW
Lock 5 to Lock 6		
Bookmark Creek[7]	448[8]	MRLB
Paringa Paddock	117	DEW
Warrego Street	42	RIT
Lock 4 to Lock 5		
Berri Evaporation Basin[7]	1,126[9]	MRLB
Disher Creek[7]	218[10]	MRLB
Nelwart Street	27	RIT
Twentysixth Street	10	RIT
Lock 2 to Lock 3		
Overland Corner (lignum basin)	239	MRLB
Lock 1 to Lock 2		
Molo Flat Eastern Channel	40	MRLB
Molo Flat Western Channel	24	MRLB
Murbook Northern Floodrunners	50	MRLB
Nilkra	466	MRLB
Lower Lakes		
Tolderol Game Reserve	122	MRLB

[7] Bookmark Creek, Berri Evaporation Basin and Disher Creek are gravity fed rather than pumped

[8] 155 ML of the volume used to support environmental outcomes at Bookmark Creek were unregulated flows

[9] 112 ML of the volume used to support environmental outcomes at Berri Evaporation Basin were unregulated flows

[10] 200 ML of the volume used to support environmental outcomes at Disher Creek were unregulated flows

Appendix E

List of Monitoring Reports for 2023-24

Bice, C., Zampatti, B., & Fredberg, J. (2024). Condition monitoring of fish movement and recruitment at the Murray Barrages 2023/24. Adelaide: South Australian Research and Development Institute (Aquatic and Livestock Sciences).

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