



2014-15 ANNUAL ENVIRONMENTAL WATERING PLAN

FOR THE SOUTH AUSTRALIAN
RIVER MURRAY

June 2014



Government of South Australia
Department of Environment,
Water and Natural Resources

2014-15 Annual Environmental Watering Plan for the South Australian River Murray

June 2014

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Foreword

The *2014-15 Annual Environmental Watering Plan for the South Australian River Murray* (the Annual Plan) is one of the key instruments in South Australia's river management framework and builds upon work done in previous Environmental Watering Plans. The Annual Plan identifies priority environmental watering actions for the 2014-15 water year. The planning process seeks to ensure the best use of environmental water every year, regardless of water availability.

The Murray-Darling Basin Authority Basin Plan has prescribed new planning and prioritisation processes for environmental water planning and these requirements have been incorporated into this Annual Plan. A wide range of community stakeholders have been engaged in its development, supporting a transparent process to determine watering priorities.

Each year the water resource outlook is different, volumes of available environmental water may change and environmental watering priorities vary. This presents a challenge to water holders and managers to be able to maximise outcomes. The Murray-Darling Basin Authority has prioritised the testing of new infrastructure to receive The Living Murray environmental water in 2014-15. South Australia has recognised this decision and consideration is being given to the testing of the new structure at Chowilla. There will also be further trials of weir pool raising at Locks 1 and 2, and possibly Lock 6.

As these are new ways of managing the river, the outcomes of watering will be closely observed and measured to allow for adaptive management of the structures in future years and to provide valuable information for the development of future structures.

Julia Grant, Executive Director, Water and Climate Change

Department of Environment, Water and Natural Resources

June 2014

Acknowledgements

In addition to staff in the Department of Environment, Water and Natural Resources (DEWNR), input from representatives and employees of the following organisations has been gratefully received:

- Commonwealth Environmental Water Office (CEWO);
- Coorong, Lower Lakes and Murray Mouth Community Advisory Panel;
- First Peoples of the Murray and Mallee;
- Local Action Planning Groups (LAP Groups), through Community Action for the Rural Environment;
- Murray-Darling Basin Authority (MDBA);
- Nature Foundation South Australia;
- Ngarrindjeri Regional Authority (NRA), including the Mannum Aboriginal Community Association Incorporated;
- River Murray Advisory Committee (RMAC);
- Scientific Advisory Group for the Lower Lakes, Coorong and Murray Mouth;
- South Australian Murray-Darling Basin Natural Resources Management (SA MDB NRM) Board;
- South Australian Research and Development Institute (SARDI); and
- Other South Australian government departments through interagency reference groups.

The following water holders are acknowledged for the planned provision of environmental water to South Australia in 2014-15:

- Commonwealth Environmental Water Holder (CEWH);
- The Living Murray (TLM) program;
- Nature Foundation South Australia; and
- South Australian Minister for Water and the River Murray.

There are many water managers, land holders, community groups and individuals who contribute time, expertise, energy and resources towards delivery of planned environmental watering actions. These actions and subsequent benefits for the river and its communities could not be achieved without their hard work and commitment.

Glossary: Terms and Acronyms

Units of measurement commonly used (SI and non-SI Australian legal)

Name of unit	Symbol
day	d
gigalitre	GL
megalitre	ML

AEP – Annual Exceedance Probability

ASS – Acid Sulfate Soils

AHD – Australian Height Datum

Barrage — specifically any of the five low weirs at the mouth of the River Murray constructed to exclude seawater from the Lower Lakes

Basin — the area drained by a major river and its tributaries

CEW – Commonwealth Environmental Water

CEWH – Commonwealth Environmental Water Holder; the person charged with responsibility for the Commonwealth Government’s water that is held for environmental purposes

CEWO – Commonwealth Environmental Water Office; the office that supports the CEWH

CLLMM – Coorong, Lower Lakes and Murray Mouth

CWMB – Catchment Water Management Board

DEWNR — Department of Environment, Water and Natural Resources (Government of South Australia)

Diversity — the distribution and abundance of different plant and animal species and communities within a specified area

EC — electrical conductivity; 1 EC unit = 1 micro-Siemen per centimetre ($\mu\text{S}/\text{cm}$) measured at 25°C; commonly used as a measure of water salinity as it is quicker and easier than measurement by TDS

Ecosystem — any system in which there is an interdependence and interaction between living organisms and their immediate physical, chemical and biological environment

Endangered species — any species in danger of extinction throughout all or a significant portion of its range

Entitlement Flow — minimum monthly River Murray flow to South Australia agreed in the Murray-Darling Basin Agreement 1992

Environmental water requirements — the water regimes needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk

Fishway — a generic term describing all mechanisms that allow the passage of fish along a waterway. Specific structures include fish ladders (gentle sloping channels with baffles that reduce the velocity of water and provide resting places for fish as they ‘climb’ over a weir) and fishlifts (chambers, rather like lift-wells, that are flooded and emptied to enable fish to move across a barrier)

Floodplain — Of a watercourse means: (1) floodplain (if any) of the watercourse identified in a catchment water management plan or a local water management plan; adopted under the Act; or (2) where (1) does not apply — the floodplain (if any) of the watercourse identified in a development plan under the *Development (SA) Act 1993*; or (3) where neither (1) nor (2) applies — the land adjoining the watercourse that is periodically subject to flooding from the watercourse

Flow bands — flows of different frequency, volume and duration

Flow regime — the character of the timing and amount of flow in a stream

Habitat — the natural place or type of site in which an animal or plant, or communities of animals and plants, live

Indigenous species — species that occur naturally in a region

Infrastructure — artificial lakes; dams or reservoirs; embankments, walls, channels or other works; buildings or structures; or pipes, machinery or other equipment

KEAs - Key Environmental Assets

LAP – Local Action Planning

LLCMM – Lower Lakes, Coorong and Murray Mouth; one of TLM icon sites

MDBA — Murray-Darling Basin Authority

MERI Framework – Monitoring, Evaluation, Reporting and Improvement Framework

Model — a conceptual or mathematical means of understanding elements of the real world that allows for predictions of outcomes given certain conditions. Examples include estimating storm run-off, assessing the impacts of dams or predicting ecological response to environmental change

Monitoring — (1) The repeated measurement of parameters to assess the current status and changes over time of the parameters measured (2) Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals and other living things

NFSA – Nature Foundation of South Australia

NGO – Non-government Organisation

QSA – River flow to South Australia, as measured at the State border

Ramsar Convention —an international treaty on wetlands titled The Convention on Wetlands of International Importance Especially as Waterfowl Habitat

Return flow – environmental water used upstream for an event returns to the river and can be used for another event downstream

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

Threatened species — any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range

TLM – The Living Murray (MDBA program)

Water allocation — (1) In respect of a water licence means the quantity of water that the licensee is entitled to take and use pursuant to the licence. (2) In respect of water taken pursuant to an authorisation under s.11 means the maximum quantity of water that can be taken and used pursuant to the authorisation.

WAP — Water Allocation Plan; a plan prepared by a CWMB or water resources planning committee and adopted by the Minister in accordance with the *Natural Resources Management Act 2004 (SA)*

Water dependent ecosystems — those parts of the environment, the species composition and natural ecological processes that are determined by the permanent or temporary presence of flowing or standing water, above or below ground. The in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, estuaries and lakes are all water-dependent ecosystems

Water licence — a licence granted under State legislation entitling the holder to take water from a prescribed watercourse, lake or well or to take surface water from a surface water prescribed area. This grants the licensee a right to take an allocation of water specified on the licence, which may also include conditions on the taking and use of that water. A water licence confers a property right on the holder of the licence and this right is separate from land title

Water year - The period between 1 July in any given calendar year and 30 June the following calendar year; also called a licensing year or a water-use year

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Summary

The Annual Plan sets out the State's agreed plan for environmental water delivery along the South Australian River Murray for the 2014-15 year. The intention is to ensure that the best environmental outcomes are achieved for the South Australian stretch of the river and its floodplains, consistent with requirements under the Murray-Darling Basin Authority Basin Plan ('the Basin Plan').

Specific objectives of the 2014-15 Annual Plan are to:

- coordinate the delivery of environmental water to South Australia to maximise the potential outcomes throughout the South Australian Lower Murray system;
- maximise outcomes from watering in South Australia by using return flows where possible;
- deliver environmental water to the Lower Lakes Coorong Murray Mouth while providing benefits to upstream environmental assets and functions en route;
- facilitate the testing of the Chowilla regulator; and
- further trials of weir pool raising.

For 2014-15, DEWNR has written a multi-site plan (refer to the detailed proposal in *Supporting Information: 2014-15 Annual Environmental Watering Plan for the South Australian River Murray*) for the use of environmental water within the South Australian River Murray. For example, if environmental water is allocated and used to test the Chowilla regulator, then there will be return flows to the River Murray downstream from Chowilla Creek. Under the WAP for the River Murray, this water may not be re-allocated for consumptive use. Therefore, it is available for use for other functions and assets as it flows down the river and will eventually be delivered to the Lower Lakes, Coorong and Murray Mouth for ecological benefit.

Detail relating to environmental watering, environmental watering priorities and implementation are provided in Parts A, B and C of the Annual Plan respectively. Supporting information, which includes details about the proposed environmental watering activities under different water availability scenarios, is provided in the companion document, *Supporting Information: 2014-15 Annual Environmental Watering Plan for the South Australian River Murray*.

The intention is to ensure that the best environmental outcomes are achieved for the South Australian stretch of the river...

PART A: OVERVIEW



*Sugar Shack Pangki Wetland
by Kate Mason*

1. Introduction

1.1 Overview

Each year South Australia prepares the Annual Plan to guide water delivery to the state. Importantly, the Annual Plan aligns with the requirements of the Basin Plan. The Annual Plan documents the agreed South Australian program for environmental water delivery along the River Murray in South Australia (including the Lower Lakes, Coorong and Murray Mouth) for the 2014-15 water year. The Annual Plan guides where environmental watering should occur within the respective water year. It should not be viewed as a long-term strategy.

The purposes of this document are to:

- formalise planned priorities for environmental watering within South Australia within a given water year and support an adaptive management framework;
- make planned environmental watering activities publicly available for stakeholder information;
- meet the requirements of holders of environmental water who provide water to South Australia;
- meet the requirements of the *Basin Plan* as well as the South Australian *Natural Resources Management Act 2004 (SA)*;
- inform CEWO planning for 2014-15;
- provide input for the annual South Australian River Murray Operation Plan 2014-15;
- introduce the *Basin Plan* principles that guide development of environmental watering priorities (Appendix F); and
- introduce new guidelines to inform flow management decisions that support the water quality objectives and targets contained within the *Basin Plan* (Appendix G).



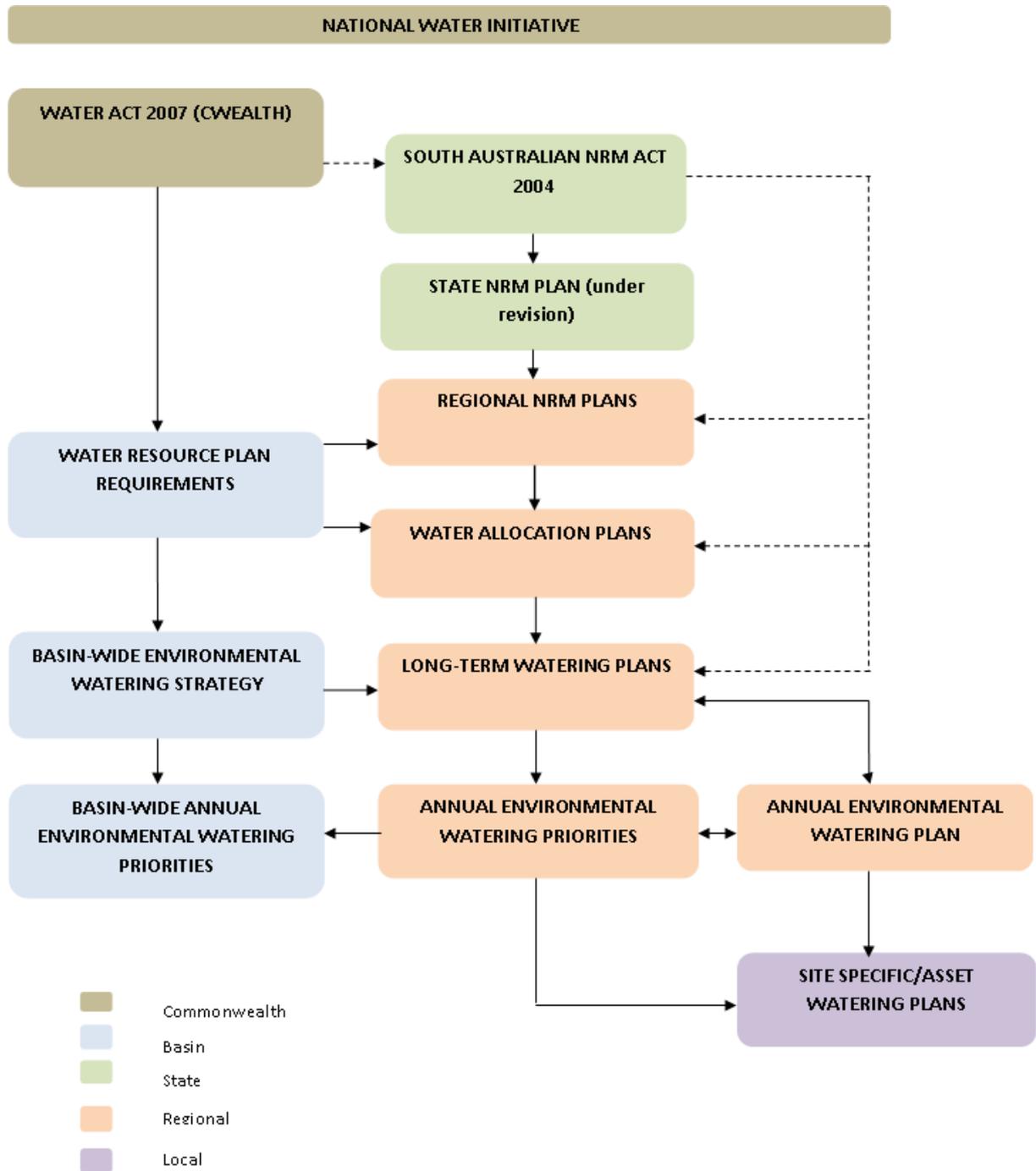
Bookmark Creek

By Irene Wegener

The Annual Plan is integral to South Australia's environmental water management processes and integrates the proposed watering activities of many groups. It has been developed based on the best available data and science; however, it may be subject to change depending on actual water availability conditions, which will inform real-time and adaptive water use.

The South Australian Murray-Darling Basin environmental water management framework is presented in Figure 1. The Annual Plan currently incorporates components of both the Long-Term Watering Plan (in development) and the South Australian River Murray Annual Environmental Watering Priorities.

Figure 1: South Australian Murray-Darling Basin environmental water policy, planning and management hierarchy (updated from Goode 2012)



1.2 2013-14 water year in review

A brief history of the 2013-14 water year is provided below to provide some context of the conditions leading up to the 2014-15 year. More information from earlier water years can be found on the DEWNR web site at: <http://www.environment.sa.gov.au/about-us/our-plans> and in Appendix B.

The 2013-14 water year started with an unregulated flow in July. This flow reached 19,000 ML/d by the end of August and 25,000 ML/d in September and October 2013. The use of environmental water during this period was considered; however, the use of these flows could not be optimised as there were flow constraints associated with works being undertaken at Lock 2 and Lock 4, Yatco and Chowilla.

In mid-October 2013, as the unregulated flows began to reduce, the flow to South Australia receded steeply. South Australia requested that environmental water be used to limit the steep recession; however, this was not possible as it was an unregulated flow period – any environmental water delivered during this unregulated flow period would have been substituted for flows already crossing the border and therefore would not have increased flow.

It was agreed that the best time for any additional environmental water delivery would be in spring when the water temperature reached approximately 20°C, as this would potentially enhance native fish breeding. When the unregulated flow ended in late October, additional environmental water was delivered to South Australia in pursuit of this outcome. Two flow pulses were delivered from the Goulburn River in October with return flows traded into South Australia. Discussions and decisions regarding the need for flow variation and for longitudinal connectivity ensured that both of these actions were undertaken.

South Australia successfully negotiated for a pre-release of water from Lake Victoria followed by capture of the first Goulburn flow pulse in Lake Victoria. Water delivered to South Australia during late October and November 2013 and releases from the Lower Lakes (brought about by deliberately lowering water levels in Lakes Alexandrina and Albert) contributed to maintaining relatively high barrage releases during November and early December. This aligned with the critical period for *Ruppia tuberosa* reproduction, and contributed to reducing the decline in Coorong South Lagoon water levels. A greater area of *Ruppia tuberosa* was inundated for a longer period of time, increasing the reproductive output. Although data analysis has not yet been completed, it is highly likely that there has been a net increase in seed bank density.

Pumping to a number of temporary wetlands was also undertaken in spring-summer.

Work at Lake Victoria in the first six months of 2014 reduced the ability to deliver entitlement flow and environmental water. This led to a different pattern of entitlement delivery to South Australia. Following a high rainfall event, all of the weir pools were raised from March to May to store the water provided through local rainfall run-off and to retain enough water to ensure flows of 2500 ML/day over Lock 1.

In 2013-14, the CEWH and the MDBA's TLM program together provided over 700 GL for the River Murray in South Australia.

Overall, good ecological outcomes were achieved from the program of environmental watering in 2013-14. These continued to build on improvements seen in recent years.

Positive results include:

- Excellent frog and vegetation responses measured in the pumped wetland sites (supporting the ongoing viability of species);
- Record number of Murray Hardyhead fish at Dishers Creek (supporting the ongoing viability of this nationally important population by ensuring breeding occurs);
- Completion of the Ruppia reproductive cycle leading to the presence of Ruppia plants in a number of locations throughout the Coorong (supporting recovery of this keystone species);
- New recruits of Congolli in Coorong lagoons; also Sandy Sprat, Small-mouthed Hardyhead, and Black Bream, Yellow-eye Mullet and Bony Herring in the South Lagoon (supporting diverse fish population recovery);
- Young and courting Pelicans on North Pelican Island and Crested Terns nesting on Teal Island (supporting breeding of different bird species); and
- Spawning of flow-cued fish species (Golden Perch and Silver Perch) occurred (as evidenced by the presence of eggs, larvae or adult reproductive biology) in the Lower River Murray channel associated with the in-channel flow pulse during the late spring/early summer of 2013-14.



Murray Hardyhead, Dishers Creek

2. Environmental Watering

2.1 What is it?

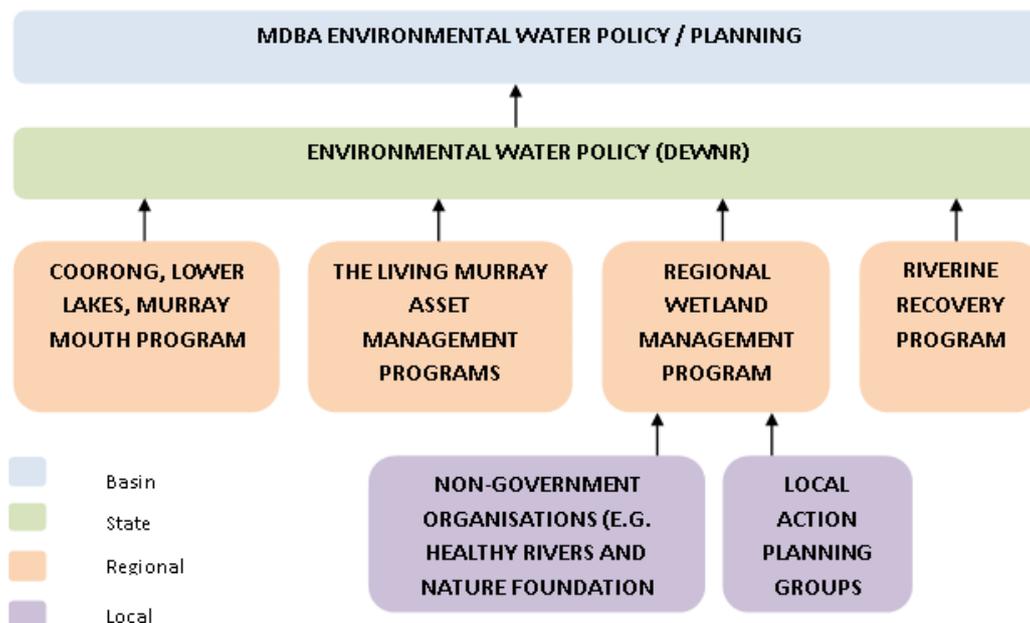
Environmental watering is the delivery or use of water to achieve environmental outcomes – that is, ecological benefits that contribute to a healthy, working river. Environmental watering ensures that important values of the South Australian River Murray, its wetlands and floodplains, Lakes Alexandrina and Albert and the Coorong are maintained and that environmental objectives are achieved.

Environmental water along the River Murray in South Australia is managed within the Department of Environment, Water and Natural Resources (DEWNR), with significant input from non-government organisations and other local stakeholders. This portfolio of work includes development of the Annual Environmental Watering Priorities, the Annual Plan, the Annual Report, the broader development of the State’s environmental watering policy, the State’s contribution to Basin-wide environmental watering policy reform, and management of the environmental water received by South Australia from sources such as the CEWH and TLM program. It also includes development of a long term watering plan required under the *Basin Plan*.

DEWNR has responsibility for management of TLM Icon Sites within South Australia – the Chowilla Floodplain, the River Murray Channel and the Lower Lakes, Coorong and Murray Mouth (LLCMM) – as well as managing environmental watering activities, monitoring, infrastructure and associated projects. Other tasks include management of smaller sites and community liaison.

Figure 2 illustrates the groups involved in environmental watering for the South Australian River Murray and their relationship to the overall Basin environmental watering program.

Figure 2: Hierarchy for South Australian environmental water planning



Environmental water is made available as ‘held’ and ‘planned’ environmental water.

- **Held environmental water** is water held on the licence of a water holder who determines that this water will be used for environmental watering activities. Held environmental water may be either a purchased allocation or an allocation granted under the water holder’s entitlements.
- **Planned environmental water** is water that is not held on a water licence, but may be committed under State water management law for environmental purposes and managed through river operations.

Two key sources of environmental water for South Australia are the CEWH and TLM. At the State level, two further sources of environmental water are:

- South Australian Government purchases of water entitlements and allocations for environmental watering purposes; and
- South Australian Minister for Water and the River Murray’s water licence with Class 9 water entitlement, specifically for use in wetlands that are actively managed through regulators and are connected to the South Australian River Murray at normal operating level.

Water allocations are also held by non-government organisations such as the Nature Foundation South Australia.

On-ground environmental water delivery and monitoring is managed by various groups in conjunction with DEWNR staff. Eleven Local Action Planning (LAP) Groups operate in the South Australian Murray-Darling Basin, and are associated with the SA MDBNRM Board. They work and engage with communities to facilitate grass roots environmental activities with local landholders and other community groups.

2.2 Planning process

Development of the Annual Environmental Watering Plan commences each February. Figure 3 outlines the overarching process used to decide and consult on the annual State priorities and subsequently to develop the Annual Plan.

Within South Australia, the annual planning process is led by DEWNR, with input from water managers, traditional owners and stakeholder groups.

The MDBA’s *Guidelines for the method to determine priorities for applying environmental water* (2012c) were considered as far as practicable in the development of this plan. To help determine environmental watering priorities, resource availability scenarios were established.

Figure 3: Process for developing the 2014-15 Environmental Watering Plan for the River Murray

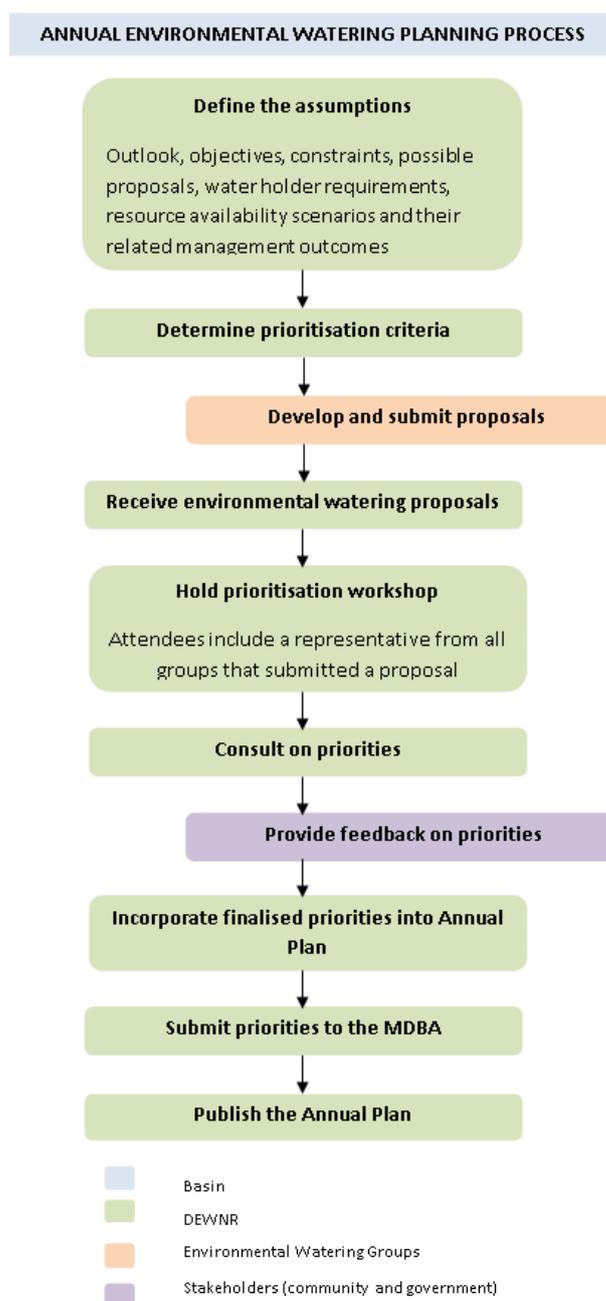


Table 1: Summary of prioritisation criteria

Criteria	Summary	Weighting
1. Scale of environmental benefit	The contribution the activity would make to meeting key site values and/or management objectives in relation to the whole River Murray system and the length of time for which the benefits will be felt.	1
2. Risk of not applying water	The risks to species, habitat, previous watering investment and/or resilience if activity does not occur.	1
3. Environmental risks associated with watering	The risks to water quality, liability and any other factors if activity occurs, with consideration for the timeframe, likelihood and consequence of the risk being realised.	1
4. Certainty / likelihood of benefit	The likelihood that the desired benefits will be achieved, with consideration of the evidence, models, past experience, and scientific understanding of the results of the activity.	1
5. Significance of site	The significance of the site in relation to state/national/international agreements and threatened species.	1

In the prioritisation workshop, proposals were assessed against agreed State criteria (summarised in Table 1, adjacent, and included as Appendix C). These are based on TLM criteria (MDBA 2012a) with some adjustments and are consistent with the principles set out in the *Basin Plan*.

Community Engagement

Two information sheets were produced and distributed to stakeholder groups. The first provided general information about the planning process and how stakeholders could have input; the second presented the draft prioritised watering actions based on the input received and sought further feedback. Following a prioritisation workshop, the proposed priorities were refined on the basis of feedback received during the consultation period.

A wide range of stakeholders and community groups were involved in consultation, which included presentations on the proposed watering priorities for 2014-15. A full list of groups and organisations who contributed during this process are listed under Acknowledgements (page iv).

Specific seasonal, operational and management factors were considered on an ongoing basis during development of the Annual Plan to continually improve understanding of State priorities and refine proposed watering actions.

Indigenous Engagement

Indigenous communities have a complex relationship with water that goes beyond simply using it for consumptive purposes. During development of the Annual Plan, consultation has been initiated with traditional owner groups along the South Australian River Murray.



A range of river users are consulted on proposed environmental watering actions.

PART A: OVERVIEW

Meetings were held with the Ngarrindjeri Regional Authority (NRA) (including the Mannum Aboriginal Community Association Incorporated (MACAI)) to discuss the proposed environmental watering for the River Channel and the LLCMM, as well as the broader annual prioritisation process. Feedback was also sought from a representative body of the First Peoples of the River Murray and Mallee Region on the proposed annual priorities.

The First Peoples confirmed support for the intent and outcomes of environmental watering in improving ecological health along the River. They welcomed opportunities for further consultation and involvement to incorporate cultural information into watering plans for the wetlands, where appropriate support could be provided for this to occur.

Engagement of traditional owners in the management of environmental water is expected to evolve further. Opportunities have been identified during the planning process to increase and improve the nature of this engagement. This is consistent with the *Basin Plan* and the 2004 National Water Initiative which promote inclusion of indigenous representation in water planning wherever possible.

Engagement with the NRA and MACAI was facilitated through the Kungah Ngarrindjeri Yunnan Agreement (KNYA) Taskforce and the TLM Indigenous Partnerships Project. A Statement of Commitment is being developed by DEWNR in partnership with the NRA.

A DEWNR wetland ecologist is working with the NRA to support their review and development of wetland management plans, and help build Ngarrindjeri capacity and skills in wetland monitoring and health assessments.

3. Ecological Watering Objectives

The main objective of environmental watering in South Australia is to maximise environmental outcomes from the available water. Specific objectives for the 2014-15 include to:

- coordinate the delivery of all water to South Australia to maximise the potential outcomes throughout the South Australian Lower Murray system;
- maximise outcomes from watering in South Australia by using return flows where possible;
- deliver environmental water to the Lower Lakes, Coorong and Murray Mouth while providing benefits to upstream environmental assets and functions en route;
- facilitate the potential testing of the Chowilla regulator and ancillary structures;
- conduct further trials of weir pool raising;
- improve condition of vegetation;
- provide breeding habitat for biota;
- provide a variable flow regime;
- improve the quality of food resources for biota;
- promote spawning and recruitment of fish;
- keep the Murray Mouth open;
- manage salinity in the Lower Lakes and Coorong;
- learn about weir pool raising operational requirements and effects; and
- increase hydraulic complexity.



Silver Gulls and Whiskered Terns at the Coorong, an internationally recognised refuge for migratory birds

It is proposed that these objectives be met through delivering water to achieve the identified Annual Environmental Watering Priorities. Table 2 and Table 3, below, provide the relevant objectives taken from the *Basin Plan* and TLM / CEWO respectively. Objectives for specific water activities are summarised in Part B, Annual Priorities and are included in the companion document, *Supporting Information*.

Table 2: Basin Plan environmental objectives

Overall Environmental Objectives	
8.04 (a)	to protect and restore water-dependent ecosystems of the Murray-Darling Basin
8.04 (b)	to protect and restore the ecosystem functions of water-dependent ecosystems
8.04 (c)	to ensure that water-dependent ecosystems are resilient to climate change and other risks and threats
Protection and Restoration of Water-Dependent Ecosystems Objectives	
8.05 (2)	to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that: <ul style="list-style-type: none"> (a) declared Ramsar wetlands that depend on Basin water resources maintain their ecological character; and (b) water-dependent ecosystems that depend on Basin water resources and support the life cycles of species listed under the Bonn Convention, CAMBA, JAMBA or ROKAMBA continue to support those species; and (c) water-dependent ecosystems are able to support episodically high ecological productivity and its ecological dispersal.
8.05 (3)	to protect and restore biodiversity that is dependent on Basin water resources by ensuring that: <ul style="list-style-type: none"> (a) water-dependent ecosystems that support the life cycles of a listed threatened species or listed threatened ecological community, or species treated as threatened or endangered (however described) in state law, are protected and, if necessary, restored so that they continue to support those life cycles; and (b) representative populations and communities of native biota are protected and, if necessary, restored.
Protection and Restoration of Ecosystem Functions of Water-Dependent Ecosystems Objectives	
8.06 (2)	that the water quality of Basin water resources does not adversely affect water-dependent ecosystems and is consistent with the water quality and salinity management plan.
8.06 (3)	to protect and restore connectivity within and between water-dependent ecosystems, including by ensuring that: <ul style="list-style-type: none"> (a) the diversity and dynamics of geomorphic structures, habitats, species and genes are protected and restored; and (b) ecological processes dependent on hydrologic connectivity... <ul style="list-style-type: none"> (i) longitudinally along watercourses; and (ii) laterally between watercourses and their floodplains (and associated wetlands); and (iii) vertically between the surface and subsurface; <ul style="list-style-type: none"> are protected and restored; and (c) the Murray Mouth remains open at frequencies, for durations, and with passing flows, sufficient to enable the conveyance of salt, nutrients and sediment from the Murray-Darling Basin to the ocean; and (d) the Murray Mouth remains open at frequencies, and for durations, sufficient to ensure that the tidal exchanges maintain the Coorong's water quality (in particular salinity levels) within the tolerance of the Coorong ecosystem's resilience; and (e) the levels of the Lower Lakes are managed to ensure sufficient discharge to the Coorong and Murray Mouth and help prevent river bank collapse and acidification of wetlands below Lock 1, and to avoid acidification and allow connection between Lakes Alexandrina and Albert, by: <ul style="list-style-type: none"> (i) maintaining levels above 0.4 metres Australian Height Datum for 95% of the time, as far as practicable; and (ii) maintaining levels above 0.0 metres Australian Height Datum all of the time; and (f) barriers to the passage of biological resources (including biota, carbon and nutrients) through the Murray-Darling Basin are overcome or mitigated.
8.06 (5)	that natural in-stream and floodplain processes that shape landforms (e.g. the formation and maintenance of soils) are protected and restored.
8.06 (6)	to support habitat diversity for biota at a range of scales (e.g. the Murray-Darling Basin, riverine landscape, river reach and asset class).
8.06 (6)	to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (e.g. recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that: <ul style="list-style-type: none"> (a) flow sequences, and inundation and recession events, meet ecological requirements (e.g. cues for migration, germination and breeding); and (b) habitat diversity, extent, condition and connectivity that supports the life cycles of biota of water-dependent ecosystems (e.g. habitats that protect juveniles from predation) is maintained.
8.06 (7)	to protect and restore ecological community structure, species interactions and food webs that sustain water-dependent ecosystems, including by protecting and restoring energy, carbon and nutrient dynamics, primary production and respiration.
Ensuring Water-Dependent Ecosystems are Resilient to Climate Change and Other Risks and Threats	
8.07 (2)	that water-dependent ecosystems are resilient to climate change, climate variability and disturbances (e.g. drought and fire).
8.07 (3)	to protect refugia in order to support the long-term survival and resilience of water-dependent populations of native flora and fauna, including during drought to allow for subsequent re-colonisation beyond the refugia.
8.07 (4)	to provide wetting and drying cycles and inundation intervals that do not exceed the tolerance of ecosystem resilience or the threshold of irreversible change.
8.07 (5)	to mitigate human-induced threats (e.g. the impact of alien species, water management activities and degraded water quality).
8.07 (6)	to minimise habitat fragmentation.

Table 3: TLM and CEWO ecological watering objectives

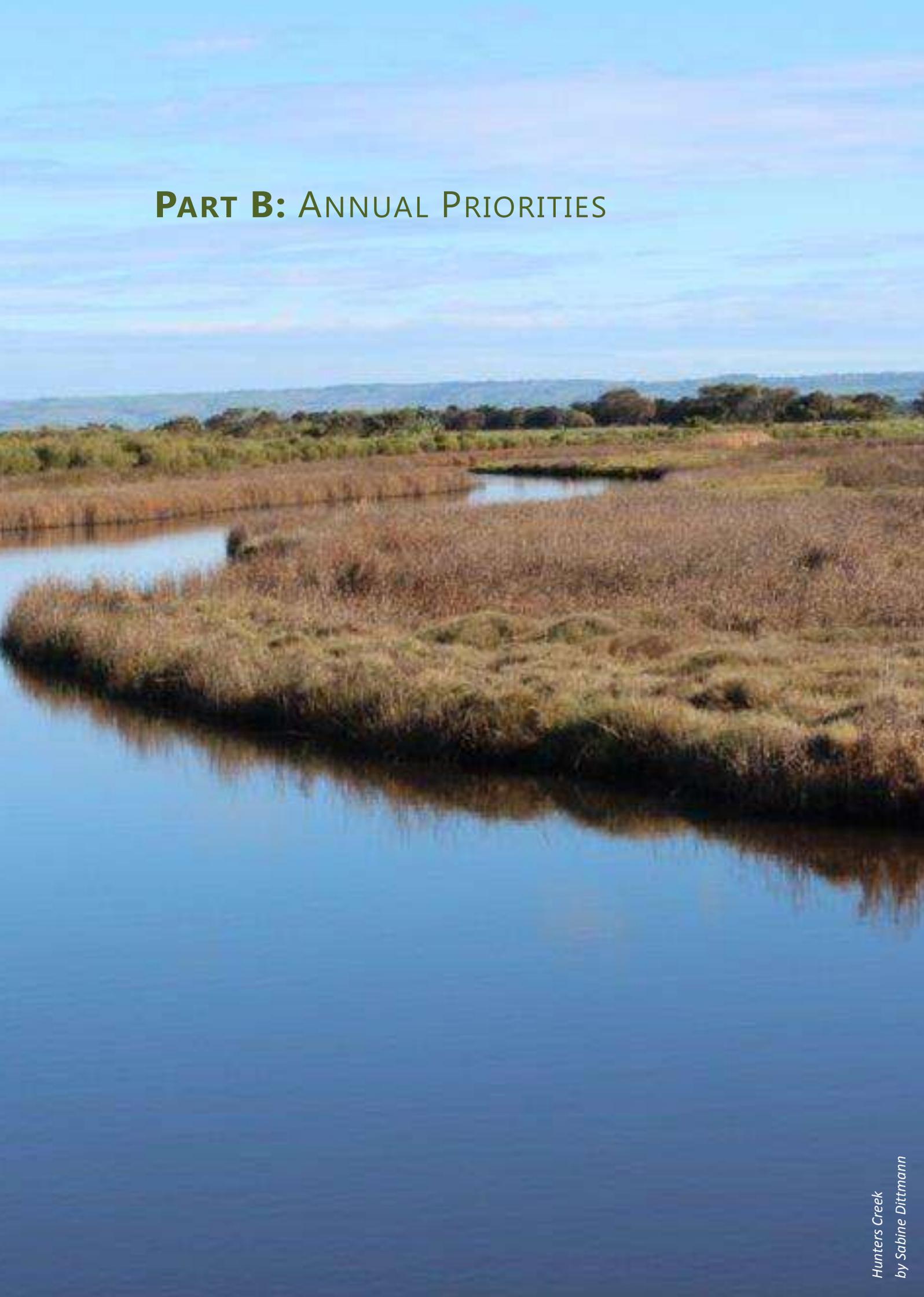
	Extreme Dry	Dry	Median	Wet
	<i>Avoid catastrophic / irretrievable loss and maintain capacity for recovery</i>	<i>Improve capacity for recovery</i>	<i>Protect ecological health</i>	<i>Improve health and resilience</i>
Ecological Watering Objectives	Avoid irreversible loss of key environmental assets	Ensure priority river reaches and wetlands have maintained their basic functions	Ecological health of priority river reaches and wetlands have been protected and improved	Improve the health and resilience of aquatic ecosystems
Management Objectives	<p>TLM / CEWO</p> <p>Avoid critical loss of species, communities and ecosystems</p> <p>Maintain key refuges</p> <p>Avoid irretrievable damage or catastrophic events</p>	<p>TLM</p> <p>Maintain river functioning with reduced reproductive capacity</p> <p>Maintain key functions of high priority wetlands</p> <p>Manage with dry-spell tolerances</p> <p>Support connectivity between sites</p> <p>CEWO</p> <p>Support the survival and growth of threatened species and communities including limited small-scale recruitment</p> <p>Maintain diverse habitats</p> <p>Maintain low flow river and floodplain functional processes in sites and reaches of priority assets</p>	<p>TLM / CEWO</p> <p>Enable growth, reproduction and small-scale recruitment for a diverse range of flora and fauna</p> <p>Promote low-lying floodplain-river connectivity</p> <p>Support medium flow river and floodplain functional processes</p>	<p>TLM / CEWO</p> <p>Enable growth, reproduction and large-scale recruitment for a diverse range of flora and fauna</p> <p>Promote higher floodplain-river connectivity</p> <p>Support high flow river and floodplain functional processes</p>



By Callie Nickolai

Regenerating River Red Gum

PART B: ANNUAL PRIORITIES



4. Assumptions

4.1 Forecast flow conditions

The annual environmental watering priorities for the South Australian River Murray for 2014-15 have been developed in accordance with the *Basin Plan*. However, a long term watering plan has not yet been written so a formal list of priority environmental assets and ecosystem functions does not exist. The priorities are summarised in Table 6. The annual priorities were developed based on the MDBA’s multi-history analysis plot (Figure 4). The percentages shown in the figure refer to the Annual Exceedence Probability (AEP) – that is, the likelihood that flows will exceed those shown (based on previous records). The optimal timing for flow enhancement actions is spring-summer.

South Australia has defined the scenarios for 2014-15 slightly differently to MDBA TLM with the 90 percent AEP representing a ‘dry’ scenario and 75 percent representing a ‘dry/median’ scenario rather than ‘extremely dry’ and ‘dry’, respectively. From a South Australian perspective, a ‘very dry’ scenario would apply under below-entitlement conditions or if we had only received entitlement flow for a number of consecutive years. These minor differences in definitions were accepted by MDBA TLM staff as appropriate for South Australian planning purposes.

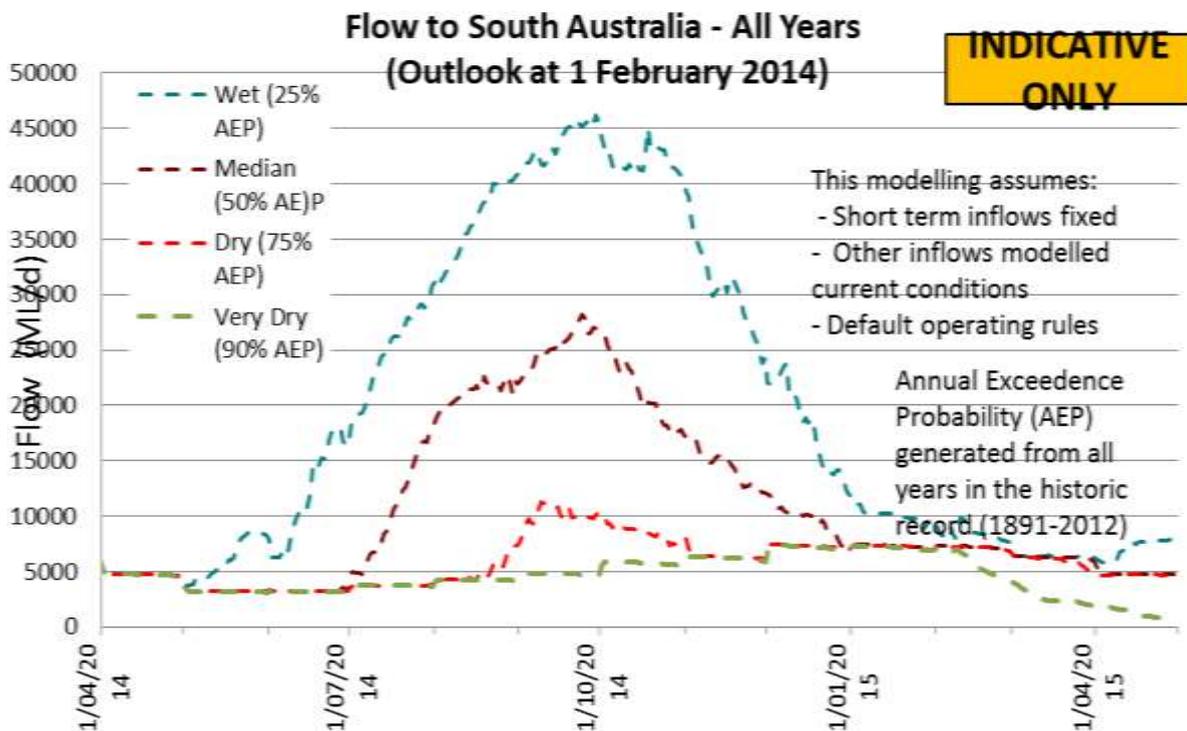


Figure 4: MDBA multi-history water resource outlook

4.2 Environmental water availability

Held Environmental Water

The expected holdings of environmental water are available from four sources – the Commonwealth Environmental Water Holder (CEWH), The Living Murray (TLM), the South Australian Government and non-government organisations.

Commonwealth Environmental Water

Total Commonwealth environmental water holdings within the Southern Connected Basin are approximately 1,202 GL, with varying levels of security and a long term average annual yield of 990 GL. The breakdown of the CEWH water holdings in the Southern Connected Basin is set out in Table 4. The exact allocations available for 2014-15 are not yet known. However, DEWNR staff were advised that 500-700 GL are likely to be available in the Southern Connected (based on dry to median outlook).

Table 4: CEWH water holdings in the Southern Connected Basin (as at February 2014)

Security	Entitlement (ML)	Long Term Average Annual Yield (ML)
High	606,634	570,831
General / Low	563,666	407,210
Conveyance	10,716	9,871
Supplementary	21,031	3,070
Total	1,202,046	990,982

The Living Murray Environmental Water

TLM water holdings are equivalent to approximately 479 GL of water, as set out in Table 5. Increased flows from the Snowy Agreement may also be available if there is consensus to call on some of this water amongst TLM partner governments. DEWNR staff has been advised that 217-245 GL of TLM water are likely to be available (based on dry to median outlook).

Table 5: TLM water holdings in the Southern Connected Basin (2014)

Security	Entitlement (ML)	Long-Term Cap Equivalent (ML)
High	114,225	106,829
General / Low	476,554	295,146
Conveyance	350,000	40,900
Supplementary	47,265	37,100
Total	988,044	479,975

South Australian Environmental Water

The volume of water held by South Australia varies from year to year, based on the water that is available and the water that is purchased. The licences holding this water are administered by DEWNR and the held water contributes to addressing the identified Priorities. Six gegalitres of Class 3A Water Access Entitlement is held on the Minister for Water and the River Murray's licence (which will be 100 percent allocated for 2014-15) and additional amounts (up to 120 GL over a 10 year rolling period of eligible years) are also required to be provided to the environment by the South Australian Government under an agreement with the Commonwealth.

PART B: ANNUAL PRIORITIES

The Water Allocation Plan (WAP) for the River Murray Prescribed Watercourse establishes 200 GL or 200,000,000 unit shares for use by pool connected wetlands. This volume is the estimated annual evaporative loss from all wetlands that are connected to the South Australian River Murray at normal operating pool level. Of this 200 GL, approximately 34 GL (or 34,781,915 unit shares) have been assigned to a Minister for Water and the River Murray's licence for use in managed pool-connected wetlands. DEWNR staff manage the water allocation for managed wetlands. The water allocation for Class 9 Water Access Entitlements in 2014-15 will be 100 percent. The priority for 2014-15 is to implement ecologically-sound hydrological regimes at all managed, pool-connected wetlands.

Non-Government Organisations

Nature Foundation SA holds 37 ML of Class 3A Water Access Entitlement on licence that is irrigation water purchased for environmental use. The Foundation also has access to up to 10 GL of water allocation each year from the CEWH for its work along the River Murray in South Australia. This is a portion of the total volume held by CEWH in the Southern Connected Basin.

The Murray Darling Association, through its Murray Darling Foundation, has established 'Water Bank' that receives donations for purchasing and holding water for future environmental activities. It holds 60 ML of Class 3A Water Access Entitlement but has no plans for environmental watering in 2014-15.

Planned Environmental Water

Unregulated flows

The WAP for the River Murray Prescribed Watercourse allows water to be allocated to high security licences only. Under the Murray-Darling Basin Agreement and the WAP, no provisions exist for the allocation and use of unregulated flows for non-environmental consumptive purposes in South Australia. Therefore, when an unregulated flow event occurs, it is not available for consumptive use. Unregulated flows generally occur in response to high rainfall events upstream from South Australia. The MDBA Environmental Watering Group has delegated authority from the Basin Officials Committee to assign unregulated flow for environmental purposes in the River Murray.

Under the different flow scenarios shown in Figure 4, unregulated flow provides the increase in volume of water above South Australia's Entitlement Flow. This unregulated flow can only be planned for in a general way, but if it occurs, it can achieve environmental outcomes in South Australia in conjunction with held environmental water.

To more closely reflect natural patterns of connectivity, regulators on managed wetlands should be fully opened during unregulated flow events to access natural high flows and optimise environmental outcomes within the wetland, unless there is strong rationale for maintaining closed regulators or otherwise delaying their opening.

Class 9 water

Under the WAP for the SA River Murray Prescribed Watercourse, 200 GL is the estimated annual evaporative loss from all wetlands that are connected to the South Australian River Murray at normal operating pool level. Of this 200 GL, approximately 34 GL (or 34,781,915 unit shares) have been assigned to a Minister for Water and the River Murray's licence for use in managed pool-connected wetlands and is therefore held environmental water (see above). The remaining 166 GL of Class 9 water will be used by non-managed, pool-connected wetlands via evaporation during normal river operations and is not available for other use.

When South Australia receives less than entitlement flow in any year and water restrictions apply, a decision matrix will be used by DEWNR to determine which hydrologically-managed pool-connected wetlands receive the

available Class 9 water held on the Minister's water licence. The criteria will include threats from prolonged drying and ecological value of the site. The number of wetlands inundated and the duration of inundation will be determined based on the volume of water available.

Water diverted from lower South-East to Coorong

Water resource managers from the South-East and River Murray will discuss optimal delivery patterns from Salt Creek to the Coorong South Lagoon, taking into account best available data and scientific input.

4.3 Delivery considerations

Delivery factors must be considered as part of managing any environmental water delivery. These are identified and taken into account during the planning process. These will be discovered, assessed and addressed on a real-time basis through relevant state and Commonwealth forums (refer to Risk Management, Section 7).

The Riverine Recovery Project is undertaking a series of works to improve management of river wetlands and anabranches from the South Australian border to Wellington. In 2014-15, several wetlands will be subject to survey, design and construction work. Flow thresholds have been identified to enable the works to be completed; these will be considered on a real-time basis in light of water delivery considerations.

Another significant consideration within South Australia relates to augmented flows across the South Australian border that reach above 60,000 ML/day due to potential implications for third parties. South Australia has a system to provide advance notice of high flows and floods to enable



Flowering Lignum, Hogwash Bend

preparation to be undertaken. Work is underway to develop a greater understanding of the implications of future increased frequency of mid to high flows in the range of 60,000 - 80,000 ML/day at the South Australian border and to facilitate the management of potential impacts.

There are also various delivery considerations upstream of South Australia that can affect delivery of water to the State. These are being progressed through the Constraints Management Strategy which is being delivered in accordance with the *Basin Plan*. These include operating limits below Hume (25,000 ML/d) and in the Goulburn and natural constraints such as the Barmah Choke and Lower Darling.

5. Environmental Watering Priorities

The annual environmental watering priorities for the South Australian River Murray for 2014-15 have been developed in accordance with principles listed in the *Basin Plan* (Appendix F). The priorities are summarised in Table 6 below. Proposed watering actions for the assets were ranked under each flow scenario (refer to Figure 4) and the agreed rankings are presented in Table 6. Tables 7, 8 and 9 provide further information with respect to the volumes of water and objectives for each of the priorities.

The potential testing of the Chowilla regulator is a very high priority for the Murray-Darling Basin Authority and for the South Australian Government. This action was not ranked against other proposed watering actions but it has been included in the following table as equal highest priority.

A decision whether to test has not yet been made. A final decision to proceed with testing of the Chowilla regulator will be made following consideration of a number of factors, including risks associated with legal proceedings and the availability of the required environmental conditions. The South Australian Government is undertaking preparations to satisfy all pre-conditions for testing should a decision to proceed with testing be made.

The Coorong is addressed in this document rather than in the annual priorities for the Murray Region Water Resource Planning Area as its primary source of water is via the River Murray.

The annual priorities have been developed based on environmental assets, and incorporate ecosystem functions relevant to each site.

Table 6: 2014-15 Environmental watering priorities for the South Australian River Murray

Ranking	Dry scenario 90 percent	Dry/Median scenario 75 percent	Median scenario 50 percent
1	12 months of barrage releases Potential testing of Chowilla regulator	12 months of barrage releases Short flow pulse for CLLMM Long flow pulse for CLLMM Potential testing of Chowilla regulator	12 months of barrage releases Long flow pulse for CLLMM Create 25,000 ML/day flow pulse for up to 90 days Potential testing of Chowilla regulator
2	Provision of water to threatened fish refuges	Provision of water to threatened fish refuges Create 15,000 ML/d flow pulse for up to 90 days	Gravity fed wetlands Pump temporary wetlands Create 25,000 ML/day flow pulse for up to 60 days
3	Create 10,000 ML/d flow pulse for up to 90 days Vary Lower Lake levels	Create 15,000 ML/d flow pulse for up to 60 days Vary Lower Lake levels	Raise weir pools 1 and 2 up to 50 cm
4	Gravity fed wetlands Pump temporary wetlands	Gravity fed wetlands Pump temporary wetlands	Lake cycling
5	Create 10,000 ML/d flow pulse for 60 days Pump Lower Lakes fringing wetlands	Raise weir pools 1 and 2 up to 20 cm	

PART B: ANNUAL PRIORITIES

Table 7: 90 percent AEP scenario

Site	Action	Additional details	Objectives	Approx. volume (GL)
LLCMM	Lake level manipulation	6 months, July – December	Wet/dry fringing wetlands – zooplankton emergence	380
	Barrage releases	12 months, fishways only	Connectivity; fish passage	120
	Pump to fringing wetlands	4 sites (Milang, Tolderol, Point Sturt, Gollan's)	Habitat for EPBC migratory birds and Southern Bell Frog	0.4
Channel	10,000 ML/day flow pulse x 60 days	September - March	Vary water levels in tailwaters; improve velocity	250 – 300
	10,000 ML/day flow pulse x 90 days	Mid-September - mid-December	Perch larval dispersal/survival	300 - 450
	Pump to temporary wetlands	30 sites – to be determined	Various – depends on sites selected	10.3
	Gravity fed wetlands	Bookmark Creek + managed wetlands	Refer to wetland management plans	35
Chowilla	Threatened fish refuges	2 sites (Dishers Creek and Berri Evaporation Basin)	Support Murray Hardyhead	1.5
	Potential testing of regulator	Within channel rise	Works and measures testing; groundwater/vegetation/fauna outcomes	39
	Pump to temporary wetlands	4 sites		Up to 6.4

Table 8: 75 percent AEP scenario

Site	Action	Additional details	Objectives	Approx. volume (GL)
LLCMM	Lake level manipulation	6 months, July – December	Wet/dry fringing wetlands – zooplankton emergence	200
	Barrage releases	12 months	Connectivity; fish passage	70
	Short pulse	Mid-October - mid-January	Coorong <i>Ruppia</i>	330
Channel	Long pulse	Mid-October - mid-March	Coorong waterbirds and fish	500
	15,000 ML/day flow pulse x 60 days	September – March	Vary water levels in tailwaters; improve velocity (sub-optimal for fish objectives)	200 – 250
	15,000 ML/day flow pulse x 90 days	Mid-October - mid-January	Perch and Murray Cod recruitment	500
	Pump to temporary wetlands	28 sites – to be determined	Various – depends on sites selected	9.5
	Gravity fed wetlands	Bookmark Creek + managed wetlands	Refer to wetland management plans	35
	Threatened fish refuges	2 sites (Disher Creek and Berri Evaporation Basin)	Support Murray Hardyhead	1.5
Chowilla	Weir raising	Lock 1 up 15cm; Lock 2 up 20cm	Trial approval process and communication protocols; increase inundation area of inundation	~8
	Potential testing of regulator	Low floodplain	Works and measures testing; Groundwater/vegetation/fauna outcomes	130
	Potential testing of regulator	Low-mid floodplain	Works and measures testing; Groundwater/vegetation/fauna outcomes	290
	Pump to temporary wetlands	4 sites		Up to 6.4

Table 9: 50 percent AEP scenario

Site	Action	Additional details	Objectives	Approx. volume (GL)
LLCMM	Lake level cycle	4 weeks, March – April	Lake Albert ecology	300
	Long pulse	Mid-October - mid-March	Coorong waterbirds and fish	500
Channel	25,000 ML/day flow pulse x 60 days (30 days sub-optimal)	September - March	Red Gum condition/ germination/ recruitment; velocity; productivity	150 – 300
	25,000 ML/day flow pulse x 90 days (60 days sub-optimal)	October – December	Murray Cod, Perch, frog breeding, waterbirds	300 – 450
	Pump to temporary wetlands	23 sites – to be determined	Various – depends on sites selected	7.4
	Gravity fed wetlands	Bookmark Creek + managed wetlands	Refer to wetland management plans	35
	Threatened fish refuges	2 sites (Dishers Creek and Berri Evaporation Basin)	Support Murray Hardyhead	1.5
	Weir raising	Lock 1 up 35cm; Lock 2 up 50cm	Trial approval process and communication protocols; increase area of inundation	~20
Chowilla	Potential testing of regulator	Low-mid floodplain	Works and measures testing; groundwater/vegetation/fauna outcomes	40
	Pump to temporary wetlands	4 sites		Up to 6.4

The managed wetlands that will receive water from the Minister's Class 9 licence and desalination licence will be determined through an assessment of 2013-14 monitoring results later in June.

In addition to the South Australian priorities listed above, the Nature Foundation South Australia is exploring environmental watering actions for 2014-15. Although these actions have not been finalised, Table 10 summarises the location and purpose of some potential actions.

Table 10: Possible Nature Foundation South Australia watering actions for 2014-15

Group	Site	Purpose	Approx. volume
Lock 3 - Lock 4 Reach	Clarks Floodplain	To maintain juvenile vegetation and sustain regeneration from previous watering events	0.3 GL for all wetlands
	Rilli Reach		
	Rilli Lagoons		
	Thiele Flat		
Lock 2 - Lock 3 Reach	Loxton Riverfront Reserve	3 GL	
	Ramco Lagoon		
Lock 1 - Lock 2 Reach	Weir pool raising	3 GL	
	Reid Flat		
	Molo Flat		
	Weir pool raising		

6. Co-operative Watering Arrangements

Holders and managers of environmental water

For the last five years, holders and managers of environmental water have worked together to plan and coordinate annual multi-site environmental watering trials. The trials attempt to maximise the use of environmental water by re-using return flows as the water moves through the Southern Connected Basin. In 2013, the MDBA Basin Officials Committee agreed that the long-term objective of the multi-site environmental watering trials is to work towards incorporating environmental delivery into normal River Murray operations. This is occurring by identifying and analysing issues and potential changes to current operational practices. An additional objective is to implement policy measures from the *Basin Plan*.

These include:

- credit environmental return flows for downstream environmental use; and
- allow the call of held environmental water from storage during un-regulated flow events.

Each year, the multi-site environmental watering trials have tested a range of actions including new accounting methods, addition of environmental water to unregulated flows, use of loss factors and

coordination of environmental releases with natural flow peaks. Each trial builds on lessons learned from the previous year and enhances understanding of the key elements for success.

The MDBA Environmental Watering Group and Water Liaison Working Group contribute to the development of the multi-site strategy each year. Real-time operations groups hold regular teleconferences to ensure coordination and communication during the trial and rapid response to any issues that may arise, such as black water events and salinity spikes. An environmental watering trial is proposed for 2014-15. Environmental water holders are working towards co-ordinated delivery from releases in the Murray, Murrumbidgee and the Goulburn to maximise environmental benefits at multiple sites.

The ecological objectives and the environmental water used will vary depending on the seasonal conditions. For example, concurrent delivery of water from the Goulburn and Murrumbidgee Rivers will increase flow along the



Cape Barren Geese

By Sabine Dittmann

PART B: ANNUAL PRIORITIES

River Murray in South Australia and boost flows into the Coorong, Lower Lakes and Murray Mouth. There will be in-stream benefits along the entire River Murray system from the Hume Dam to the Murray Mouth.

South Australia is participating in planning for the multi-site watering trial for 2014-15 through the MDBA Environmental Watering Group and Water Liaison Working Group, and will contribute to the operations groups for the management and delivery of the environmental water available from all water holders.

For 2014-15, DEWNR has written a multi-site plan (see Supporting Information document) for the use of environmental water within the South Australian River Murray. When environmental water is used for a watering event using an environmental regulator or lock along South Australia's River Murray, the use volume will be calculated using modelling, and return flows will be re-used for other environmental watering activities further down the river.

7. Risk Management

Risks related to the planned environmental watering actions for 2014-15 have been identified and assessed in accordance with DEWNR's Risk Management Framework for Water Planning and Management, which is consistent with the Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000: 2009). Managers undertake their own risk assessment when developing watering proposals. A detailed risk register is provided in Appendix E, including control measures. The applied risk criteria are outlined in Appendix D.

Key identified risks relating to the environmental watering program include:

- disruption to construction works from the planned environmental watering activities, or vice versa;
- impacts on water quality, mostly in terms of salinity;
- legal issues;
- undesirable impacts of invasive species; and
- undesirable impacts on native species.

These risks are generally manageable. For instance, the impact from or on infrastructure construction works will be managed on a real-time basis through regular communications with key parties. Site-specific risks will be managed by water managers as required. More general risks relating to river operations and water quality are managed by the DEWNR River Operations Team in conjunction with the environmental water policy and programs teams. DEWNR has responsibility for communicating any significant risks to the broader community.

With regard to the Guidelines in Appendix G, potential salinity impacts from operation of the Chowilla regulator have been extensively modelled by DEWNR. Testing trials and monitoring over the next few years will enable this modelling to be validated.

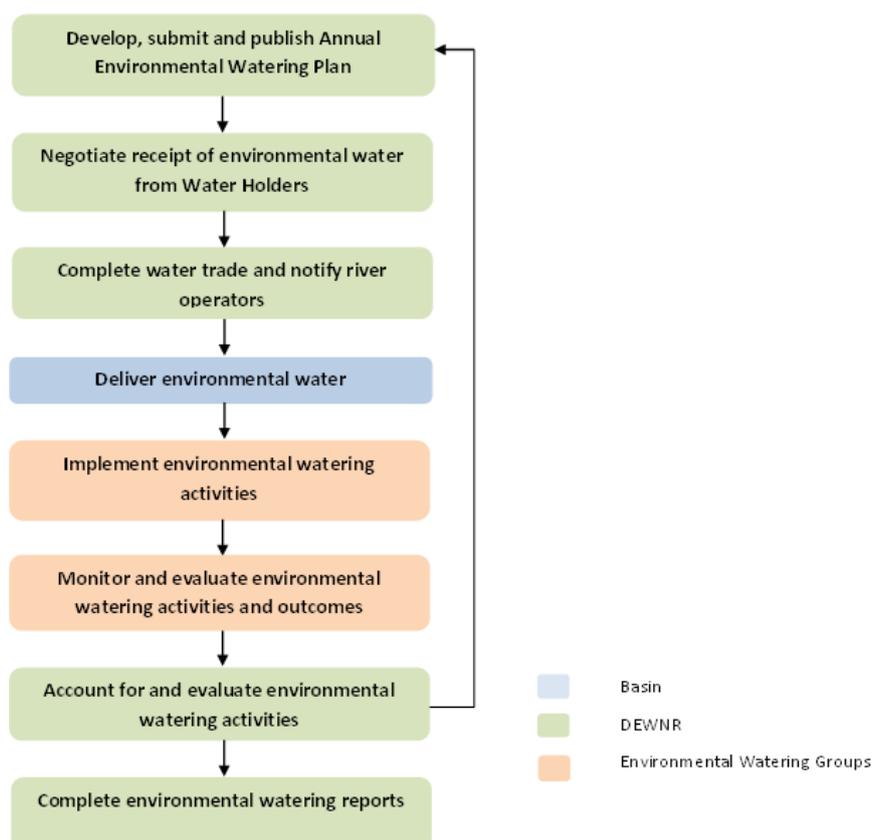
PART C: IMPLEMENTING THE PLAN



8. Implementation Process Overview

Implementation of the Annual Plan is undertaken throughout the water year by a variety of officers and groups at a local, State and Basin level, as illustrated in Figure 5 below. The implementation process concludes with an environmental watering report and development of the following year's Environmental Watering Plan.

Figure 5: Implementation process for the Annual Environmental Watering Plan



8.1. Securing environmental water

Negotiating receipt of environmental water

The CEWH and TLM have developed annual plans for the use of their water in 2014-15 concurrently with South Australia's planning process. During 2014-15, ongoing discussions will be held between these parties to determine which proposed watering activities will be supported based on water availability and conditions.

Completing water trades

A water account has been established for the South Australian Minister for Water and the River Murray to enable DEWNR to manage environmental water trades within and into South Australia from TLM, the CEWH and non-government organisations. All environmental water allocation trades occur through this account to provide transparency and for ease and accuracy of accounting and reporting. Management of the account has been delegated within DEWNR. Site Use Approvals and Works Approvals are also managed by DEWNR. The Minister holds additional accounts for the management of the water purchased to meet obligations with the Commonwealth Government.

8.2 Delivering environmental water

Delivery of water to South Australia is managed by SA Water in consultation with DEWNR under the direction of River Murray Water (MDBA). The real-time management of water required by South Australia for all purposes (including environmental water) is coordinated by DEWNR in liaison with SA Water and the MDBA on the preferred pattern of delivery to South Australia and related matters including delivery of regulated flow (Entitlement Flow, trade, Additional Dilution Flow and environmental water) and unregulated flow. Consultation is also carried out across government to identify any potential risks and to optimise the use of water for the best outcomes. Real time environmental management committees operate to adapt flows to changing conditions. These include the Barrage Operations Working Group, Environmental Reference Group and CEWO teleconference.

The South Australian River Murray Annual Operating Plan incorporates the annual priorities and watering actions. Therefore, the water delivery required to support these priorities and actions is integrated with broader river operations planning to ensure management on a real-time basis, and appropriate feedback to the MDBA.

8.3 Implementing watering actions

The implementation of environmental watering is managed by water managers in consultation with other interested parties. There are several methods available for implementing environmental watering actions.

Pool-connected wetlands can be managed, if **regulators** have been installed, by opening the regulator to allow inflows to the site. This is environmental watering via gravity and is a relatively cheap mode of environmental water delivery once a regulator has been constructed. A significant amount of regulator construction work has occurred in the South Australian River Murray in recent years and will continue in 2014-15.

Above-pool wetlands can have water delivered via **pumping**. A variety of permanent and temporary pumps are used, depending on the watering timeframes. Pumping can be a costly way to deliver environmental water. Funding is sought from year to year as required.

Environmental regulators such as the one that has been built at Chowilla will potentially water a significant area of the floodplain surrounding their location. This is a new way of managing environmental water and will require considerable testing and monitoring over the next few years.

The barrages influence water movement into Coorong and out to sea through the Murray Mouth. They are operated by SA Water and advice is provided by DEWNR and the MDBA utilising the Barrage Operations Working Group.

Channel and floodplain watering actions are implemented through the addition of environmental water to flows that come across the South Australian border.

Some aspects of the river's natural flow regime (including for low-level wetlands and floodplain areas) can be reinstated by using the River Murray locks to manipulate weir pool height and thereby achieve desired water levels. Such manipulations can vary in magnitude, rate of change, duration, timing and frequency: the aim is to manipulate these variables to more closely mimic pre-regulation conditions that native species are adapted to and thereby achieve the greatest ecological benefits for a given volume of water. Weir pool manipulation can be used to enhance the environmental benefits received from small to medium flows. At the same time, a range of operational constraints and risks to other river users need to be overcome or effectively managed.

Weir pool manipulations are in their infancy and, by their nature, are relatively large-scale activities. At this stage, the intent is to implement moderate-scale weir pool raising events as exploratory activities. This will test the process and increase knowledge for improving environmental river management through weir pool manipulation. This will also aid in generating understanding and community support for weir pool manipulations in the future. For 2014-15, weir pool manipulations are planned for Locks 1, 2 and possibly 6. A range of investigations will also be undertaken to enhance operational decision making and address constraints to weir pool manipulation, again to inform any manipulations in subsequent years.

8.4 Measuring impacts

Monitoring and evaluation

Monitoring is broadly classified into two categories: condition monitoring and intervention monitoring. Condition monitoring is undertaken at regular intervals to assess the ongoing condition of the sites while intervention monitoring focuses on the assessment of a specific watering action.

The primary responsibility for development and implementation of monitoring programs for environmental watering depends on the location and funding program; however, it generally rests with the following State agency programs:

- South Australia's TLM Icon Site Program: LLCMM and Chowilla Floodplain (DEWNR);
- Regional Wetland and Floodplain Program (DEWNR);
- Murray Futures Coorong, Lower Lakes and Murray Mouth Project (CLLMM Project, DEWNR);
- Weir manipulation (RRP, DEWNR); and
- Long term intervention monitoring program (CEWO, SARDI, DEWNR).



Peron's Tree Frog – monitoring will determine whether native species such as this are benefiting from environmental watering activities

The LLCMM and Chowilla Floodplain Icon Site programs include funding for both condition and intervention monitoring. The methods and parameters monitored under TLM are outlined in the South Australia TLM Icon Site Condition Monitoring Plans approved by the MDBA (see Maunsell 2009 and Wallace 2009). Monitoring within the CLLMM Project is complementary to the LLCMM Icon Site monitoring program.

Additional monitoring at other sites will be undertaken by DEWNR, with support from the South Australian Murray-Darling Board Natural Resources Management (SA MDBNRM) Board Wetland Program. Monitoring techniques undertaken at other sites managed and monitored by DEWNR generally follow the methods outlined in *Your Wetland: Monitoring Manual* (Tucker 2004).

PART C: IMPLEMENTING THE PLAN

Specific parameters monitored at each site are dependent on the environmental watering objectives, risks, resources and the ecological and physical characteristics of the site.

As environmental watering progresses, it will become increasingly important to undertake strategic and regionally integrated environmental water monitoring. As the volumes of environmental water and number of watering sites grow, it will be more difficult to monitor all sites that receive water. It will be necessary to identify indicator sites and key parameters for monitoring, as well as consider ways to monitor the outcomes of environmental watering at a regional level rather than on an individual site basis.

DEWNR currently relies on information gathered through existing monitoring programs as described above. These programs have been established with specific purposes that generally relate to site-specific management plans and enable adaptive management of these sites. Information on the type of information gathered through each of these programs can be sourced from relevant site managers.

Further information regarding the monitoring and management of environmental watering priorities is provided in the Supporting Information companion document.

The monitoring data collected during the water year is assessed and evaluated by ecologists to determine whether environmental watering objectives have been achieved. This data is used as input to planning for the following years by helping to determine environmental watering priorities and to manage adaptively to get the best ecological outcomes from the available water. For example, was the water delivered in the appropriate season and for sufficient duration? If not, why not and can this be improved? Did unexpected outcomes occur and if so can the reason be determined.

Accounting and reporting

DEWNR is responsible for maintaining records and reporting on environmental watering data such as allocations, trades, water use volumes, timing and ecological outcomes. Reporting on the benefits and ecological outcomes of environmental watering events occurs through individual site reports. These are consolidated into the Annual Environmental Watering Report and other reports required by the CEWO and TLM. There are also new reporting requirements associated with the *Basin Plan* with some reporting being annual and some five yearly. DEWNR has undertaken work in 2013-14 to assess how existing reporting can be aligned with the new reporting requirements under the *Basin Plan*.

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APPENDICES

A. Roles and Responsibilities

Environmental water policy, planning and management for the River Murray in South Australia is undertaken by DEWNR in consultation with other State agencies involved in River Murray environmental projects. Various elements of planning, delivery and reporting are undertaken by State agencies, working collaboratively with non-government organisations such as LAP Associations, community groups and landholders. The roles and responsibilities of each organisation are summarised below.

DEWNR

Policy Development

- Establishment of a strategic framework for environmental water management in South Australia;
- Development of long-term watering plans;
- Coordination of environmental water policy and planning development;
- Coordination of development of wetland policy; and
- Management of environmental water held by the State against the Minister's licence.

Annual Planning

- Development of the Annual Environmental Watering Priorities and Plan for the River Murray in South Australia;
- Development of environmental water proposals on behalf of LAP and community groups;
- Development of water proposals for managed wetlands; and
- Provision of recommendations on preferred hydrological regimes and adaptive management of wetlands, including the development of wetland management plans and environmental water requirements for wetlands.

Management of Environmental Watering Projects

- Coordination and implementation of Riverine Recovery Project – wetland management plans, Management Action Database development, modelling through the Savings at Wetlands from Evapotranspiration daily Time-series (SWET) model, on-ground works;
- Management and monitoring of South Australia's TLM icon sites (LLCMM, Chowilla and River Channel) including:
 - management of delivery of water and other water related on-ground works;
 - site planning and investigations;
 - development of water bids;
 - condition and intervention monitoring programs;
 - data analysis and reporting on watering events;
 - community consultation, including Aboriginal engagement;
- Management of wetland watering events through engagement and supervision of pumping contractors and operation of infrastructure; and
- Management of wetlands located on Crown Lands and within national parks including the development of management and watering plans, environmental water requirements, management of on-ground works and watering events, monitoring and reporting.

Consultation with Community Stakeholders

- Liaison with wetland managers (LAPs, SA MDB NRM Board and landholders) for development of environmental watering proposals, delivery of water and reporting of outcomes;
- Consultation and engagement with community groups on environmental watering priorities; and
- Management of wetlands in conjunction with LAPs, landholders and community groups.

Liaison with Commonwealth and Operations

- Coordination of consolidated South Australian environmental watering proposals for submission to major environmental water holders (e.g. CEWH, TLM);
- Liaison with water holders (CEWH, TLM and NGOs) on environmental watering proposals, priorities and delivery of water;
- Participation on MDBA Environmental Watering Group, TLM Committee and Environmental Water Working Group; and
- Participation on River Murray operations committees and groups.

Accounting and Reporting

- Development and maintenance of environmental water accounting systems;
- Environmental water trades, licence management and reconciliation;
- Collation of reports for water holders, government agencies and community groups;
- Communication of environmental water use, processes and outcomes, e.g. annual reporting and media releases; and
- Monitoring, data analysis and reporting on ecological outcomes in an adaptive management framework.

SA MDB NRM Board

- Provision of community input to consultation on environmental watering priorities.

LAP Associations

- Assist landholders and community groups with management of natural resources in their respective areas, including wetlands and floodplains;
- Assist the community through community engagement, monitoring, development of funding applications, liaison with government departments on their behalf, management of projects;
- Management of on-ground works, e.g. installation of structures and weed control; and
- Management of specific wetlands with support from DEWNR and the SA MDB NRM Board.

Non-government organisations

- Work collaboratively with DEWNR, other agencies and the community in the provision of water to priority sites; and
- Acquisition of water through purchase or donation for use on ecological assets.

Community group and landholder involvement

- Management of some wetlands with support from the SA MDB NRM Board, DEWNR staff and LAPs; and
- Monitoring of some parameters at sites (depending on the capacity and experience of the community group).

B. Environmental Water Use in South Australia, 2007-2013

Environmental Water Use 2007-08

In 2007-08, an Annual Environmental Watering Plan was not developed. Rather than environmental watering, the focus was on implementing a number of drought actions, including the disconnection from the river channel of 27 regulated wetlands and six unregulated wetlands to achieve evaporative water savings for critical human water needs. By the end of June 2008, approximately 63,000 ML of savings had been achieved from these closures.

Although managed wetlands were closed for evaporative water savings, a total volume of 4,642 ML was allocated to specific environmental projects during 2007-08. This comprised 4,417 ML of water sourced through TLM, water donations of 10 ML and a contribution of 215 ML by the Hardy Wine Group to the partial rewetting of the Banrock Station Wetland.

Environmental Water Use 2008-09

An Annual Environmental Watering Plan was developed in 2008-09, which outlined the priority wetlands to be watered during the year. In 2008-09, a total of 34,089 ML of environmental water was used to benefit 47 wetlands. The main objective was to restore and protect the health of key refuge sites for plants and animals and to avoid irreversible losses.

A number of managed wetlands were disconnected in the previous year to achieve evaporative water savings. Due to prolonged periods of dry experienced at these wetlands, they were at increased risk of salinisation and declining tree health. In 2008-09, 17 of these wetlands were identified as being in urgent need of water and were refilled with 25,373 ML using evaporative water savings achieved in 2008-09 and previous years.

In 2008-09, South Australia was also successful in receiving environmental water from the following sources:

- 2,081 ML of TLM water was used at 11 wetlands within the Chowilla floodplain icon site;
- 70 ML from The Living Murray River Murray Increased Flow Account (TLM RMIF) was used at three wetlands within the Chowilla and LLCMM icon sites;
- 6,517 ML of CEWH water was used at 11 sites;
- Nature Foundation South Australia provided 7 ML to Hogwash Bend;
- Healthy Rivers Australia provided 8 ML to Akuna wetlands and 1 ML to Boggy Creek; and
- A private irrigation donation of 32 ML was provided to Akuna wetlands.

Environmental Water Use 2009-10

In 2009-10, environmental watering proposals were developed and a total of 534,900 ML of environmental water was delivered to 36 sites within South Australia. This volume included 486,300 ML delivered to Lakes Alexandrina and Albert. The remaining 48,600 ML of environmental water was delivered to 33 other South Australian River Murray wetlands.

The water delivered to the Lower Lakes comprised:

- 48,300 ML of TLM water;
- 20,000 ML of CEWH water;
- 248,000 ML of South Australia Lower Lakes Environmental Reserve, including the early delivery of 78,000 ML of the 2010-11 Reserve (with the remaining 92,000 ML to be delivered in early 2010-11); and
- 170,000 ML of water sourced from Darling inflows.

The volume delivered to South Australian River Murray wetlands (excluding Lakes Alexandrina and Albert) came from the following sources:

- 4,534 ML of TLM water delivered to 10 sites;
- 8,924 ML of CEWH water delivered to 10 sites;
- 47 ML of donated water delivered to Paiwalla wetland; and
- 35,095 ML of State water from various sources delivered to 15 wetlands.

A further 290 ML was allocated to two sites within the New South Wales section of the Chowilla floodplain, which is managed by South Australia as the Chowilla icon site manager, and 1,802 ML of CEWH and South Australian water was carried over for delivery in 2010-11.

Environmental Water Use 2010-11

An Annual Environmental Water Plan for 2010-11 was prepared. At the time of writing the plan, the Murray-Darling Basin was still in the midst of the worst drought on record. The plan described watering proposals for priority sites under the dry and extreme-dry scenarios. Due to the extended lack of flooding and stressed ecosystem condition, significant volumes of water were sought, as follows:

- up to 170,000 ML for the Lower Lakes from TLM and/or at least 140,000 ML from CEWH;
- 5,500 ML each from TLM and CEWH for barrage releases;
- 20,464 ML from TLM for 26 wetland sites either located on the Chowilla floodplain or fringing the Lower Lakes; and
- 17,900 ML from CEWH for 30 discreet wetland and floodplain sites located outside of the TLM icon sites.

Additionally, refilling of 12 pool-level wetlands that remained disconnected from the river was identified as a priority. The volume required to refill these wetlands was estimated to be 2,556 ML, with State allocations identified as the potential source of water.

The provision of 3,734 ML of water to 13 Chowilla wetlands and three wetland sites fringing the Lower Lakes was approved by TLM.

The CEWH agreed to provide 2,310 ML of Commonwealth environmental water to nine of the 30 sites that had been identified in the water bid.

However, climatic and flow conditions changed dramatically over the course of the 2010-11 water year, and by early September 2010, South Australia was experiencing unregulated flow conditions. Flows continued to rise during 2010 and into 2011, peaking at approximately 93,000 ML/day in mid-February 2011. At the end of the water year (30 June 2011), South Australia was still experiencing unregulated flows with flows of approximately 20,000 ML/day. As a result, significant areas of the floodplain were inundated by the natural high flow event, and only 290 ML of TLM and CEWH water was delivered to the wetlands identified in the original watering bids before the sites were naturally inundated.

The improved river flow conditions resulted in an increase in State water allocations and larger volumes becoming available from the main water holders. The priorities for managed environmental watering actions also changed as South Australia moved from an extreme dry to a wet scenario. In general, all pool level and above pool level managed wetlands were connected to the river and large volumes of water were allocated to the Lower Lakes and barrage releases (either directly or as return flows from upstream watering actions).

Over the course of the 2010-11 water year, 399,414 ML of environmental water was delivered to 10 sites in South Australia, which comprised volumes from the following sources:

- 157,347 ML from TLM;
- 139,191 ML from CEWH;
- 92,000 ML from the 2010-11 South Australia Lower Lakes Environmental Reserve;
- 8,873 ML of Victorian state water;
- 100 ML from donations; and
- 1,903 ML allocated and carried over from 2009-10.

The majority of the water (397,457 ML) was delivered to the Lower Lakes to increase water levels and provide for barrage releases. The remaining 1,957 ML was delivered to nine discrete wetlands, five located on the Chowilla floodplain, two on the Pike floodplain, one on the Katarapko floodplain and one at Hogwash Bend.

Environmental Water Use 2011-12

Rainfall across the Murray-Darling Basin was above average from June 2011 to March 2012. Between March and October 2011, flow conditions changed considerably from those forecast and this changed priorities at a Basin and State scale. Forecasts provided in March 2011 were for a return to Entitlement Flow by June 2011; however, unregulated flows continued and flow to South Australia was approximately 35,000 ML/day at the end of September 2011.

Additional work went into identifying options for enhancing an unregulated flow event and the watering proposals to TLM and CEWH were revisited on several occasions as flow conditions unfolded. This information was fed into cross-jurisdictional discussions regarding a multi-site watering action that intended to use large volumes of TLM and CEWH water. The multi-site watering proposal raised significant policy and operational constraints but continued in a modified format.

Delays in decision-making meant opportunities to build on natural high flows for improved ecological benefits were missed. The critical August 2011 timeline for receiving advice about approvals for barrage release water was not met, which affected the ability to meet the proposed intra-annual pattern of barrage releases. Unregulated flows provided sufficient volume to meet the 1,000 GL/year barrage release target; however, at that time it was deemed that additional water was required to implement the appropriate annual regime and provide ecological conditions and cues. Environmental water releases were needed to achieve a November 2011 peak, as well as provide for barrage releases throughout summer when very little, if any, water for barrage releases is provided through Entitlement Flow.

Securing water for barrage releases was the highest priority watering action. The TLM watering proposal to pump water to above pool wetlands located on the Chowilla floodplain also remained a priority.

CEWH water releases commenced in December 2011, but a return to unregulated flow conditions and unresolved Basin policy constraints stopped delivery after a few weeks. Subsequent high flows meant that no further environmental water was required in South Australia.

In the north of the Basin, significant rainfall events in late November and early December 2011 occurred. This resulted in increased flows to and releases from Menindee Lakes and the commencement of flood operations. During March 2012 much of the southern Basin received record high rainfall. High inflow from a number of major rivers that flow into the River Murray upstream of Wentworth resulted in an unregulated flow event, which

peaked at the South Australian border in April 2012 at 59,700 ML/day. The higher flow above 50,000 ML/day continued until mid-May 2012. From July 2011 to the end of May 2012, the total flow over the South Australian border was approximately 9,600 GL.

Increased flows to South Australia from both regulated and unregulated sources had a positive impact on water levels in the Lower Lakes, resulted in significant volumes discharged over the barrages, lowered salinity levels in the lakes, improved fish passage and contributed to keeping the Murray Mouth open. The levels of the Lower Lakes were cycled to help mitigate salinity levels in Lake Albert. Salinity in Lake Alexandrina had been consistently below 500 EC. There had been continuous flow through the barrages to the Coorong since September 2010.

South Australia received a total of 468 GL of environmental water during 2011-12. This included approximately 139 GL from TLM, 329 GL from the CEWH, 300 ML from Nature Foundation South Australia, with 95 GL of this being return flows from environmental watering that occurred upstream in the Goulburn and Broken Creeks.

2011-12 was a very different year to previous years in terms of planning and prioritising for environmental water, and many new challenges arose due to the high flow conditions. The need to revisit watering proposals was challenging, particularly with many uncertainties surrounding natural flow conditions, environmental water releases for upstream watering actions and approvals for watering in South Australia. This highlights the need for State water managers and water holders to be flexible and adaptive throughout the environmental water management process.

Environmental Water Use 2012-13

The 2012-13 water year started with a good water availability outlook. Following the flow peak of 60,000 ML/day into South Australia in April 2012, flows had receded to 15,000 ML/day at the commencement of the 2012-13 water year. Flows increased as winter and spring progressed, and the unregulated flow to South Australia was managed by River Murray Operations, MDBA to initially remain below 45,000 ML/day in September, and below 50,000 ML/day in October. The intent was to prevent flooding the construction work on the Chowilla Environmental Regulator. By mid-October, there was a sudden and significant drop in flows. Additional environmental water was released in November to create a spring pulse of close to 20,000 ML/day in December. Further environmental water was delivered through to June to maintain lake levels and support connectivity through continuous barrage outflows.

In 2012-13, the CEWH and the MDBA's TLM program together provided over 800 gigalitres (GL) for a spring pulse, flows through the river channel and to the LLCMM. Delivery of this water was supported by ongoing monitoring (including of flow rates) Lake Albert cycling and extension of the proposed late spring pulse.

Overall, there were good ecological outcomes from the program of environmental watering in 2012-13. These continued to build on improvements seen in recent years. Positive results for the 2012-13 water year include:

- continued breeding of Darters *Anhinga nouaehollandiae*, Cormorant spp and White Ibis *Threskiornis moluccus* at specific connected wetland sites;
- maintenance of frog breeding habitats (fringing aquatic vegetation), tadpoles and metamorphs at several wetland sites (e.g. Causeway and Little Duck lagoons and Bookmark Creek);
- increased number of threatened Murray Hardyhead fish in the Berri Basin including young-of-year fish; and
- maintenance of the health of *Ruppia tuberosa* (indicator vegetation) in the Coorong, although shallow submerged plants are showing sign of stress.

Some minor adverse impacts were caused by the steep recession in flows during late spring which left some breeding birds and frogs stranded.

C. Prioritisation Criteria

Ranking criteria 1 – 5 are essentially the same as TLM ‘Methodology for applying ranking criteria’ (provided in MDBA, 2012a) with some minor changes. One additional criteria has been added for the State prioritisation of South Australian River Murray watering proposals to better align with the ‘Principles to determine priorities for applying environmental water’ within the *Basin Plan 2012* (Cth). These are a starting point for further discussion only.

As stated against TLM criteria, it is acknowledged that these ranking criteria are a decision support tool and that other factors will contribute to the final decision including water availability and operational feasibility.

1. Scale of environmental benefit

high	<ul style="list-style-type: none"> contribution to key site values and/or key environmental asset (KEA) site management objectives is high (for example breeding event) total area of target community or site watered major outcomes at River Murray system-scale outcomes of the watering (for example maintenance of habitat) can be sustained for a lengthy period of time (e.g. greater than 12 months)
medium	<ul style="list-style-type: none"> able to contribute partially (approximately half) to key site values and/or to KEA site management objectives important outcomes at icon site scale at least half of target community or site watered outcomes of the watering is sustainable for a reasonable length of time (e.g. 6-12 months)
low	<ul style="list-style-type: none"> minor contribution to key site values and/or KEA site management objectives outcomes at localised scale will require follow up watering within short term (e.g. 3-6 months) in order to sustain outcomes

2. Risk of not applying water

high	<ul style="list-style-type: none"> not watering would result in a catastrophic risk to a species or key habitat component or site value that would have a long recovery time high loss of previous watering investment (ecological, volume or \$) site is reaching end of resilience period
medium	<ul style="list-style-type: none"> high risk of loss of a local population of a species, but limited scope for recovery (i.e. poor recolonisers) or long recovery time loss of key habitat components that have a short recovery time moderate loss associated with previous watering investment may not be able to fully deliver minimum regime
low	<ul style="list-style-type: none"> risk of loss of a local population (of a common species) but scope for recovery within short term minor loss associated with previous watering investment may not be able to fully deliver optimum watering regime

3. Environmental risks associated with watering

low	No discernible risks (for example liability, flooding, salinity spikes, blackwater events and other water quality risks) associated with watering. Mitigation strategies ensure no short- or long-term impacts
medium	High localised risks associated with watering. Mitigation strategies may ensure no long-term impacts but may have negative short-term impacts
high	Major widespread risks associated with watering. Mitigation strategies may not be able to prevent long-term negative impacts on ecosystem health

4. Certainty/likelihood of benefit

high	☑ Considerable evidence, sound conceptual model with rigorous scientific underpinning, done successfully before at this site
medium	☑ Anecdotal support, sound conceptual model supported by good understanding of the processes that would lead to the outcome
low	☑ Limited understanding, unsure of outcome, lack of consensus on likely outcome

5. Significance of Site

high	Ramsar Supports state/national listed threatened species
medium	Supports species listed under international agreements (Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement) Significant previous investment in environmental management
low	New site

D. Risk Criteria

Likelihood

Description	Likelihood of Occurrence
Almost certain (AC)	The event is expected to occur in most circumstances
Likely (L)	The event will probably occur in most circumstances
Possible (P)	The event could occur at some time
Unlikely (U)	The likelihood of the event occurring is low
Rare (R)	The event may occur only in exceptional circumstances

Consequence

	Environmental	People and property	Operational
Critical (C)	Irreversible damage to the environmental values of an aquatic ecosystem and/or connected waters/other parts of the environment; localised species extinction	Death or multiple life threatening injuries or severe trauma; major economic/social impact to multiple communities/ multiple industries	Predicted transmission loss will prevent the achievement of planned outcomes of the watering event (e.g. large majority proportion of water will be lost prior to destination).
Major (Ma)	Long-term damage to environmental values and/or connected waters/other parts of the environment; significant impacts on listed species; significant impacts on water supplies	Life threatening injury/ severe trauma or multiple serious injuries causing hospitalisation; sustained and significant public complaints; severe economic and/or social impact to communities	Predicted transmission loss will significantly detract from the planned outcomes of the watering event (e.g. majority proportion of water will be lost prior to preferred destination).
Moderate (Mo)	Short-term damage to environmental values and/or connected waters/other parts of the environment; short-term impacts on species	Minor injury/trauma or First Aid Treatment Case; sustained public complaints; isolated but significant economic and/or social impact	Predicted transmission loss will moderately detract from the planned outcomes of the watering event (e.g. large minority proportion of water lost prior to preferred destination).
Minor (Mi)	Localised short-term damage to environmental values and/or connected waters/other parts of the environment; temporary loss of water supplies	Short-term but significant public complaints; minor economic and/or social impact contained to small number of individuals	A small amount of water will be lost in transit and this will have a small impact on the environmental outcomes (e.g. small minority proportion of water lost prior to preferred destination).
Insignificant (I)	Negligible impact on environmental values etc.	Minor or isolated public complaints; no economic and social impact	Transmission loss minimal and will not affect the planned outcomes of the watering event (e.g. minimal amount of water lost prior to preferred destination).

The level of risk is determined by the *likelihood* of the hazard occurring, and the level of impact (*consequence*).

Overall risk level rating

		CONSEQUENCE				
		Insignificant	Minor	Moderate	Major	Critical
LIKELIHOOD	Almost certain	low	medium	high	severe	severe
	Likely	low	medium	medium	high	severe
	Possible	low	low	medium	high	severe
	Unlikely	low	low	low	medium	high
	Rare	low	low	low	medium	high

E. Risk Register

Chowilla

Identification of Risk and associated mitigation measures	Controls in place or suggested for managing risk <i>(e.g. landowners will be notified before event to ensure stock are removed from low-lying areas)</i>	Likelihood*	Consequence*	Degree of risk*
		(After controls in place)		
Injury, property / infrastructure damage, stock/crop damage, road access	If testing of the constructed infrastructure by SA Water proceeds, it will be undertaken under strict OHS&W guidelines. Lessee and neighbouring landholders will be consulted and provided early notification and frequent updates regarding testing to enable alternative stocking and access arrangements to be implemented. If testing proceeds it will be undertaken in close consultation with National Parks (Game Reserve manager) regarding management of access; campsites; visitor communications.	U	Mi	Low
Negative public response	Comprehensive communications and engagement to be undertaken incorporating advice and involvement from Community Reference Committee; key stakeholder engagement and wider community engagement via the media.	U	Mi	Low
Water quality <i>Black water, salinity, acid sulfate soils, algal blooms, transmission of pesticides, cold water pollution, other</i>	Based on current understanding, testing within the "Critical Operational Limits" that have been defined in the event management plan are considered to provide appropriate risk mitigation approaches for (i) maintaining the flow mosaic that is characteristic of the Chowilla Anabranch system, and (ii) management of several water quality issues that are of direct significance to the Basin Plan. Monitoring is in place with real-time access to data and alarm systems established for key parameters. The Chowilla Operations Group will receive real time data regarding key water quality parameters and will actively direct necessary testing responses. Monitoring needs to be undertaken over the full range of tests to confirm these boundaries and the capacity to achieve them.	U	H	Low
Invasive species <i>Spread of weeds, exotic fish etc</i>	Based on the risk assessment, it is anticipated that introduced fish species including common carp will respond to floodplain inundation. Aligning management actions with river hydrology and maintenance of flow velocities to protect habitat in order to ensure native fish are provided with favourable conditions is the primary mitigation tool.	P	Mo	Med
Water loss <i>Unauthorised take, major transmission losses</i>	Agreed methods will be used to determine how water used (evaporation, seepage and water retained) will be accounted for.	P	L	Low
Delivery constraints <i>Failure of delivery infrastructure</i>	SA Water are experienced river operators. If testing proceeds, operations will be undertaken in accordance with an agreed Commissioning Plan which details necessary surveillance, monitoring and constraints on first tests.	U	Mi	Low
Third party impacts <i>Property damage (e.g. crops, livestock, residences), flooding of roads, injury to people</i>	Raising of Lock 6 in conjunction with any potential testing will lead to inundation of land on the southern side of the River Murray. Landholders are being consulted and measures implemented to minimise impacts. If testing proceeds, close and ongoing communications will continue prior to and during testing to ensure any potential third party impacts are considered and mitigated (alternative access arranged; stock relocated).	P	Mi	Low
Failed breeding event <i>Disrupted life cycles, eg Triggering bird breeding event which cannot be completed</i>	The Operations Plan and Event Plan provide guidance for timing and duration of events. Comprehensive monitoring will need to be undertaken to enable adaptive management. Water may be retained at some sites using wetland infrastructure to enable breeding cycles to complete.	L	Mo	Med

Identification of Risk and associated mitigation measures	Controls in place or suggested for managing risk <i>(e.g. landowners will be notified before event to ensure stock are removed from low-lying areas)</i>	Likelihood*	Consequence*	Degree of risk*
		(After controls in place)		
Geomorphic impacts <i>e.g. erosion</i>	The Operations Plan and Event Plan provide clear guidance for rates of rise and fall and management of flows for potential testing to avoid geomorphic impacts such as scour and bank failure. If testing proceeds, careful monitoring will be undertaken and testing modified to manage erosion risks around and downstream of structures as they are tested for the first time.	L	Mo	Low

Lower Lakes, Coorong and Murray Mouth

Injury, property / infrastructure damage, stock/crop damage, road access	Barrage operations by SA Water are undertaken under strict OHS&W guidelines. The proposed lake operating levels will not impact road access or other infrastructure.	U	Mi	Low
Negative public response	There is a general understanding by the public in regards to the need to continue barrage releases to restore the health of the Coorong and to manage lake levels for ecological benefits. Media releases outlining the benefits of these management strategies will be developed over 2014/15.	U	Mi	Low
Water quality <i>Black water, salinity, acid sulfate soils, algal blooms, transmission of pesticides, cold water pollution, other</i>	Large releases from the LLCMM will help alleviate water quality issues in the MDB. ASS hot-spots on the margins of the Lower Lakes will remain inundated under this management regime, but will continue to be monitored by the EPA through the CLLMM Murray Futures DEWNR Program.	R	Mo	Low
Invasive species <i>Spread of weeds, exotic fish etc.</i>	Oriental Weatherloach (<i>Misgurnus anguillicaudatus</i>) are now in South Australia. All fish monitoring programs in the LLCMM will be asked to document the presence of this species.	L	Mo	Med
Species impacted by inappropriate flooding regimes - <i>promote Carp breeding etc.</i>	Lake levels will be operated so that the seasonal 'rise' will be timed to <u>late</u> spring, to reduce the chance of a carp breeding event in fringing wetlands.	U	Mi	Low
Water loss <i>Unauthorised take, major transmission losses</i>	Transmission losses are likely between the South Australian border and the barrages and will be accounted for.	R	I	Low
Delivery constraints <i>Failure of delivery infrastructure</i>	SA Water are experienced river operators, and undertake barrage maintenance as part of their usual operations.	U	Mi	Low
Third party impacts <i>Property damage (e.g. crops, livestock, residences), flooding of roads, injury to people</i>	Flooding is unlikely due to careful control of water levels and releases managed by the Barrage Operations Teleconference Committee. Large unregulated flow events in late autumn may lead to difficulties in releasing water into a saturated Coorong. This may result in higher than preferred lake levels. This will be avoided by the majority of environmental water being used in spring and summer.	U	Mo	Low
Failed breeding event <i>Disrupted life cycles e.g. triggering bird breeding event which cannot be completed</i>	<i>Ruppia tuberosa</i> recruitment in the Coorong South Lagoon is again a major objective of this watering period. Water releases will be managed where possible to prevent a consecutive breeding event. Continued releases through December, January and February are required to maintain water levels throughout this period.	L	Mo	Med

Identification of Risk and associated mitigation measures	Controls in place or suggested for managing risk <i>(e.g. landowners will be notified before event to ensure stock are removed from low-lying areas)</i>	Likelihood *	Consequence *	Degree of risk *
		(After controls in place)		
Geomorphic impacts <i>e.g. erosion</i>	Lake-shore erosion will be minimised by only holding lake levels at upper levels for short periods of time. The morphology of the Murray Mouth will continue to be monitored by SA Water. If sand deposition is evident, barrage operations will be changed so that flows are prioritised through Goolwa to keep the mouth open.	U	Mo	Low

Channel

Risk	Description of risk situation (action, scenario, timing, etc)	Controls in place or plan for managing risk	Likelihood *	Consequence *	Degree of risk *
Third party impacts <i>e.g. injury, property/ infrastructure damage, stock/crop damage, road access</i>	At river flows less than 40,000 ML/day QSA, flow remains in-channel and presents a negligible risk to third parties. Between 40,000 – 60,000 ML/day QSA, minor inconvenience may be caused on a localised scale as floodrunners, creeks and anabranches begin to flow. Impacts can include inundation of, or restricted access to, some boat moorings and ramps, pumping infrastructure, access tracks, recreational reserves and camp grounds. 'High flow' advice is issued for the River Murray. When flows reach 60,000 ML/day QSA, there is a greater number of potential third party impacts including the potential for inundation of private properties close to the edge of the River Murray. A 'minor flood warning' is issued for the shack areas only downstream of Cadell (and a high flow warning elsewhere for the River Murray).	Generally, there is four to six weeks notice of expected flows to the SA border. Therefore, early, widespread communication and information to affected stakeholders and the community provide sufficient warning to facilitate flood preparedness. This is the key risk treatment to manage third party impacts of flows in this range and ensure safe use of the River. Based on the AEP curves from the MDBA, flow to SA would exceed 60,000ML/day under the wet scenario only. Detailed work is being undertaken to increase understanding of the likely third party impacts of flows at and above 60,000 ML/day QSA along the River Murray. The outcome of this work will determine whether additional controls are required to manage risks of flows being augmented beyond 60,000 ML/day.	U	Mo	Low
Impact on construction works	Works on the Pike floodplain will be impacted by flows of 30,000ML/day.	Provide flow outlook information to DEWNR staff involved in construction works. Discuss potential mitigation measures (e.g. increasing coffer dam heights) with a minimum of four weeks lead time. Discussions are underway with Project Managers within DEWNR to target one agreed flow constraint for all construction activity on the River Murray floodplain in SA. Ongoing liaison with Project Managers will be undertaken throughout 2013/14 during real-time management of environmental water.	U	Mi	Low
Water quality issues <i>e.g. black water, salinity, acid drainage from LMRIA,</i>	Blackwater events in the River Murray generally originate in the upper catchment areas (i.e. central Murray floodplain forests) and can impact on dissolved oxygen levels in the Lower Murray catchment. Key factors influencing such events are water temperature and carbon loading, which are	Watering actions proposed under the dry, dry/median and median scenarios are within channel and will result in limited additional vegetation being inundated. Flows peaked at ~25,000 ML/day in 2013/14 and ~50,000 ML/day in 2012/13. Therefore, plant material accumulated in these areas has been	U	I	Low

Risk	Description of risk situation (action, scenario, timing, etc)	Controls in place or plan for managing risk	Likelihood *	Consequence *	Degree of risk *
<i>algal blooms, transmission of pesticides, cold water pollution, other</i>	<p>in turn influenced by flood timing and whether or not the accumulated plant material litter has been flooded before (Wallace et al 2014b).</p> <p>In South Australia, the regional groundwater table is situated above the surface of the River Murray. This creates a naturally occurring gradient resulting in saline groundwater discharging to the lower elevation River Murray, either directly or via the floodplain. Increased salt mobilisation can occur due to:</p> <ul style="list-style-type: none"> • Rapid changes in river level resulting in increased gradients between the river and the regional groundwater • Groundwater recharge through inundation of the floodplain. 	<p>inundated relatively recently. These flow rates are within the range likely to be experienced under a dry, dry/median or median scenario in 2014/15.</p> <p>The timing of environmental water delivery will be in response to natural flow peaks. The addition of environmental water to extend the duration of a flow peak or manage the rate of recession will also provide a dilution flow and likely play a role in mitigating potential water quality impacts.</p> <p>A rapid rate of recession of the flow peak could result in increased discharge of saline groundwater. Environmental water is being added to natural flow peaks and, where the natural recession is predicted to be rapid, environmental water may be used to reduce the rate of recession.</p>			
Negative public response	Public perception that e-water is being inefficiently used.	Communications and community engagement will highlight the potential positive outcomes from watering actions, including evidence from previous actions.	U	I	Low
<i>Invasive species e.g. spread of weeds, exotic fish, etc</i>	Increased spawning and recruitment by exotic species particularly carp.	<p>Although management options for preventing carp recruitment are limited, given the already sizable carp population within the region, it should not be a reason for preventing implementation of a flow pulse. Rather, watering actions should be designed to produce the best possible outcomes for native fish to off-set any response by carp. An in-channel flow pulse will be undertaken in late spring/early summer, when water temperatures are higher and a positive response by large-bodied native fish is more likely.</p> <p>Adult carp can be excluded from some permanent wetlands through the operation of carp screens, and wetland managers will be advised of any upcoming environmental water delivery to allow them to operate carp screens accordingly.</p> <p>For other proposed actions, the addition of environmental water is unlikely to cause a significant increase in carp recruitment above what would occur as a result of natural flow peaks.</p>	U	I	Low
<i>Geomorphic impacts e.g. erosion, bank slumping</i>	<p>Prolonged saturation of bank sediments and steep recession of river levels may result in bank slumping and bank erosion leading to increased sediment mobilisation and water quality problems associated with turbidity.</p> <p>Banks are particularly susceptible to slumping during rapid recession of high flows.</p>	Bank slumping may be prevented by maintaining a rate of recession that is equivalent to a change in water level of <5cm per day. DEWNR staff will aim to work with River operators and MDBA staff to manage the rate of recession during real-time management of environmental water.	U	Mo	Low

Risk	Description of risk situation (action, scenario, timing, etc)	Controls in place or plan for managing risk	Likelihood *	Consequence *	Degree of risk *
Water loss e.g. <i>unauthorised take, major transmission losses</i>	Environmental water may be lost through evaporation losses, re-regulated or diverted for consumptive use.	Transmission losses are expected to be minimal for flow pulse actions (as they remain within channel) and for actions that increase the duration but not magnitude of a flow peak (as the floodplain will already be wet, minimising loss through infiltration). Losses associated with boosting the height of a flow peak are a result of increasing the area of inundation, which is the intent of the watering action and necessary for a positive response by the additional vegetation watered. These 'losses' have been factored into the volume calculated to be returned at the end of the system for subsequent delivery to the LLCMM.	U	I	Low
Failed breeding event e.g. <i>disrupted life cycles (triggering bird breeding event which cannot be completed)</i>	Flows are provided at wrong time or insufficient duration to support successful breeding events.	Watering actions have been proposed with durations that are based on the best available conceptual understanding of eco-hydrological responses. This information has been used to developed environmental water requirements based on expert opinion or results from monitoring and observations of positive ecological outcomes.	P	Mo	Med

* See Appendix D for explanation of abbreviations related to the risk rankings in these tables

F. Principles to guide environmental watering priorities

(*Basin Plan* – Chapter 8, Part 6, Division 12, 8.53 – 8.59)

1. Consistency with principles of ecologically sustainable development and international agreements
2. Consistency with objectives in Chapter 8, Part 2 of the Plan (as identified in Table 2, page 13)
3. Flexibility and responsiveness
4. Condition of environmental assets and ecosystem functions
5. Likely effectiveness and related matters
6. Risks and related matters
7. Robust and transparent decisions

G. Guidelines for having regard to 'Targets for Managing Water Flows' (Basin Plan, Chapter 9: Water Quality and Salinity Management Plan)

Introduction

Chapter 9 of the *Basin Plan* establishes the Water Quality and Salinity Management Plan (WQSMP) for the water resources of the Murray-Darling Basin. The chapter establishes the key causes of water quality degradation and sets water quality objectives and targets for Basin Water resources.

As part of the implementation of the WQSMP, all river operators and holders of environmental water are required to have regard to 'Targets for managing water flows' (9.14) when making flow management decisions.

As part of annual Basin Plan reporting requirements, South Australia will be required to report on how it has had regard to the targets in Chapter 9 when making flow management decisions (*Item 14, Schedule 12, Water Act 2007 - Basin Plan 2012*).

The guidelines presented here are intended to assist South Australian river operators, environmental water managers and holders of environmental water to have regard to the targets when planning and making flow management decisions. They will assist in demonstrating that the South Australian Government has had regard for the targets when making flow management decisions.

It is proposed that these guidelines be reviewed when the MDBA has prepared water quality and salinity guidelines or by June 2015.

What are the targets?

The targets to have regard to when making flow management decisions are outlined in Chapter 9, of the *Basin Plan* and include:

1. To maintain dissolved oxygen at a target value of at least 50% saturation.
2. The targets for recreational water quality (values for cyanobacteria cell counts or biovolume meet the guidelines values set out in Chapter 6 of the Guidelines for Managing Risks in Recreational Water).
3. The levels of salinity at the following reporting sites should not exceed the values set out below 95% of the time (where time is defined as the current water accounting period and the previous 4 water accounting periods, i.e. a rolling five year average):
 - 1) River Murray at Murray Bridge - 830 EC
 - 2) River Murray at Morgan - 800 EC
 - 3) River Murray at Lock 6 - 580 EC
 - 4) Darling River downstream of Menindee Lakes at Burtundy - 830 EC
 - 5) Lower Lakes at Milang - 1,000 EC

Who must have regard to targets for managing flows?

The Murray-Darling Basin Authority, Basin Officials Committee, agencies of Basin States, the Commonwealth Environmental Water Holder, holders of held environmental water and managers of planned environmental water must have regard to the targets when performing functions relating to the management of water flows or making decisions about the use of environmental water.

How to have regard to water quality targets

The following principles should be considered in developing plans or making operational decisions about the management of flow and the use of environmental water in the River Murray.

High level principles

When planning and managing water flows or making decisions regarding the use of environmental water the following principles will be considered:

1. Long term and annual planning for environmental watering and management of water flows will include arrangements and consider measures to achieve the targets and mitigate any adverse impacts on water quality.
2. Management of water flows and operation of structures for environmental benefit require a coordinated approach to planning and decision making in order to identify and address cumulative impacts.
3. Where water flow changes are proposed that could result in a breach of the water quality targets for managing water flow (9.14), actions to avoid the breach must be considered.

Planning principles

1. In developing long term and annual plans and policies for management of held and planned environmental water, environmental watering and management of water flows, the potential for planned actions to impact on the water quality targets for managing water flows should be assessed.
2. Where there is potential for impact, the long term and annual plans and policies should:
 - o consider the operating principles outlined below;
 - o identify arrangements to support consideration of the targets in decision making;
 - o consider arrangements to support a coordinated approach that takes account of interactions with other relevant flow management and environmental water management planning and decision making;
 - o include arrangements for documenting decision making processes and how the targets were considered;
 - o identify relevant monitoring, evaluation and reporting arrangements; and
 - o include notification arrangements where necessary.

Operating principles

When undertaking flow management or environmental watering actions the following must be considered:

3. That the flow decision is consistent with relevant operational and environmental watering plans and policies including:
 - o the South Australian Annual Environmental Watering Plan/Priorities;
 - o South Australia's River Murray Annual Operating Plan;
 - o the MDBS's River Murray System Annual Operating Plan; and
 - o the MDBA's Objectives and Outcomes for River operation in the River Murray System.
4. If there is a high possibility that the flow decision may result in either salinity, dissolved oxygen or cyanobacteria exceeding target values, a risk assessment should be undertaken which considers:
 - a) potential impacts from the water flow decision*;
 - b) current in-stream conditions (including upstream of the South Australian border);
 - c) forecast flow conditions; and
 - d) available mitigation strategies.

** If the likelihood of impact is high further detailed assessment may be required.*

5. The need to undertake **monitoring and evaluation** of the implementation of the flow management decision to assess actual changes to relevant water quality parameters (before and after using existing monitoring or event based) and to determine long term trends.
6. Completing relevant **notification** requirements. This will include:
 - o a River Murray Action Request form to the Department of Environment, Water and Natural Resources River Murray Operations; and
 - o may include community notification through appropriate channels when required.
7. Putting in place appropriate **reporting** arrangements, including:
 - o documentation of decision making process and how targets for managing water flows (9.14) were considered; and
 - o processes to allow provision of monitoring information and documentation on how targets were considered to the Departmental Basin Plan monitoring, evaluation and reporting coordinator.