Victorian Murray Long-term Watering Plan

Minor Update

June 2021

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VICTORIA State Government | Environment, Land, Water and Planning

Cover Photo
Barmah Forest, Keith Ward Goulburn Broken Catchment Management Authority

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

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Abbreviations

ARI	Arthur Rylah Institute for Environmental Research
BE	Bulk entitlement
BWS	Basin-wide environmental watering strategy
CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
CMA	Catchment Management Authority
CMS	MDBA Constraints Management Strategy 2013 to 2024
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DELWP	Victorian Department of Environment, Land, Water and Planning
EVC	Ecological Vegetation Class
EWAG	Environmental Watering Advisory Group
EWMP	Environmental Water Management Plan
IPAPF	Invasive Plants and Animals Policy Framework
LTWP	Long-term Watering Plan
MDBA	Murray-Darling Basin Authority
MDFRC	Murray-Darling Freshwater Research Centre
MEWG	Basin Plan Monitoring and Evaluation Working Group
PVC	Permissible Consumptive Volume
RCS	Regional Catchment Strategy
RWS	Regional Waterway Strategy
SDL	Sustainable Diversion Limit
SRA	Sustainable Rivers Audit
SWP	Seasonal Watering Plan
SCBEWC	Southern Connected Basin Environmental Watering Committee
TLM	The Living Murray program
VEWH	Victorian Environmental Water Holder
VEFMAP	Victorian Environmental Flows Monitoring and Assessment Program
VWQMN	Victorian Water Quality Monitoring Network
WetMAP	Wetland Monitoring and Assessment Program for environmental water
WRPA	Water resource plan area

Glossary

Term	Basin Plan definition (Chapter, Part, Section)	Victorian definition	Example
Asset (see also priority environmental asset)	A water-dependent ecosystem that satisfies at least one of the following criteria: • is formally recognised in international agreements or, with environmental watering, is capable of supporting species listed in those agreements • is natural or near-natural, rare or unique • provides vital habitat • supports Commonwealth, State or Territory listed threatened species or communities • supports, or with environmental watering is capable of supporting, significant biodiversity. For expanded definitions see Schedule 8, also C8, P5, S8.49.	A significant water-dependent ecosystem (place). May be a single wetland, wetland complex, or a river.	Hird Swamp Lake Murphy Piambie WMU Hattah Lakes Broken Creek
Basin Plan	The Basin Plan (MDBA, 2012a) was developed in accordance with the Commonwealth *Water Act 2007* (Cth). It sets out an overarching framework underpinned with specific obligations to enable sustainable use of water resources within the Murray-Darling Basin.		
Basin States	State and Territory jurisdictions within the Murray-Darling Basin (Australian Capital Territory, New South Wales, Queensland, South Australia, Victoria).		

Term	Basin Plan definition (Chapter, Part, Section)	Victorian definition	Example
Ecosystem function	A process within or between assets which supports physical or trophic dynamics that benefit the asset and contribute to achieving ecological objectives. Under the Basin Plan an ecosystem function meets at least one of the following criteria: • "supports the creation and maintenance of vital habitats and populations • supports the transportation and dilution of nutrients, organic matter and sediment • provides connections along a watercourse (longitudinal connections) • provides connections across floodplains, adjacent wetlands and billabongs (lateral connections)" (C8, P5, S8.50) (for details see Schedule 9).	A physical process involving the interactions, movement, energy exchange, or condition of biota, soil, water, nutrients, or other physical features, and will support an environmental value.	*Lateral connectivity between floodplains, anabranches and wetlands* *Providing habitat* *Water quality* *Terrestrial litter production (for potential transport to wetlands and rivers)* *Decomposition* *Aquatic primary production.*
Priority environmental asset or ecosystem function	An ecological asset or ecosystem function (defined above) that can be managed with environmental water (C8, P5, S9.49).	An asset with significant environmental values (as per Schedule 8 of the Basin Plan), that can be managed with some form of environmental water. Important ecosystem functions (as per Schedule 9 of the Basin Plan) that can be managed with some form of environmental water, and are likely to support environmental values at a priority asset.	
Ecological/environmental objective	An objective for the protection, and if necessary, restoration, of a priority environmental asset or priority ecosystem function (C1, P3, S1.07).	The desired condition for specific environmental value(s) that may be managed with environmental water. An objective includes a desired trajectory (e.g. 'maintain' or 'improve') for a desired measurable outcome (e.g. 'extent or 'species richness'). Measured through the more specific ecological target (see below).	*Improve abundance of large-bodied native fish Maintain species richness of frog communities.*

Term	Basin Plan definition (Chapter, Part, Section)	Victorian definition	Example
Ecological/environmental target	A target that must be met in order to achieve an ecological objective. (C1, P3, S1.07)	A measurement of progress towards, or achievement of, the ecological objective. Targets should be specific, measurable, attributable, realistic and timebound. Measured by environmental monitoring at the event-based, intervention, or condition scales. Results of this measurement indicate whether adaptive management is required to accomplish the objective (for example, management of the timing, frequency, duration or volume of environmental water).	*A positive trend in the catch per unit effort (CPUE) of large bodied native fish over the 10-year period to 2025.* *Maintain the number of native frog species recorded in 8 out of 10 years to 2025.*
Environmental watering requirement	The environmental watering requirements of a priority environmental asset or priority ecosystem function, as the case may be, identified using the methods set out in Part 5 of Chapter 8. For details see C8, P5, S8.51.	Hydrological objectives: the flow components (river) or flooding regime (wetland/floodplain) that will support an environmental value reliant on hydrology for all or part of its life cycle. May consist of one or more of cease-to-flows, minimum flows, freshes, bank-full flows, and over-bank flows in a river, or filling volumes and drying in a wetland, plus timing (which seasons during the year), durations (how long does it need to occur for) and recurrence interval (every year or less frequently). May vary for dry, average and wet conditions depending on the hydrological tolerances of the environmental value. Environmental watering requirements / regime: an integration of the hydrological objectives at a specific asset that will support one or more of the ecological objectives, and be the means to achieve the ecological targets. Measured by compliance monitoring for environmental water deliveries.	*Winter fresh of 1,000 – 1,800 ML/day for 1-2 days, once per year in Jul-Aug.* *Maintain baseflows year-round, winter freshes each year, and winter overbank flows 1 in 3 years.*

Term	Basin Plan definition (Chapter, Part, Section)	Victorian definition	Example
Environmental entitlement	see *held environmental water*	An environmental entitlement is a right to water granted to the Victorian Environmental Water Holder for the purpose of maintaining the Environmental Water Reserve or improving environmental values and health of the water ecosystems and other users that depend on environmental condition. Issued by the Minister for Water under the *Water Act 1989* (Vic) and relate to the Commonwealth definition for *held environmental water*	
Environmental value		In this context, an environmental value is a water-dependent species or community present in or supported by an asset or an ecosystem function.	*Murray cod, river red gums, wetland* *Ecological Vegetation Classes (EVCs), brolga.*
Passing flow		The volume of water that water corporations or licensed diverters are obliged to provide out of storage or past a diversion point before water can be taken for consumptive use.	
Held environmental water	Water available under a water access right; or a water delivery right; or an irrigation right; for the purposes of achieving environmental outcomes (including water that is specified in a water access right to be for environmental use).	Water that is set aside for the environment as an environmental entitlement, as per the *Water Act 1989* (Vic).	
Planned environmental water	As per the *Water Act 2007* (Cth), water that is committed or preserved for achieving environmental outcomes and cannot be taken or used for any other purpose.	May refer to passing flows or above cap water, but only where specifically provided for environmental purposes.	

Summary

This long-term watering plan (LTWP) has been prepared by the Victorian Government in accordance with its obligations under the Murray-Darling Basin Plan ('Basin Plan'). It concerns the Victorian Murray water resource plan area, which includes the Victorian River Murray catchment above Lake Hume, as well as river and wetland assets that are connected to or watered via the River Murray system.

This is a minor update to the 2015 LTWP for the Victorian Murray water resource plan area, as required under the Basin Plan (s. 8.22) following the accreditation in 2020 by the Murray-Darling Basin Authority (MDBA) of Victoria's North and Murray Water Resource Plan (DELWP, 2020) and a minor update to the Basin-wide environmental watering strategy (MDBA, 2019). The most significant changes to this LTWP include:

- Increased information included from asset-based environmental water management plans (EWMPs) (watering requirements and objectives).
- Updated information from Victoria's North and Murray Water Resource Plan[1] (DELWP, 2020), including an updated risks section and definitions of planned environmental water and shared benefit water.
- Better alignment with Basin Plan including cross-reference of objectives with the Basin-wide environmental watering strategy (MDBA, 2019) and Basin Plan environmental watering plan (EWP) including Division 6 principles.
- Information about groundwater dependency of priority environmental assets.
- Inclusion of a Ramsar site section.
- Inclusion of information on the environmental watering that will occur.
- Updated monitoring section.
- Updated list of priority environmental assets and functions.
- Inclusion of revised information from updated EWMPs in the Victorian Murray.

The next update of this LTWP will occur after the MDBA's update of the Basin-wide environmental watering strategy, planned for 2023.

This LTWP focuses on the use of environmental water to achieve ecological outcomes in the Victorian Murray water resource plan area. It has been developed with regard to the Basin-wide environmental watering strategy (MDBA, 2019) and primarily uses a bottom-up approach, drawing on a considerable body of work undertaken at the regional and asset scale by Catchment Management Authorities (CMAs) in their Regional Catchment Strategies, Regional Waterway Strategies and environmental water management plans (EWMPs). The LTWP describes environmental objectives and targets for water-dependent priority environmental assets (rivers and wetlands) and ecosystem functions in the region, and the corresponding environmental watering requirements for these objectives. However, this LTWP does not provide detailed management guidance for priority environmental assets; this information remains in the asset-scale EWMPs.

The Victorian Murray LTWP fits within Victoria's existing water entitlement and policy framework and has been prepared using best available information at the time of writing. The Victorian Murray LTWP is one of three LTWPs prepared to meet Victoria's planning obligations under Chapter 8 of the Basin Plan. The remaining LTWPs have been prepared for the Victorian Murray and Wimmera-Mallee water resource plan areas.

Key elements of this plan are summarised below.

Priority environmental assets

Priority ecosystem assets are located in the catchments of the River Murray, Lower Broken Creek and Loddon Rivers. They include river and wetland assets that meet criteria for priority assets, in that they are able to receive environmental water, and meet criteria set out in Schedule 8 of the Basin Plan.

1. The water resource plans for Northern Victoria and Victorian Murray were both combined in one document.

Priority ecosystem functions

Two main ecosystem functions have been identified for the Victorian Murray water resource plan area: hydrological connectivity and water quality. These are considered priority in that they may be managed with environmental water and meet criteria in Schedule 9 of the Basin Plan.

Water-dependent ecological values

The Victorian Murray water resource plan area supports important water-dependent ecological values, including native fish (e.g. Murray hardyhead and trout cod); vegetation (e.g. river red gum communities and black box communities); waterbirds (e.g. painted snipe and white-bellied sea eagle), as well as frogs, turtles and platypus.

Objectives

The LTWP includes twenty-four[2] objectives for identified ecological assets and ecosystem functions to support waterway health in the Victorian Murray water resource plan area. These are listed in the table below and were developed from the ecological objectives set in asset-scale EWMPs, which were prepared by CMAs in consultation with local communities.

Objectives were extracted from individual EWMPs and standardised into a consistent suite of language involving trajectory (e.g. improve), aspect (e.g. abundance) and value (e.g. large-bodied native fish). Similar objectives across assets and ecosystem functions were grouped, producing a set of objectives relevant across the water resource plan area.

Theme	No.	Objectives
Connectivity	VM1	Improve connectivity between floodplains, anabranches and wetlands
Vegetation	VM2	Improve the species richness of aquatic vegetation in wetlands
	VM3	Improve the species richness of in-channel aquatic vegetation
	VM4	Improve the extent of aquatic vegetation
	VM5	Improve the condition of river red gum dominated EVCs
	VM6	Maintain the condition of black box dominated EVCs
	VM7	Maintain the extent of black box dominated EVCs
	VM8	Improve the condition of shrub and lignum dominated EVCs
	VM9	Successful growth and flowering of Moira grass plants
Waterbirds	VM10	Improve breeding opportunities for colonial-nesting waterbirds
	VM11	Improve breeding opportunities for waterbirds
	VM12	Improve habitat for waterbirds
	VM13	Improve feeding areas for waterbirds
Fish	VM14	Improve the abundance of large-bodied native fish
	VM15	Maintain the abundance of small-bodied native fish in wetlands
	VM16	Maintain distribution of threatened small-bodied native fish in wetlands
	VM17	Improve habitat for native fish
	VM18	Maintain species richness of native fish
Other Fauna	VM19	Improve habitat of frog communities
	VM20	Maintain species richness of frog communities
	VM21	Improve habitat of turtle and crayfish communities

2. These objectives are effectively the same as in the original LTWP and are now separated out into different themes to assist alignment with monitoring.

Theme	No.	Objectives
Macroinvertebrates	VM22	Improve abundance of macroinvertebrates
	VM23	Improve number of macroinvertebrate functional groups present
Water Quality	VM24	Maintain water quality within an appropriate range to allow for ecosystem processes

Cooperative arrangements

Victoria has strong cooperative arrangements for the management and delivery of environmental water between holders of held environmental water, waterway managers and owners and managers of environmental assets. The Victorian government has established these arrangements, in consultation with delivery partners and communities. The arrangements are underpinned by a range of policy, regulatory and governance frameworks.

Four types of authorities collaborate to deliver environmental water in Victoria: waterway managers, storage managers (water corporations), environmental water holders and public land managers.

Coordination and cooperation between Victorian environmental watering program partners is critical in ensuring the success of environmental watering activities across the State. As the decision-making body for use of Victoria's held environmental water, the Victorian Environmental Water Holder (VEWH) leads the coordination process.

An annual process takes place that involves CMA planning and consultation with Traditional Owners, communities and stakeholders to prepare Seasonal Watering Proposals; preparation of the Seasonal Watering Plan by the VEWH; consideration and prioritisation of actions in the Seasonal Watering Plan, in consultation with the Commonwealth Environmental Water Holder (CEWH) and the Murray-Darling Basin Authority (MDBA); the release of seasonal watering statements by the VEWH; and delivery coordination and consultation with storage managers. The Southern Connected Basin Environmental Watering Committee (SCBEWC) coordinates the delivery of environmental water across the southern Murray Darling Basin.

CMAs partner with Traditional Owners and Aboriginal Victorians in the management and planning of waterways and catchments. This includes formally recognised Traditional Owner groups and those that have not yet been formally recognised.

Constraints

Operational and physical constraints limit delivery of water for the environment and the outcomes that can be achieved. These constraints have been examined and prioritised across the Basin, initially through the MDBA's Constraints Management Strategy 2013 to 2024 (MDBA, 2013a) and then through reach-focused projects that are being led by Basin states.

Policy measures to overcome the most notable operational constraints have now been implemented. State-led projects, called 'constraints measures', are exploring the potential impacts of delivering higher flows and how these can be addressed to support system-wide environmental outcomes through the reconnection of rivers to their floodplains. Working closely with affected communities will be critical to success.

Risks

Long-term risks associated with providing for the environmental water requirements under this plan fall into two broad categories:

- Risk of failure to achieve (or demonstrate achievement of) the intended environmental objective.
- Risk of adverse impacts in the provision of environmental water.

The risks associated with a failure to achieve the intended environmental objectives are grouped into four types of risk: failure to provide recommended watering regime, failure to provide complementary works, external factors (e.g. climate change), and failure to demonstrate outcomes.

The risks associated with adverse impacts arising from the provision of environmental water have been assessed by their impact on environmental, social, cultural and economic values and management options identified.

Existing processes are in place for managing these risks at the regional and site-specific scale.

Consultation

Consultation has occurred through a three-part devolved approach. It has aimed to:

- *Involve* local communities, who have worked directly with CMAs to ensure information and concerns were understood and considered.
- *Collaborate* with the VEWH and CMAs, who have provided material and guidance for the LTWP.
- *Consult* with the water corporations, land managers, MDBA, CEWH, upstream and downstream states, and the Murray and Lower Darling Rivers Indigenous Nations (MLDRIN) who provided information where relevant and feedback on the content.

Traditional Owner groups across northern Victoria were consulted on their objectives for water management during preparation of Victoria's North and Murray Water Resource Plan (DELWP, 2020). This included Bangerang, Barapa Barapa, Dhudhuroa, Waywurru, Yaitmathang, Dja Dja Wurrung, First Peoples of the Millewa-Mallee (Nations of the Nyeri Nyeri, Ngintait and Latji Latji), Tati Tati Wadi Wadi, Taungurung, Wadi Wadi, Wamba Wemba, Weki Weki and Yorta Yorta.

Consultation with relevant Traditional Owner groups on this LTWP was also carried out in 2020, together with consultation on improving the guidance for EWMPs on Traditional Owner partnership. Feedback has informed an update of Victoria's EWMP Guidelines, to be released in June 2021. Due to the heavy reliance of Victoria's LTWPs on EWMPs, this was the key focus for Traditional Owner consultation.

Next Steps

This LTWP is one of several steps towards full implementation of the Basin Plan. Further work will be pursued in the time between this LTWP iteration and the next, due to occur after the next update of the Basin-wide environmental watering strategy in 2023. This work will progress knowledge and application of:

- Landscape scale (top down) approaches that can be integrated with the asset scale (bottom up) approach taken in this LTWP iteration.
- Use of EWMPs to meet LTWP requirements.
- Further asset-based technical work (through EWMPs for new assets, reviews and updates of existing EWMPs where needed, in line with the EWMP Guidelines that were updated concurrent with this LTWP update).

1. Introduction

The Murray-Darling Basin Plan aims to improve water security and establish a sustainable and long-term adaptive management framework for Murray-Darling Basin water resources.

The Basin Plan was released in November 2012 and sets out an overarching framework underpinned with specific obligations, to enable sustainable use of water resources within the Murray-Darling Basin.

The Murray-Darling Basin Authority (MDBA) works with Basin states to implement the Basin Plan. In Victoria, the responsibility for meeting state obligations for the Basin Plan is being met by the Department of Environment, Land, Water and Planning (DELWP), with important contributions from all water resource and asset managers.

All Basin states must develop a series of planning documents under the Basin Plan, including long-term watering plans (LTWPs) for environmental assets and ecosystem functions.

Separate LTWPs have been developed for each of Victoria's water resource plan areas, including the Wimmera-Mallee, Northern Victoria and the Victorian Murray (Figure 1). These areas are based on surface water management boundaries (not catchment boundaries) and include priority rivers and wetlands that may be managed with environmental water.

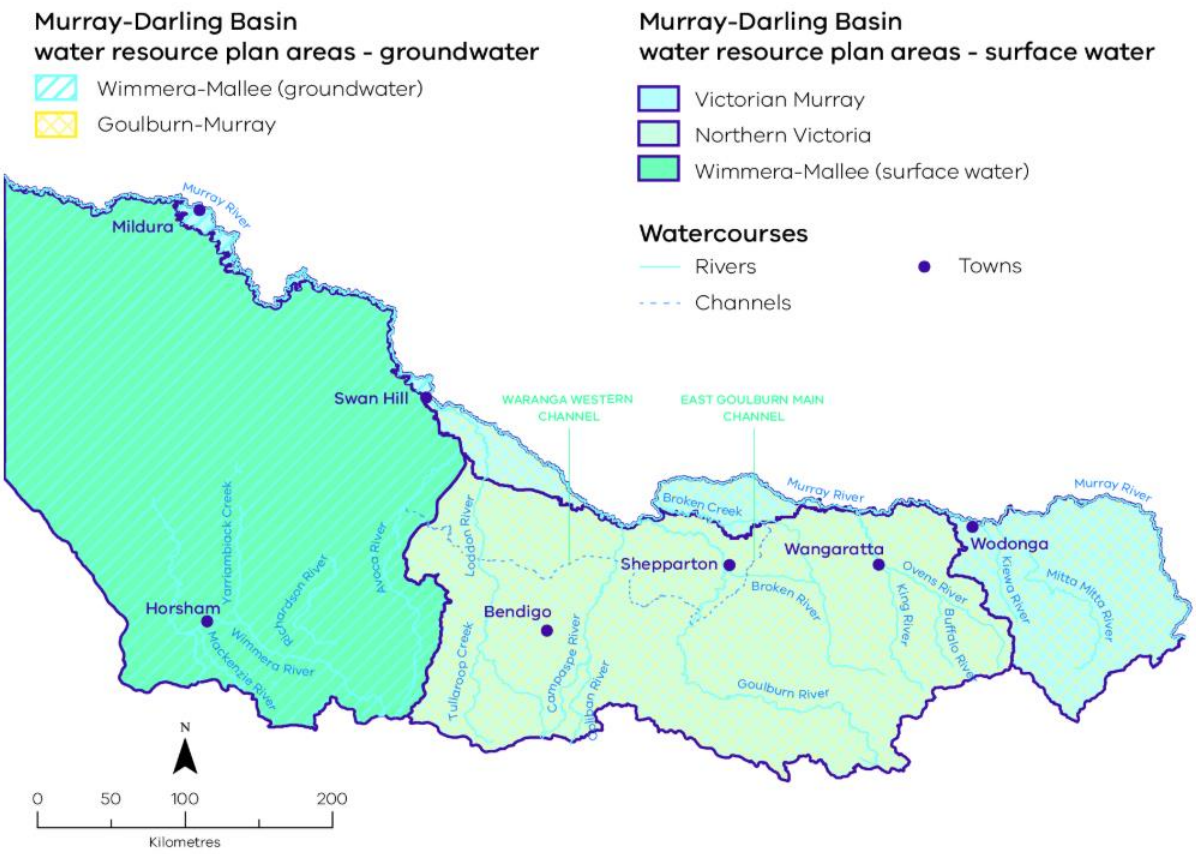


Figure 1: Victoria's three surface water resource plan areas – Victorian Murray, Northern Victoria, and Wimmera-Mallee

This LTWP for the Victorian Murray water resource plan area incorporates information and planning that is both general to Victoria and specific to the water resource plan area. The first version of this LTWP was released in 2015 and this is the first update to it.

1.1 Context

Many Victorian waterways have been highly modified by human use over the past 150 years and the construction and operation of water storages and other water interception activities have altered the natural flow regime of rivers and inundation patterns of wetlands. While complementary catchment management activities are important (see Section 7), environmental water delivery is a critical management tool to improve the health of these areas and support a shared resource that meets economic, cultural and recreational needs.

Provision of a suitable watering regime is essential to achieve the objectives and targets outlined in this plan. This does not require restoration of a completely natural water regime. Specific components may have higher importance for different biota or support vital parts of their lifecycle. Water requirements to meet objectives and targets can be developed so that the volume, timing, duration, frequency and quality of environmental water that is provided is clearly linked to the proposed outcomes from the environmental flows.

Basin Plan

The Basin Plan (MDBA, 2012a) establishes long-term management objectives in relation to:

- Environmental outcomes.
- Water quality and salinity.
- Long-term average sustainable diversion limits.
- Trading in the water market.

For the **environmental outcomes** of the Basin Plan, the MDBA and Basin states (QLD, NSW, VIC, ACT and SA) are working toward attainment of four overarching objectives:

- To protect and restore water-dependent ecosystems of the Murray-Darling Basin.
- To protect and restore the ecosystem functions of water--dependent ecosystems.
- To ensure that water--dependent ecosystems are resilient to climate change and other risks and threats.
- To ensure that environmental watering is co-ordinated between managers of planned environmental water, owners and managers of environmental assets, and holders of held environmental water.

While overall Basin Plan implementation will support these objectives, the most specific actions are set out in Chapter 8 ‘Environmental Watering Plan’, which outlines planning required from the MDBA and Basin states to achieve the objectives. This planning provides for both long-term and annual environmental water objectives, at both the Basin and a more localised scale, as shown in Figure 2.

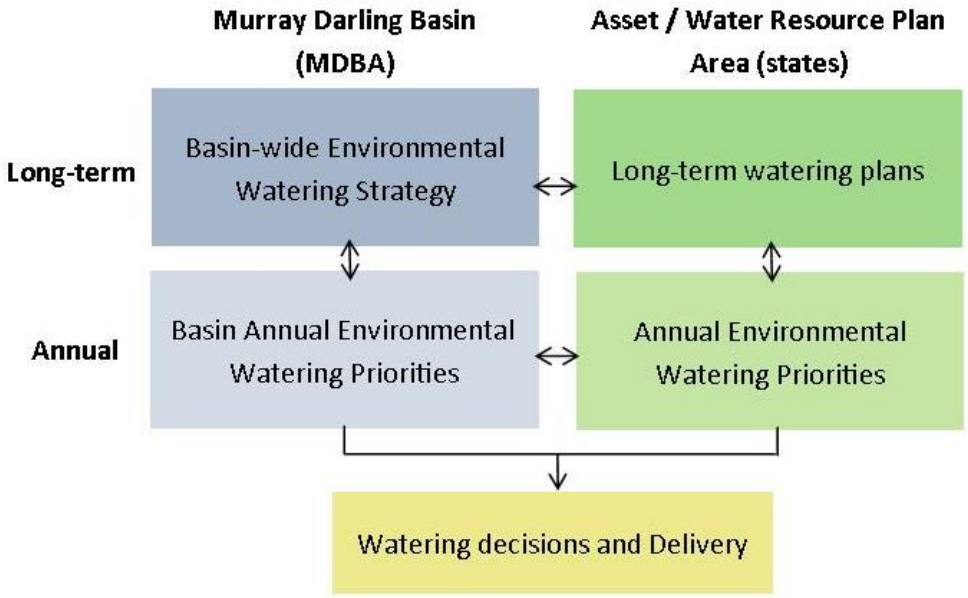


Figure 2: The long-term and annual planning documents required under Basin Plan Chapter 8 'Environmental Watering Plan'

To date, the MDBA and Basin states have completed annual watering priorities for each watering season since 2014-2015. The MDBA also released its first Basin-wide environmental watering strategy in late 2014 (MDBA, 2014a) and updated it in 2019 (MDBA, 2019).

1.2 Scope of the plan

This plan focuses on identifying the environmental watering objectives and requirements of priority river and wetland assets and ecosystem functions to achieve ecological outcomes in the Victorian Murray water resource plan area. It identifies the priority environmental assets and ecosystem functions for the water resource plan area, long-term environmental objectives and targets for these, watering requirements to meet the objectives and targets, cooperative arrangements between delivery partners, high level constraints for the water resource plan area and the long-term risks of providing environmental water. It also describes how the targets in the plan can be monitored and evaluated.

Due to the environmental watering focus, this plan is not intended to provide holistic management for catchments or waterways (this is addressed in the Victorian Waterway Management Strategy (DEPI, 2013b)). However, in recognition of co-dependencies between all waterway management issues, this LTWP also includes a section on complementary actions that must work alongside environmental watering, in order to meet waterway health outcomes.

This plan has been prepared according to the existing Victorian environmental water management framework and processes and using best available information at the time of writing.

The information in this plan has come primarily from asset-based Environmental Water Management Plans (EWMPs) that have been developed by Catchment Management Authorities (CMAs) to guide environmental water use over the long-term. EWMPs have been used as underlying documents to this plan because the content aligns well with Basin Plan requirements for LTWPs. EWMPs must be consulted for full asset-specific information when reading this LTWP and are available at https://www.water.vic.gov.au/waterways-and-catchments/rivers-estuaries-and-waterways/environmental-water/environmental-water-management-plans.

EWMPs are prepared by CMAs in consultation with their local communities. They set out the important ecological values of an asset, the condition of these values, the objectives for environmental watering and the water regime required to meet the objectives. EWMPs also set out constraints to watering at an asset and the risks associated with meeting the watering objectives. The purpose and content of EWMPs are explained in more detail in Appendix B.

A common set of terms has been defined for this LTWP to enable cross referencing between Victoria's three LTWPs and existing state planning documents. The common set of terms enables the application of a consistent language both within this document and across Victoria's three LTWPs (see Glossary). The definitions and terminology have been based on that adopted and used through Victoria in the development and implementation of EWMPs.

1.3 Purpose of the long-term watering plan

LTWPs assist planning for environmental water outcomes, to meet the Basin Plan objectives and targets, and the overall environmental objectives for water-dependent ecosystems outlined in Part 2 of Chapter 8 of Basin Plan.

The requirements for LTWPs are outlined in Chapter 8 of the Basin Plan. A LTWP must have regard to the Basin-wide environmental watering strategy (MDBA, 2019) and be consistent with the principles the Basin Plan sets out for environmental watering (BP Ch 8, Part 6). A table detailing each of the Basin Plan requirements and where they are met in the LTWP is provided in Appendix A. This LTWP also recognises there are Basin-wide obligations to take account of cultural outcomes.

Victoria's LTWPs have collated long-term environmental water planning information for priority rivers, wetlands and ecosystem functions in the northern Victorian water resource plan areas and inform:

- Victoria's Annual Watering Priorities (as per Figure 2).
- the Basin-wide environmental watering strategy and Basin Annual Watering Priorities (as per Figure 2).
- Water resource plans, particularly the environmental watering requirements (see below).
- Long-term outcomes and environmental water demand in the Commonwealth Environmental Water Holder's (CEWH) Portfolio Management Plans.
- Decisions for environmental watering by the Southern Connected Basin Environmental Watering Committee (SCBEWC) where relevant.

The water resource plan for the Victorian Murray (DELWP, 2020) was accredited by the MDBA in June 2020. Water resource plans are a state obligation under the Basin Plan that must set out arrangements for the sustainable use, management and monitoring of water resources in the water resource plan area, and include planning for environmental water, indigenous values and uses and the broad approaches to the way risks to the water resources should be addressed. Water resource plans are a key driver in implementing the outcomes of the Basin Plan at both a local and Basin-wide level.

This first update to the Victorian Murray LTWP is required under Basin Plan due to the accreditation of the water resource plan for the Victorian Murray. The aim of this update is to ensure alignment with the water resource plan for the Victorian Murray and does not make substantive change to the document. A further update is planned following the next planned update by the MDBA of the Basin-wide environmental watering strategy in 2023 (Figure 3).

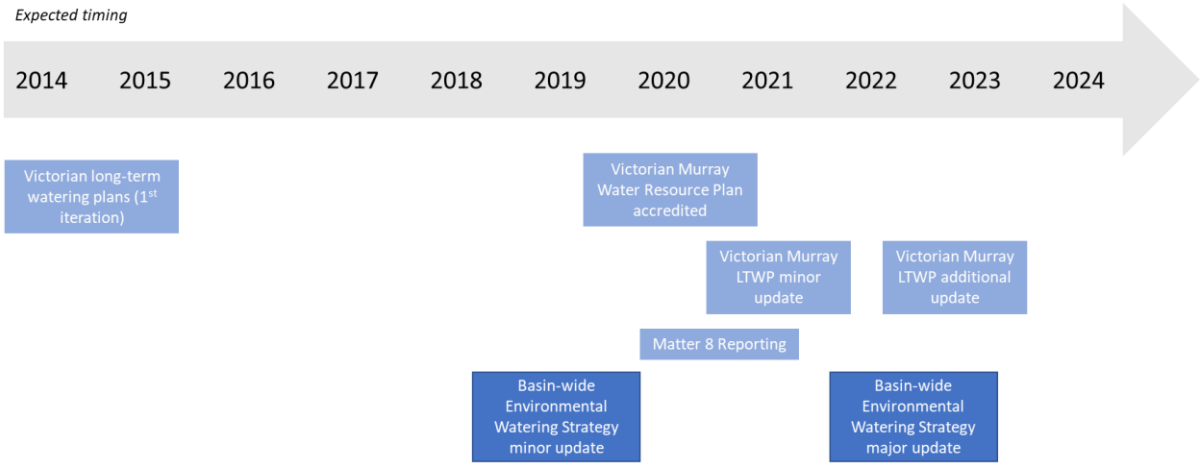


Figure 3: Victoria's long-term environmental water planning process in the context of other planning and strategic documents

1.4 Basin-wide environmental watering strategy

The Basin-wide environmental watering strategy (BWS) (MDBA, 2019) was first published by the MDBA in 2014 and updated in November 2019. Its purpose is to assist environmental water managers to plan and manage environmental watering at the Basin scale. The BWS identifies expected environmental outcomes grouped under four ecological themes: river flows and connectivity, native vegetation, waterbirds and fish. BWS expected environmental outcomes relevant to Victoria are listed in Appendix K. Alignment of LTWP objectives to the BWS expected environmental outcomes is shown in Section 3.3.

As well as having regard to the BWS during preparation, LTWPs must also be consistent with any particular assets or functions, and their requirements, identified within the BWS. Assets considered important for supporting vegetation, waterbirds and fish at the Basin-scale are identified in the BWS; those assets listed in the North and Murray Water Resource Plan are listed in Section 2.4.

1.5 Division 6 principles

The Basin Plan sets out eleven principles to be applied in environmental watering and requires Basin states to have regard to them when developing long-term watering plans. Alignment with Division 6 principles is addressed in b).

1.6 Victorian frameworks

1.6.1 Entitlement framework

Environmental water in Victoria is defined and protected as the Environmental Water Reserve under the *Water Act 1989* (Vic) and is provided in three ways:

- **Environmental water entitlements**: a proportion of water held by the environment in perpetuity. In general, the entitlements are a share of the available resource (inflows) in storages that can be released to meet specific environmental needs.
- **Obligations on consumptive entitlements**: the volume of water that water corporations or licensed diverters are obliged to provide out of storage or past a diversion point before water can be taken for consumptive use.
- **'Above cap' water**: the water available above limits on consumptive volumes of surface water and groundwater. Most water available to the environment is 'above cap' water, which can be a very unreliable source of water.

In regulated systems, environmental water is set aside mainly through environmental water entitlements. In unregulated rivers, environmental water is provided primarily through management of existing diversions via license conditions, rostering and restriction rules.

Section 4 provides further details on the provision of environmental water in Victoria, including explanations of held and planned environmental water. More information is also provided in the Victoria's North and Murray Water Resource Plan (DELWP, 2020)

1.6.2 Waterway management framework

State Strategy

The state policy for the environmental management of waterways is documented in the Victorian Waterway Management Strategy (VWMS) (DEPI, 2013b). The VWMS outlines the overarching policy for environmental management of Victorian waterways and how existing programs of management support this policy. It establishes integrated, devolved decision making. The VWMS aims to maintain or improve the environmental condition of waterways to support environmental, social, cultural and economic values.

The VWMS documents policies and actions for major waterway management issues including environmental water management, riparian management, water quality, the river channel, wetlands and invasive species management in waterways. It acknowledges that co-dependencies exist between all management areas in maintaining or improving outcomes for waterway health. The VWMS is currently being reviewed and an updated version is expected to be released in 2023.

The Victorian Waterway Management Program is based on an eight-year adaptive management cycle (five-year cycle for Melbourne Water), where learning occurs at all stages and is used to update and improve the program in subsequent cycles. It comprises three main phases:

- Strategy and planning.
- Implementation and monitoring.
- Evaluation and reporting.

Community participation and research and innovation occur across all parts of the Program. The Program is a partnership between state government, regional agencies and authorities, other management partners (such as Traditional Owners) and local communities. As part of the program, DELWP is responsible for establishing the state policy framework for waterway management. Regional implementation is led by waterway managers from our nine catchment management authorities and Melbourne Water in the Port Phillip and Westernport region.

Regional Strategies

In northern Victoria, CMAs[3] are nominated as regional waterway managers under Part 10 of the *Water Act 1989* (Vic).

CMAs have established Regional Catchment Strategies that are the primary integrated planning framework for land, water and biodiversity management in each region in Victoria, providing an overarching strategic framework for actions. CMAs have also prepared Regional Waterway Strategies that identify, in consultation with local communities, the regional priorities for on-ground works and environmental water based on the **values** (environmental, social, cultural, economic), **threats**, and **condition**.

In the Victorian Murray water resource plan area, the relevant CMAs and their Regional Waterway Strategies are:

- Goulburn Broken; Goulburn Broken Waterway Strategy 2014-2022 (GBCMA, 2014).
- Mallee; Mallee Waterway Strategy 2014-22 (MCMA, 2014).
- North Central; North Central CMA Waterway Strategy 2014-22 (NCCMA, 2014).
- North East; North East Waterway Strategy (NECMA, 2014).

Regional Waterway Strategies are currently being reviewed and will be updated in 2023.

1.6.3 Environmental water framework

Of the waterway management issues outlined in the VWMS, environmental water plays a significant role in waterway health. River regulation and licenced surface and groundwater use across Victoria has reduced the amount of water available and affected the hydrological regimes required to support environmental values.

To provide more appropriate water regimes for the environment, the adaptive management cycle is applied and includes:

- Ensuring environmental water needs are understood.
- Ensuring environmental water is protected – this includes having appropriate policy and legislation in place.
- Ensuring the water regime is managed to meet environmental objectives (planning and delivering water for the environment).
- Overcoming physical or operational constraints to enable best use of the water and maximise outcomes for the environment.
- Monitoring outcomes to evaluate whether objectives are being achieved and to inform adaptive management.
- Reviewing the process to adapt and improve as required.

Necessary to support these are:

- Clear roles and responsibilities.
- Management of risks relating to environmental water.
- Adequate research to support environmental watering knowledge.

3. In the Port Phillip and Westernport region Melbourne Water is the designated waterway manager. In every other region in Victoria CMAs are the designated waterway managers.

- Appropriate investment at each stage.

1.6.4 Environmental water planning, prioritisation and delivery

Using the State and regional strategies as a basis, waterway managers (CMAs in northern Victoria) and the Victorian Environmental Water Holder (VEWH) undertake detailed and adaptable planning for environmental water at both the long-term and annual scales. Figure 4 presents the environmental water planning and delivery framework in Victoria. This includes legislation at the national and state levels, state and regional waterway strategies, development of EWMPs and annual Seasonal Watering Proposals by CMAs, and the state-wide Seasonal Watering Plan released by the VEWH each year.

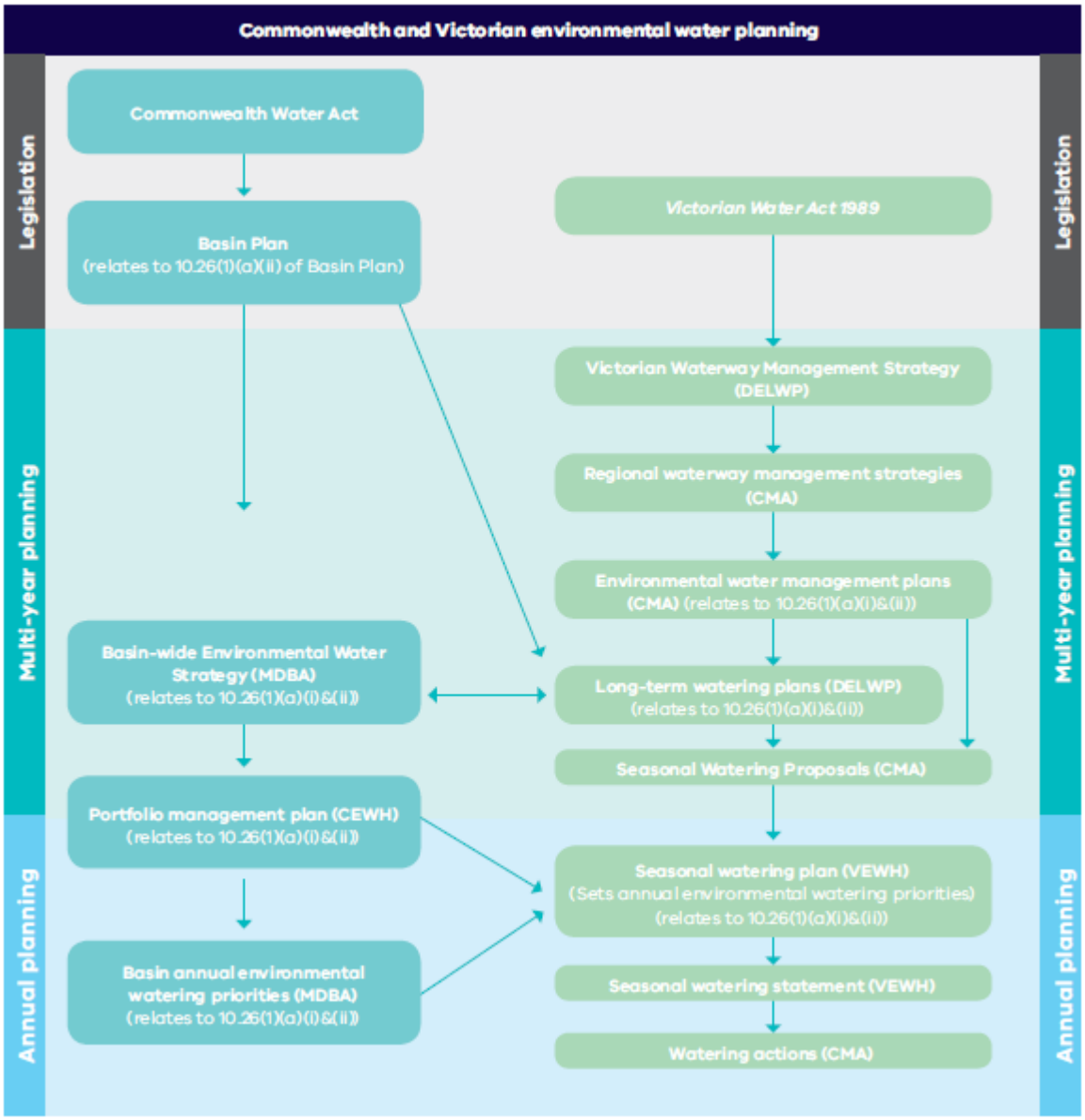


Figure 4: Environmental water planning and delivery framework in Victoria – Basin, State and Regional scales (Basin Plan specific components referred to above are described in Basin Plan Part 6, section 10.26)

The VEWH's Seasonal Watering Plan identifies priority watering actions across the state by applying criteria that include extent of environmental benefit, certainty of achieving environmental benefit, water requirements of a site, feasibility of the watering action and overall cost effectiveness (Figure 5).

Prioritisation criteria	Types of factors considered
Extent and significance of environmental benefit	▶ Size of the area being watered ▶ Expected ecological outcomes ▶ Expected scale of response ▶ Conservation status of the species or community that will benefit ▶ Expected contribution to regional environmental objectives
Likelihood of success	▶ Evidence that the desired outcomes are likely to be achieved ▶ External threats that may affect getting the desired results
Longer-term benefits	▶ Value added to previous watering undertaken at the site ▶ Longer-term environmental benefits expected ▶ Ability to sustain these values into the future
Urgency of watering needs	▶ History of watering at the site ▶ Potential for irreversible damage if the watering does not occur ▶ Risks associated with not delivering the water
Feasibility of the action	▶ Capacity of infrastructure to meet the delivery requirements ▶ System or operational constraints ▶ Flexibility in the timing of delivery ▶ Likelihood that planned management actions will mitigate external threats
Environmental or third party risks	▶ Adverse environmental outcomes that may arise ▶ Third-party risks associated with the event ▶ Effectiveness of mitigation to manage third-party and environmental risks
Cost effectiveness of the watering action	▶ Likely environmental benefit compared against: • costs to deliver and manage water • costs of interventions to manage external threats and risks
Efficiency of water use	▶ Volume of water needed to achieve the desired outcomes ▶ Volume and timing of return flows that may be used at downstream sites (see section 1.4.2) ▶ Alternative supply options such as use of consumptive water en route or augmenting natural flows ▶ Risks of spills from storages in the upcoming water year and any carryover water (see section 1.4.2) that may be available
After consideration of above criteria	
Cultural, economic, social and Traditional Owner benefits	▶ Traditional Owner values and aspirations ▶ Recreation, community events and activities ▶ Economic benefits

Figure 5: VEWH criteria for prioritising environmental watering actions

1.6.5 Seasonally adaptive approach

Victoria uses a 'seasonally adaptive' approach to identify annual watering actions, along with complementary works and measures, recognising that achieving objectives may require more than just delivering water (Table 1). It is a flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts, depending on the amount of water available in a particular year. This approach recognises that it will take time to realise the ecological outcomes associated with the BWS and the objectives outlined in the Basin Plan. For example, increasing the abundance and diversity of native fish populations is likely to require successful recruitment over multiple years, depending on such things as the

life history of the target species, availability and quality of habitat (including refuge habitat during dry periods), and the opportunity for fish to migrate and spawn.

Table 1: Victorian seasonally adaptive approach to river and wetland management

	Drought	Dry	Average	Wet to very wet
Long-term ecological objectives	Long-term objectives to move towards ecologically healthy rivers - set through the Victorian and regional waterway management strategies			
Short-term ecological objectives	• Priority sites have avoided irreversible losses and have capacity for recovery	• Priority river reaches and wetlands have maintained their basic functions	• The ecological health of priority river reaches and wetlands has been maintained or improved	• The health and resilience of priority river reaches and wetlands has been improved
Annual management objectives	• Avoid critical loss • Maintain key refuges • Avoid catastrophic events	• Maintain river functioning with reduced reproductive capacity • Maintain key functions of high priority wetlands • Manage within dry-spell tolerances	• Improve ecological health and resilience	• Maximise recruitment opportunities for key river and wetland species • Restore key floodplain linkages
Environmental water reserve	• Water critical refuges • Undertake emergency watering to avoid catastrophic events • Provide carryover (for critical environmental needs the following year) • If necessary, use the market to purchase water • Dry inflow contingency planning???	• In priority river reaches provide summer and winter baseflows • Water high priority wetlands • Provide river flushes where required to break critical dry spells • Provide carryover (for critical environmental needs the following year) • If necessary, use the market to sell or purchase water	• Provide all aspects of the flow regime • Provide sufficient flows to promote breeding and recovery • Provide carryover to accrue water for large watering events • If necessary, use the market to sell or purchase water	• Provide overbank flow • Provide flows needed to promote breeding and recovery • If necessary, use the market to sell or purchase water
River and wetland catchment activities	• Protect refuges (including stock exclusion) • Increase awareness of the importance of refuges • Enhanced monitoring of high risk areas and contingency plans in place • Investigate feasibility of translocations • Environmental emergency	• Protect refuges • Protect high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Environmental emergency management plans in place	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Monitor and survey river and wetland condition	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Monitor and survey river and wetland condition

	Drought	Dry	Average	Wet to very wet
	management plans in place • Protect high priority river reaches and wetlands through fencing; pest, plant and animal management; and water quality improvement works • Implement post-bushfire river recovery plans	• Improve connectivity • Implement post-bushfire river recovery plans	• Improve connectivity between rivers and floodplain wetlands	• Emergency flood management plans in place • Implementation of post flood river restoration programs

1.6.6 Delivery partners

Several organisations work together to deliver environmental water outcomes in Victoria. These organisations and their roles are described in the Cooperative Arrangements section of this plan (Section 5).

1.6.7 Shared benefits

Shared benefits are additional opportunistic benefits that can be achieved from environmental watering, including social, cultural, recreational and economic benefits. While the primary purpose of environmental watering is to achieve ecological outcomes, the *Water Act 1989* (Vic) was amended in 2019 to require environmental water managers to consider whether shared benefits can be achieved when planning for watering events. This includes consideration of recreational and Aboriginal values in the planning and management of waterways and catchments. However, the use of environmental water to provide for specific social, cultural, recreational, economic and/or Traditional Owner benefits cannot be prioritised at the expense of achieving environmental objectives.

Waterway managers work with communities to identify the environmental, social, cultural and economic values of waterways through Regional Waterway Strategies, EWMPs and seasonal watering proposals. Environmental water managers will continue to work with stakeholders to achieve shared benefits from environmental watering, as per the engagement principles outlined in Chapter 6 of the Victorian Waterway Management Strategy. More information on shared benefits is provided in section 4 of this plan and in Chapter 12 of the Victoria's North and Murray Water Resource Plan (DELWP, 2020).

2. Water resource plan area – priority environmental assets and ecosystem functions

The Victorian Murray water resource plan area covers a broad range of aquatic environments from the highlands in the far east, to the drier mid-Murray in the far west. It includes the downstream reaches of many northern Victorian tributaries and numerous floodplain wetlands along the River Murray. Some river systems are fully contained within the water resource plan area, others begin in different water resource plan area and flow north into this one. Waterways in this water resource plan area are managed by North East, Goulburn Broken, North Central or Mallee CMA.

2.1 Features of the Victorian Murray water resource plan area

The Victorian Murray water resource plan area (Figure 6) extends from Omeo in the far east of Victoria to the South Australian border in the north west of the state. The water resource plan area can be characterised by two distinct regions. The first of these regions comprises the Victorian tributaries of the River Murray upstream of Albury. The second region comprises the lower reaches of tributaries from the Northern Victoria water resource plan area and the anabranches and floodplain wetlands along the length of the River Murray to the South Australian border.

2.1.1 Topography

The topography of the region varies between the highly undulating valleys in the north east, down to the floodplains of the River Murray. The highest point in the water resource plan area is Mt Bogong, Victoria's highest peak at 1986 metres above sea level, and the lowest point on the floodplains near Mildura below 50 m above sea level (Figure 7). The eastern part of the region has elevations ranging from 150 to almost 2000 m AHD (at Mt Bogong), while the Murray floodplain area gradually drops from 150 to 30 m AHD (ABS, 2012). Figure 7 presents the (relative) topography in the Victorian Murray water resource plan area.

2.1.2 Geology, soils and land use

The upper Murray area landscape is dominated by the key industries of dairy, beef, wool, cropping and horticulture. Over 55% of the North East (the area defined by the North East CMA) is public land. This includes over 200 parks and reserves, used for a variety of biodiversity, eco-tourism and recreational fishing activities. The Murray floodplain area also has some areas of public conservation land, coupled with large areas of irrigation agriculture.

The River Murray floodplain area is largely comprised of alluvium and incised alluvium geology units. The Upper Murray area is comprised of a mixture of sandstone and granite areas (Adaminaby Group, Omeo Metamorphic Complex, Early Devonian Granite, and Silurian Granite).

2.1.3 Rainfall distribution

The climate for the Victorian Murray is quite varied as it extends over a large geographic area. In the upper ranges, the average annual rainfall is up to 2000 mm in some areas and drops to below 300 mm near Mildura. The rainfall occurs throughout the year, with the highest monthly averages in winter in the upper ranges but spread across the year in the vicinity of Mildura (BoM, 2015).

2.1.4 Working rivers

The rivers of the Victorian Murray water resource plan area provide for environmental, economic, social and cultural benefits. As such the rivers have been modified to varying extent from their natural state. The modifications have impacted on the hydrologic regime, physical form, riparian vegetation, water quality and instream ecology. It is not intended that these streams be restored to a pre-

development state but be managed as ‘working rivers’ with agreed sustainable levels of modification and use, which may include improvements in ecological values and functions.

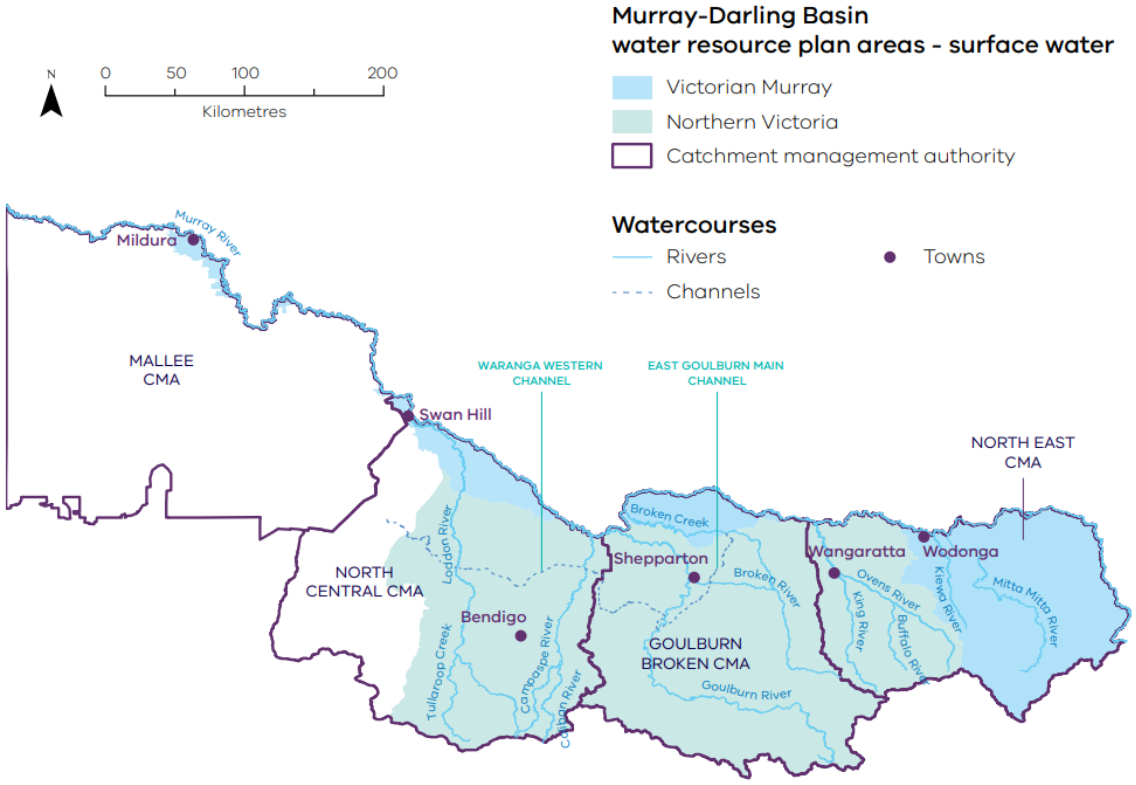


Figure 6: Victorian Murray and Northern Victorian water resource plan areas showing catchment management authority boundaries

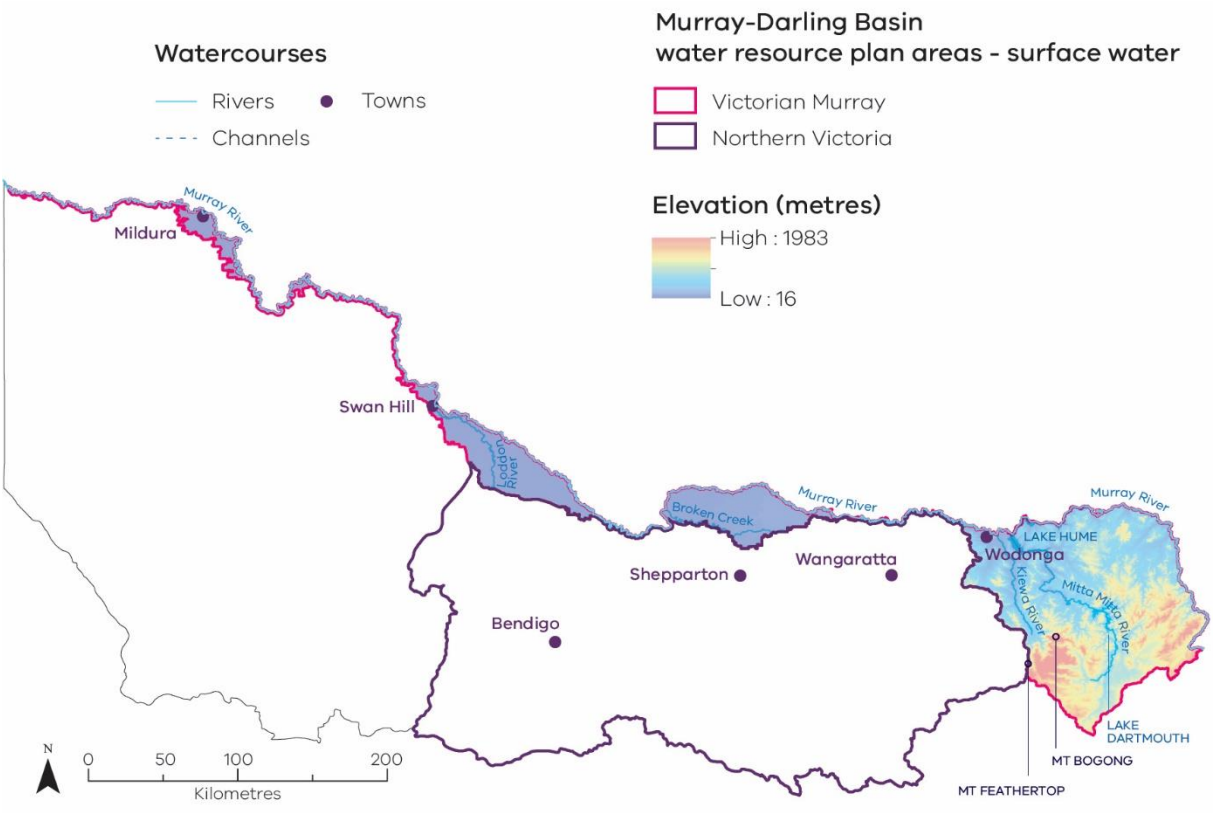


Figure 7: Topography across the Victorian Murray water resource plan area

2.2 Representativeness

An objective of the Basin Plan is to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, and to support biodiversity by ensuring representative populations, communities and species are protected, and where necessary restored. The CEWH has used the Australian National Aquatic Ecosystems (ANAE) classification framework to define the distinct waterway types and their location in the Basin (Brooks, 2017). This provided the basis for assessing the waterway types across the Basin that have received CEWH environmental water e.g. (Hale J., 2020).

Victoria has undertaken a similar representativeness assessment with the waterway type of each priority environmental asset in the Basin Plan area (see Section 2.4). Each asset has been classified using the ANAE framework and compared to the total area of the relevant waterway type(s) at two different scales, for the entire Basin Plan area in northern Victoria and also for each water resource plan area (Brooks, 2019). Broadly, most waterway types present in northern Victoria are represented by existing priority environmental assets. Some waterway types are well represented, in particular river red gum swamps and black box woodland riparian zones, while others including clay pans, river red gum floodplains and mixed woodland floodplains are less well represented. Some of the sparsely represented types tend to be disconnected from water delivery channels or may occur at higher elevations and, as such, be difficult to water. Others, such as clay pans may be considered to have low ecological value and hence not be a priority for environmental water. Yet others (e.g. saltmarshes), would be damaged by addition of fresh water. For this LTWP update, the data provided by (Brooks, 2019) has been complemented with more recent data for riverine ANAE types generated as part of an update to the ANAE classification. This data has been generated using more accurate slope attribute data, which has overcome many issues related to the coarse (raster) data used previously (S. Brooks, *Brooks.eco*, pers. comm.; see also Brooks et al., 2014).

Thirty nine of the 47 ANAE wetland types recorded across the Victorian Murray water resource plan area are represented as priority ecosystem assets (Table 2). Based on the relative proportion of PEA wetland area compared with that for each ANAE type across the Victorian Murray, two types are over-represented (Temporary river red gum swamp, Black box woodland riparian zone or floodplain), while consisting of two ANAE types are under-represented (Woodland riparian zone or floodplain, Clay pan). The under-represented ANAE types are mainly floodplain and claypan systems that do not normally receive environmental water.

Eight ANAE river types are present across the Victorian Murray water resource plan area (Table 3). Based on the relative length of each ANAE river type, two ANAE river types are under-represented as priority ecosystem assets (Temporary high energy upland stream, Temporary transitional zone stream), while two river types are over-represented (Temporary lowland stream, Permanent lowland stream).

Table 2: Representativeness* of wetland priority environmental assets compared with Victorian Murray water resource plan area ANAE waterway types

ANAE Type	Victorian Murray WRPA		Victorian Murray priority environmental assets		Difference	Representation in WRPA
	Area (ha)	%Area	Area (ha)	% Area		
Pt1.1.2: Temporary river red gum swamp	35843.7	20.1	34208.9	25.7	+5.6%	Over
F1.8: Black box woodland riparian zone or floodplain	29449.0	16.5	32289.6	24.3	+7.8%	Over
F1.2: River red gum forest riparian zone or floodplain	23185.7	13.0	15186.7	11.4	-1.6%	Similar
F1.12: Woodland riparian zone or floodplain	18692.4	10.5	2541.3	1.9	-8.6%	Under
Pt3.1.2: Clay pan	14373.1	8.1	1407.9	1.1	-7.0%	Under
F1.4: River red gum woodland riparian zone or floodplain	13619.4	7.6	11542.2	8.7	+1.1%	Similar
Pt1.2.2: Temporary black box swamp	6526.4	3.7	2920.2	2.2	-1.5%	Similar
F2.2: Lignum shrubland riparian zone or floodplain	5050.4	2.8	Not represented	-	-2.8%	Similar
Pp4.2: Permanent wetland	3981.4	2.2	1401.4	1.1	-1.1%	Similar
Lp1.1: Permanent lake	3886.8	2.2	551.7	0.4	-1.8%	Similar
Rp1.4: Permanent lowland stream	3326.9	1.9	1704.1	1.3	-0.6%	Similar
Pt2.3.2: Freshwater meadow	2861.4	1.6	5832.1	4.4	+2.8%	Similar
Rt1.4: Temporary lowland stream	2426.0	1.4	1520.0	1.1	-0.3%	Similar
Pt1.6.2: Temporary woodland swamp	1727.3	1.0	645.4	0.5	-0.5%	Similar
Lsp1.1: Permanent saline lake	1676.2	0.9	11.8	0.0	-0.9%	Similar
Lst1.1: Temporary saline lake	1510.9	0.8	764.6	0.6	-0.2%	Similar
Pst4: Temporary saline wetland	1441.3	0.8	1385.9	1.0	+0.2%	Similar
Pt2.1.2: Temporary tall emergent marsh	1341.1	0.8	1023.1	0.8	0.0%	Similar
F1.6: Black box forest riparian zone or floodplain	1142.8	0.6	35.5	0.0	-0.6%	Similar
Pt1.7.2: Temporary lignum swamp	1125.5	0.6	2862.4	2.2	+1.6%	Similar
Pst1.1: Temporary saline swamp	995.6	0.6	Not represented	-	-0.6%	Similar

ANAE Type	Victorian Murray WRPA		Victorian Murray priority environmental assets		Difference	Representation in WRPA
	Area (ha)	%Area	Area (ha)	% Area		
Pt4.2: Temporary wetland	657.9	0.4	586.6	0.4	0.0%	Similar
Pt1.8.2: Temporary shrub swamp	581.0	0.3	57.5	0.0	-0.3%	Similar
Psp4: Permanent saline wetland	546.6	0.3	320.3	0.2	+1.7%	Similar
Pp2.1.2: Permanent tall emergent marsh	434.7	0.2	63.8	<0.0	-0.2%	Similar
Pt2.2.2: Temporary sedge/grass/forb marsh	396.0	0.2	232.6	0.2	0.0%	Similar
Lt1.1: Temporary lake	378.2	0.2	1750.5	1.3	+1.1%	Similar
Pt4.1: Floodplain or riparian wetland	218.0	0.1	97.3	0.1	0.0%	Similar
Lsp1.2: Permanent saline lake with aquatic bed	181.0	0.1	93.7	0.1	0.0%	Similar
Pst2.2: Temporary salt marsh	176.0	0.1	Not represented	-	-0.1%	Similar
Pp2.4.2: Permanent forb marsh	163.0	0.1	155.0	0.1	0.0%	Similar
Psp2.1: Permanent salt marsh	100.0	0.1%	Not represented	-	-0.1%	Similar
Rp1: Permanent stream	76.6	<0.1	2.7	<0.1	0.0%	Similar
Pst3.2: Salt pan or salt flat	49.2	<0.1	Not represented	-	-0.1 to 0%	Similar
Rt1.2: Temporary transitional zone stream	48.5	<0.1	Not represented	-	-0.1 to 0%	Similar
Rt1.1: Temporary high energy upland stream	47.9	<0.1	5.0	<0.1	0.0%	Similar
Pp2.3.2: Permanent grass marsh	41.1	<0.1	50.8	<0.1	0.0%	Similar
F2.4: Shrubland riparian zone or floodplain	39.9	<0.1	22.3	<0.1	0.0%	Similar
Pp2.2.2: Permanent sedge/grass/forb marsh	34.8	<0.1	29.7	<0.1	0.0%	Similar
Rp1.2: Permanent transitional zone stream	30.8	<0.1	20.8	<0.1	0.0%	Similar
Rp1.3: Permanent low energy upland stream	24.0	<0.1	36.3	<0.1	0.0%	Similar
Rt1: Temporary stream	7.1	<0.1	1.4	<0.1	0.0%	Similar
Rp1.1: Permanent high energy upland stream	5.3	<0.1	2.0	<0.1	0.0%	Similar
Rt1.3: Temporary low energy upland stream	1.1	<0.1	1.7	<0.1	0.0%	Similar
F4: Unspecified riparian zone or floodplain	0.5	<0.1	Not represented	-	-0.1 to 0%	Similar

ANAE Type	Victorian Murray WRPA		Victorian Murray priority environmental assets		Difference	Representation in WRPA
	Area (ha)	%Area	Area (ha)	% Area		
Pps5: Permanent spring	<0.0	<0.1	Not represented	-	-0.1 to 0%	Similar
Pu1: Unspecified wetland	0.0	<0.1	8.3	<0.1	0.0%	Similar

*Over- or under- representation is based on a ± 5% deviation of the relative proportion of the priority environmental asset area for a particular ANAE type to the total priority environmental asset area, compared with that of the ANAE type for the whole Wimmera-Mallee adapted from (Brooks, 2019). ANAE is the Australian National Aquatic Ecosystems (ANAE) classification framework.

Table 3: Representativeness* of Victorian Murray riverine priority environmental assets compared with ANAE waterway type

ANAE Type	Victorian Murray WRPA		Victorian Murray priority environmental assets		Difference	Representation in WRPA
	Length (km)	%Length	Length (km)	%Length		
Rt1.1: Temporary high energy upland stream	7379.3	63.1%	Not represented	-	-63.1%	Under
Rt1.2: Temporary transitional zone stream	1510.2	12.9%	0.1	0.0%	-12.9%	Under
Rt1.4: Temporary lowland stream	1454.2	12.4%	227.3	28.4%	+15.9%	Over
Rp1.4: Permanent lowland stream	661.7	5.7%	570.7	71.2%	+65.6%	Over
Rp1.1: Permanent high energy upland stream	304.7	2.6%	Not represented	-	-2.6%	Similar
Rp1.2: Permanent transitional zone stream	221.6	1.9%	3.0	0.4%	-1.5%	Similar
Rp1.3: Permanent low energy upland stream	108.5	0.9%	Not represented	-	-0.9%	Similar
Rt1.3: Temporary low energy upland stream	50.5	0.4%	Not represented	-	-0.4%	Similar

*Over- or under- representation is based on a ± 5% deviation of the proportion of the riverine priority environmental asset length for a particular ANAE type to the total priority environmental asset length, compared with that of the ANAE type for the whole Victorian Murray (adapted from (Brooks, 2019).

2.3 Significant ecological values of the Victorian Murray water resource plan area[4]

The Victorian Murray water resource plan area contains a myriad of extensive riverine, floodplain and wetland systems connected to the River Murray. The area includes four Ramsar sites: Barmah Forest, Gunbower Forest, Hattah-Kulkyne Lakes and Kerang Wetlands. The first three sites are also TLM Icon Sites, along with Lindsay, Mulcra and Wallpolla Islands. There are also other wetlands along the Murray and the lower reaches of some rivers (Broken Creek and the Loddon River) that are recognised as nationally important.

The information below focuses on the priority environmental assets that receive held environmental water (HEW) and are managed for environmental outcomes.

Significant water-dependent ecological values in the Victorian Murray water resource plan area are presented in Figure 8, aligned with themes set out in the Basin-wide environmental watering strategy (MDBA, 2019).

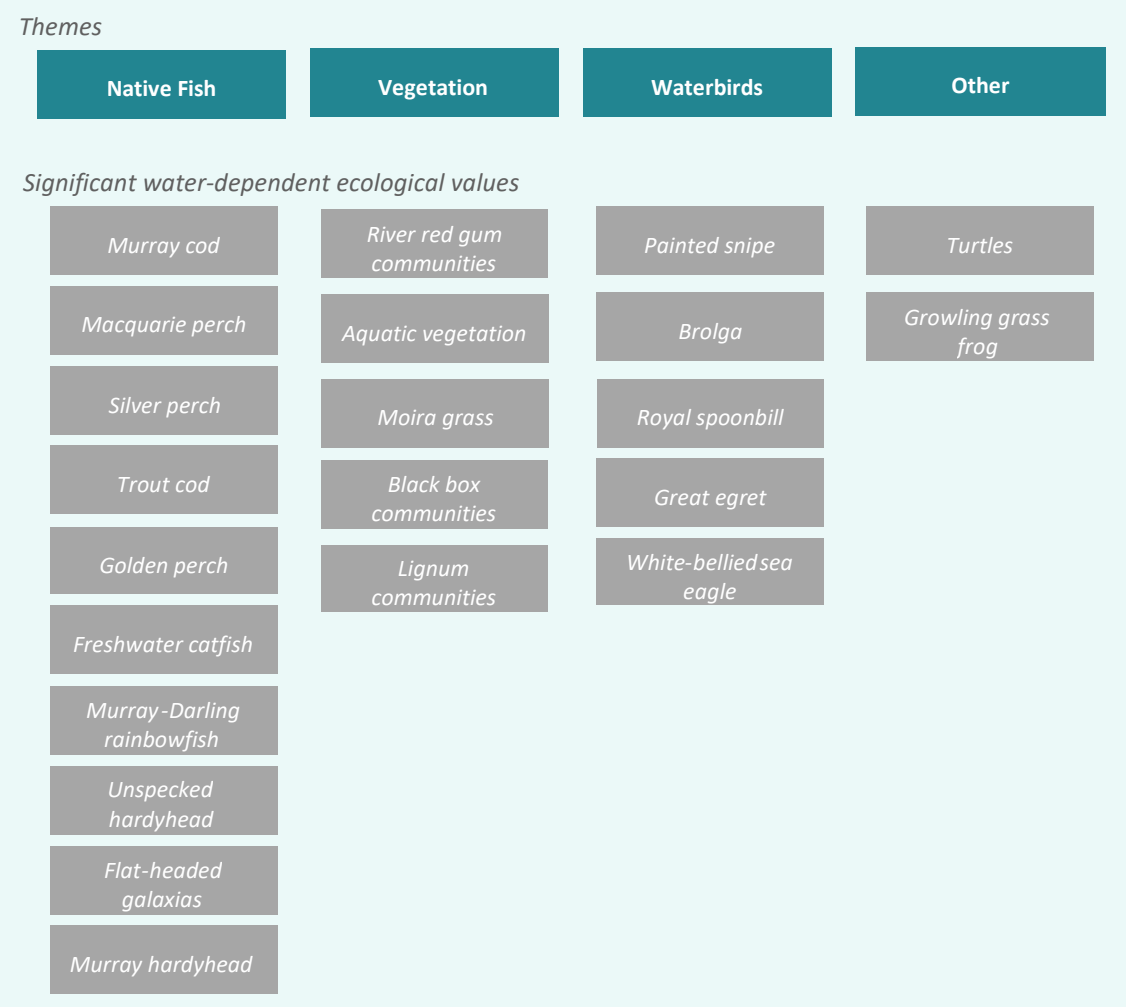


Figure 8: Significant water-dependent ecological values in the Victorian Murray water resource plan area

[4] Sourced from the Seasonal Watering Plan 2020-21 (VEWH, 2020) produced by the Victorian Environmental Water Holder.

2.3.1 Ramsar-listed priority environmental assets

Ramsar sites are formally recognised for containing representative, rare or unique wetlands, or wetlands that are internationally important for conserving biodiversity. A wetland must satisfy one or more of the criteria for identifying wetlands of international importance to be designated to this list.

National guidelines are being developed to provide clear guidance on how Ramsar sites must be managed, under both the Ramsar Convention and Commonwealth Environment Protection and Biodiversity Conservation Act. A key component includes monitoring of a site's ecological character description, which is a baseline of wetland condition at the time of its listing as a wetland of international importance. The ecological character descriptions of all Australia's Ramsar-listed wetlands are at http://www.environment.gov.au/water/wetlands/publications.

The Basin Plan requirements for states in regard to Ramsar sites are:

- Declared Ramsar wetlands that depend on Basin water resources maintain their ecological character (section 8.05 (2a) of the Basin Plan).
- A declared Ramsar wetland is an environmental asset that requires environmental watering (Schedule 8 Criteria for identifying an environmental asset).
- Declared Ramsar wetlands have sufficient water quality to maintain the ecological character of those wetlands (section 9.04 (1) of the Basin Plan).

There are also water quality targets for declared Ramsar wetlands under Schedule 11 to the Basin Plan – Target values for target application zones.

These requirements are fulfilled in Victoria's water quality and salinity management plans in Appendix A of Victoria's North and Murray Water Resource Plan (DELWP, 2020).

Implementation of the Basin Plan contributes to maintaining the ecological character of Ramsar wetlands. Section 5.02 of the Basin Plan states that the Basin Plan aims to give effect to international agreements, such as the Ramsar Convention, through an integrated approach to water management. Section 8.05 further specifies that water dependent ecosystems are to be protected and restored, in part, by ensuring that declared Ramsar wetlands maintain their ecological character. As noted in the Basin Plan, provision of environmental water needs to be supported by other management actions. It is the responsibility of jurisdictions to maintain the ecological character of Ramsar wetlands through various strategies, investment, partnerships and on-ground actions.

As noted above, the Victorian Murray water resource plan area has four Ramsar sites[5]: Barmah Forest, Gunbower Forest, Hattah-Kulkyne Lakes and Kerang Wetlands. The watering regime is a critical component to support the ecological character of these sites; altered flow regime(s) caused by water resource use and climate change are noted as a high risk threat (DELWP, 2017a,b,c,d), particularly for adverse effects on river red gum forests and woodlands and native fish abundance and diversity. Managing the current and potential future impacts of threats is addressed in site management plans prepared for each Ramsar site. Strategies to address water regime and climate change threats (DELWP, 2017a,b,c,d) include:

- Continuing to develop and implement environmental watering proposals to maintain the ecological character of the Ramsar site.
- Working with partner agencies to remove barriers to the passage of native fish, turtles and other aquatic species in waterways of the Ramsar site.
- Working with partner agencies to identify opportunities and options for managing environmental water in a changing climate.

The Ramsar site management plans also identify strategies to deal with other high-risk threats related to invasive plant and animal species.

5. Kerang Wetlands are Ramsar-listed and located in the Avoca and Loddon River catchments but are watered from the River Murray and so are included in the Victorian Murray LTWP.

Barmah Forest (along with the Millewa Forest across the river in NSW) is the largest river red gum forest in Australia and considered the most intact freshwater floodplain system along the River Murray. It supports a broad range of floodplain vegetation communities including river red gum forest and woodland and large, open wetlands, including once extensive Moira grass plains. The forest is an important feeding and breeding site for waterbirds, particularly colonial nesting species, including egrets, spoonbills, ibis, bitterns and night herons, as well as for frogs and turtles. When inundated, the forest creeks and wetlands support a diverse assemblage of native fish, including Murray-Darling rainbowfish, freshwater catfish, golden perch, flat-headed galaxias, Macquarie perch, Murray cod and silver perch.

Gunbower Forest (along with the Koondrook-Perricoota Forest across the river in NSW) represents the second-largest river red gum forest in Australia. It supports a range of important environmental values including diverse and rare wetland habitats, threatened plant and animal species and large areas of remnant vegetation communities (such as river red gum forest). The forest provides a diversity of habitats for birds and supports several migratory waterbirds protected under international agreements. Large breeding events of colonial nesting waterbirds have been recorded.

Gunbower Creek is an integral part of the Gunbower system, providing important habitat for native fish including Murray cod, and freshwater catfish. The creek is a valuable refuge and provides a source population for surrounding connected waterways. Index of Stream Condition results indicate Gunbower Creek to be in moderate environmental condition (DEPI, 2013c).

Hattah-Kulkyne Lakes comprises more than 20 perennial and intermittent freshwater floodplain lakes, set in an arid landscape. Flood-dependent vegetation at Hattah-Kulkyne Lakes ranges from wetland communities that require frequent flooding to those higher on the floodplain that require only periodic inundation (such as lignum and black box-dominated communities). The lakes are recognised for their waterbird breeding habitat and provide an important drought refuge for waterbirds including the spoonbill, egret, night heron, bittern, for migratory bird species and many ducks. Sixteen native fish species have been recorded in the lakes; four of these have conservation significance in Victoria (golden perch, silver perch, Murray cod, and Murray-Darling rainbowfish, see Table 4).

Kerang Wetlands consists of 23 named lakes, marshes and swamps of varying area, depth and salinity. Vegetation communities including black box, river red gum, tangled lignum, chenopod shrubland, grassland and reedbeds, support over 150 native plant species and 102 native fauna species. More than 75 species of waterbird have been recorded at the site, with more than 50 species nesting and feeding, including several protected under international agreements. Fish species of conservation significance include Murray cod, Murray hardyhead, Macquarie perch and silver perch (Table 4).

2.3.2 TLM icon sites

The Victoria Murray area contains four TLM icon sites, including three of the Ramsar sites described above – Barmah Forest, Gunbower Forest and Hattah-Kulkyne Lakes (referred to as ‘Hattah Lakes’ under TLM). In addition, the Lindsay, Wallpolla and Mulcra Islands Icon Site, located west of Mildura, includes semipermanent and ephemeral waterways and wetlands that support a range of vegetation types including river red gum and black box woodlands and lignum shrublands, providing diverse habitat for frogs, turtles and waterbirds. Many of the creeks and streams provide flowing water habitat for native fish such as Murray cod, freshwater catfish, silver perch, Murray-Darling rainbowfish and unspecked hardyhead (Table 4). When flooded, waterways and wetlands within this system provide important habitat for a range of wetland-dependent species including many waterbirds (e.g. great egret and red-necked stint).

Table 4. Significant native fish in the Victorian Murray water resource plan area

Common name	Scientific name	Conservation significance[6]
Murray cod	*Maccullochello peeli peeli*	Vulnerable (EPBC Act) FFG list Vulnerable (Victoria)
Macquarie perch	*Macquaria australasica*	Endangered (EPBC Act) FFG list Endangered (Victoria)
Silver perch	*Bidyanus*	FFG list Vulnerable (Victoria)
Trout cod	*Maccullochella macquariensis*	Endangered (EPBC Act) FFG list Critically Endangered (Victoria)
Golden perch	*Macquaria ambigua*	Near Threatened (Victoria)
Freshwater catfish	*Tandanus*	FFG list Endangered (Victoria)
Murray-Darling rainbowfish	*Melanotaenia fluviatilis*	FFG list Vulnerable (Victoria)
Unspecked hardyhead	*Craterocephalus stercusmuscarum fulvus*	FFG list
Flat-headed galaxias	*Galaxias rostratus*	Vulnerable (Victoria)
Murray hardyhead	*Craterocephalus fluviatilis*	Endangered (EPBC Act) FFG list Critically Endangered (Victoria)

2.3.3 Central Murray wetlands

The Central Murray wetlands on the lower Loddon River and River Murray floodplains (Figure 9, top left) include three of the Ramsar sites (Barmah Forest, Gunbower Forest and Kerang Wetlands, see above), as well as others of regional significance including Guttrum and Benwell Forests and the Wirra-Lo Wetland Complex. These wetlands are considered highly significant, supporting several vulnerable or endangered species such as the Murray hardyhead and the growling grass frog, and bird species listed under legislation and international agreements, including the Australasian bittern, great egret and white-bellied sea eagle.

2.3.4 Lower Murray wetlands

The lower Murray wetlands are located in the linear floodplain along the River Murray from the Murrumbidgee River Junction to the South Australian border (Figure 9, bottom left). There is a wide variety of wetland types, depending on their location in the landscape, the interaction with groundwater and their management history, so wetlands may be permanent, temporary, fresh or saline. These differences in water regime and water quality provide a diverse range of habitats for different plants and animals. The dominant tree species found at most wetland sites are river red gum and black box. These trees form significant forests on the floodplain which provide habitat, particularly for birds, reptiles and mammals.

2.3.5 Broken Creek catchment

The Broken Creek diverges from the Broken River downstream of Benalla and enters the River Murray near Barmah Forest. Only the Lower Broken Creek, downstream of the confluence with

6. DSE (2013) *Advisory List of Threatened Vertebrate Fauna in Victoria*. Department of Conservation and Environment, Melbourne.

Boosey Creek, is considered in this LTWP. The Upper Broken Creek is considered as part of the Northern Victorian LTWP.

The Lower Broken Creek refers to the Broken Creek from its confluence with Boosey Creek to the Murray River and is considered part of the Victorian Lower Murray LTWP. Water for the environment is provided to Lower Broken Creek via outfalls from irrigation areas. The Lower Broken Creek system is largely characterised by box dominated riparian vegetation and plains grassy woodlands, which support numerous threatened species of state and national conservation significance including brolga. Sections of the creek run through the Ramsar-listed Barmah Forest.

The most recent Index of Stream Condition (third benchmark) results indicate Lower Broken Creek to be in primarily moderate environmental condition (DEPI, 2013c, part 3 – Goulburn Broken).

2.4 Priority environmental assets within the Victorian Murray water resource plan area

Priority environmental assets listed in this LTWP (Table 5) are water-dependent ecosystems that can be managed with environmental water and meet one or more of the criteria listed in Basin Plan Schedule 8 (see Glossary). An asset may be a single wetland or waterbody (e.g. Johnsons Swamp), a wetland complex (e.g. Barmah Forest), or a river/creek (e.g. Gunbower Creek). Asset locations are shown in Figure 9.

It is important to note that the priority rivers in Table 5 are regulated and have HEW; this plan seeks to guide use of HEW to meet objectives and targets. There are also unregulated rivers within the WPRA that have important environmental values. However, in unregulated systems, there is no HEW to manage for specific environmental outcomes, so the aim for unregulated rivers is to maintain existing arrangements (e.g. conditions regulating the take of water through Bulk Entitlements and licences, see Section 4.4).

Wetlands that are listed in the BWS as important environmental assets at the Basin scale for waterbirds in the Victorian Murray water resource plan area are Gunbower Creek/Forest, Hattah Lakes, Kerang Lakes, and Lindsay, Wallpolla and Mulcra Islands.

2.4.1 Changes to priority environmental assets since the previous LTWP

The list of priority environmental assets has been updated since the 2015 LTWP. Four assets are no longer considered priority environmental assets, as they do not receive held or planned environmental water, including Golf Course Lake, Lake Wandella, Kiewa River, and Mitta Mitta River.

Two new assets now receive HEW and some information for these assets has been included in this update. Their further inclusion as priority environmental assets will be assessed for the next LTWP update in 2023:

- **Butlers Creek**[7], Baggs Lagoon and Ducksfoot Lagoon (also close to Mildura and part of the Kings Billabong Park) are to be managed as a semi-permanently inundated water area with seasonal variations in water level. Butlers Creek provides preferred habitat for the endangered freshwater catfish and the vulnerable growling grass frog. Breeding of large wading birds can be supported in the flooded lignum vegetation communities within Ducksfoot Lagoon, and large numbers of piscivorous water birds can be supported by high levels of aquatic productivity and the abundant fish community.
- **Neds Corner**, located approximately 60 km west of Mildura on the Murray River floodplain, consists of three wetlands and a floodplain depression. The wetland is surrounded by river red gum and black box woodland and supports a diversity of frogs and waterbirds including the vulnerable waterbird species hardhead (*Aythya australis*), inland dotterel (*Charadrius australis*) and eastern great egret (*Ardea modesta*). It also supports the local Aboriginal community's totem species, the pelican and black swan. Vegetation communities present include the vulnerable alluvial plains semi-arid grassland.

7. This asset was previously included as part of the Kings Billabong Lagoon complex but is now listed separately.

Table 5: Priority environmental assets in the Victorian Murray water resource plan area

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[1]	Asset Characteristics
Broken River catchment				
Lower Broken and Nine Mile Creeks	Broken	Goulburn Broken CMA	3 4 5	Pathway for migration, movement of native water-dependent biota Endangered & vulnerable EVCs EPBC, FFG, vulnerable & endangered Victorian advisory listing
Black Swamp	Broken	Goulburn Broken CMA	2 4	292 red gum swamp - vulnerable FFG Act, EPBC act, DSE listed
Kinnairds Swamp	Broken	Goulburn Broken CMA	2 3 4 5	Some deep freshwater marsh remains. FFG Act, EPBC act, DSE listed Supports significant levels of native biodiversity and supports 125 plains grassy wetland - endangered community within the basin.
River Murray catchment				
Barmah Forest, including Tullah Creek	Murray	Goulburn Broken CMA	1 3 4 5	Ramsar, JAMBA, CAMBA, ROKAMBA, Bonn Convention important breeding, nursery & feeding habitat – waterbirds & native fish EPBC Act, FFG Act Supports significant numbers of native water-dependent species
Belsar and Yungera Islands	Murray	Mallee CMA	4 2	FFG Act, EPBC act, DSE listed EVC 103 riverine chenopod woodland - endangered
Belsar and Yungera floodplain	Murray	Mallee CMA	2 3 4 5	River red gum communities. includes a number of deep, frequently inundated wetlands including Yungera Creek. EPBC Act, FFG Act, DSE listed highly diverse ecotone where the riverine and lower Murray floodplain environments integrate. Site has 22 EVCs.
Bottle Bend	Murray	Mallee CMA	1 2 4	JAMBA, CAMBA, ROKAMBA, BONN 292 red gum swamp - vulnerable FFG Act, EPBC act, DSE listed
Bumbang Island	Murray	Mallee CMA	1 5	EPBC Act, FFG Act, DSE listed Providing appropriate water requirements to support the vegetation communities will support habitat for birds that have adapted to the required flooding and drying cycle

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[1]	Asset Characteristics
Burra Creek floodplain	Murray	Mallee CMA	1 4 5	CAMBA, JAMBA EPBC Act, FFG Act, DSE listed High level of ecological communities which would support high level of biodiversity as a result of environmental watering.
Butlers Creek[2]	Murray	Mallee CMA	3 4	EPBC Act, FFG Act, DSE listed Listed as a nationally important wetland in the Directory of Important Wetlands in Australia (DIWA) (as part of the larger Kings Billabong site).
Cardross Lakes	Murray	Mallee CMA	1 3 4 5	JAMBA, CAMBA Significant water depth, good water quality and diversity of aquatic habitat at Cardross Lakes made it the most significant wetland in the region, particularly for native fish. Provides connectivity. EPBC Act, FFG Act, DSE listed High fauna diversity. Good water quality and diversity of aquatic habitat.
Carina Bend	Murray	Mallee CMA	4 5	FFG Act, EPBC act, DSE listed Diverse range of water dependent flora and fauna species
Chaffey and Johnstons	Murray	Mallee CMA	4 5	FFG Act, DSE listed High level of ecological communities which would support high level of biodiversity as a result of environmental watering
Hattah Lakes (TLM Icon site)	Murray	Mallee CMA	1 3 4	Ramsar, JAMBA, CAMBA, ROKAMBA Linkage enables movement and dispersal of biota between floodplain and terrestrial bioregions EPBC Act, FFG Act, DSE listed. High value drought refuge for wet-land for wet-land dependent waterbirds High level of biodiversity
Hattah Lakes North (supply measure site)	Murray	Mallee CMA	3 4	Provides connectivity EPBC Act, FFG Act, DSE listed
Karadoc Swamp	Murray	Mallee CMA	1 3 4 5	JAMBA, CAMBA, ROKAMBA, BONN High habitat diversity FFG Act, EPBC act, DSE listed Has previously supported significant biodiversity
Kings Billabong	Murray	Mallee CMA	1 4 5	JAMBA, CAMBA FFG Act, EPBC act, DSE listed Supports significant biodiversity Listed as a nationally important wetland in the Directory of Important Wetlands in Australia (DIWA)

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[1]	Asset Characteristics
Lake Koorlong	Murray	Mallee CMA	1 3 4 5	JAMBA, CAMBA Significant water depth, good water quality and diversity of aquatic habitat at Cardross Lakes made it the most significant wetland in the region, particularly for native fish. Provides connectivity EPBC Act, FFG Act, DSE listed High fauna diversity. Good water quality and diversity of aquatic habitat
Lakes Hawthorn and Ranfurly	Murray	Mallee CMA	1 4 5	JAMBA, CAMBA, ROKAMBA FFG Act, EPBC act, DSE listed High level of biodiversity
Lindsay, Wallpolla and Mulcra Islands (TLM Icon site)	Murray	Mallee CMA	1 3 4 5	JAMBA, CAMBA, ROKAMBA, BONN Providing longitudinal connection to the River Murray and its floodplains, as well as lateral connection into the semi-arid Mallee environment EPBC Act, FFG Act, DSE listed Important as habitat for both nomadic and migratory waterbirds. 17 water dependent EVCs are present
Lindsay-Wallpolla Islands (supply measure site)	Murray	Mallee CMA	2 3 4 5	Large deep pools - drought refuge, triggers breeding Supports significant numbers of water dependent species EPBC Act, FFG Act, DSE listed EVC 103 – riverine chenopod woodland – endangered
Margooya Lagoon	Murray	Mallee CMA	1 4	JAMBA, CAMBA, ROKAMBA FFG Act, EPBC act, DSE listed
Merbein Common	Murray	Mallee CMA	1 3 4 5	JAMBA, CAMBA Waterbird breeding habitat FFG Act, EPBC act, DSE listed Water-dependent and migratory species
Neds Corner[2]	Murray	Mallee CMA	3 4	EPBC Act, FFG Act, DSE listed EVC 806 – alluvial plains semi-arid grassland & EVC 104 – lignum swamp; vulnerable
River Murray – Lock 6-10	Murray	Mallee CMA	1 3 4	JAMBA, CAMBA EPBC Act, FFG Act, DSE listed
River Murray – Lock15	Murray	Mallee CMA	1 4 5	JAMBA, CAMBA, ROKAMBAEPBC Act, FFG Act, DSE listed The flora of the system is diverse, with over 630 native plant species known to occur

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[1]	Asset Characteristics
Murrumbidgee Junction	Murray	Mallee CMA	1 3 5	JAMBA, CAMBA Water dependent species which will benefit from the wetlands in the target area receiving water FFG Act, EPBC act, DSE listed EVC 103 riverine chenopod woodland - endangered, 809 floodplain grassy wetland - endangered
Nyah and Vinifera FMU (Nyah Forest, Vinifera Forest) (supply measure sites)	Murray	Mallee CMA	2 4	Regent parrot and carpet python are indirectly dependent on water, i.e. they require riparian trees, vigorous ground cover and fallen timber FFG Act, EPBC act, DSE listed
Piambie WMU (Bridge creek, Heywood Lake)	Murray	Mallee CMA	1 4 5	CAMBA FFG Act, EPBC act, DSE listed Flows into the creek and wetlands of the floodplain are less frequent. 103 riverine chenopod woodland - endangered
Pound Bend	Murray	Mallee CMA	1 3 4 5	JAMBA, CAMBA The movement of species of fish, invertebrates and amphibians is driven by floodplain and wetland connectivity. The site is important for specific dispersal and connectivity functions. EPBC Act, FFG Act, DSE listed High fauna biodiversity
Psyche and Woorlong	Murray	Mallee CMA	4 5	EPBC act, FFG Act, DSE listed Recognised as a significant conservation area
Sandilong Creek	Murray	Mallee CMA	1 4 5	JAMBA, CAMBA, ROKAMBA, BONN EPBC Act, FFG Act, DSE listed High level of ecological communities which would support high level of biodiversity as a result of environmental watering. Significant freshwater catfish population
Spences Bend (Bullock Swamp)	Murray	Mallee CMA	1 3 4 5	CAMBA Dominated by lignum which becomes an extensive aquatic habitat for fish, reptiles and macroinvertebrates when inundated EPBC Act, FFG Act, DSE listed Six bird species are considered water-dependent because they forage or nest in or over water, or require flooding to trigger breeding and fledging (eastern regent parrot) Twelve ecological vegetation classes (EVCs) occur

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[1]	Asset Characteristics
Tata / Boundary bend	Murray	Mallee CMA	1 3 4 5	CAMBA Includes species that forage or nest in or on water or require flooding to trigger breeding and fledging EPBC act, FFG Act, DSE listed Eastern regent parrot, which is indirectly dependent on water as they require healthy river red gum and black box for nesting habitat
Walshes Bend	Murray	Mallee CMA	4 5	EPBC Act, FFG Act, DSE List Thirteen Ecological Vegetation Classes (EVC's) occur at Walshes Bend. Four of these are listed as vulnerable within the Robinvale Plains bioregion
Wemen-Liparoo	Murray	Mallee CMA	3 4 5	Contains a floodplain wetland complex of four wetlands which are categorised as deep freshwater marsh, shallow freshwater marsh and permanent open freshwater EPBC Act, FFG Act, DSE listed A high level of ecological communities exist within the site (9 EVCs)
Gunbower Creek	Murray	North Central CMA	1 3 4 5	JAMBA, CAMBA, ROKAMBA Important waterbird & native fish feeding & breeding habitat EPBC Act, FFG Act, threatened species Capable of supporting significant water dependent species 19 EVCs
Gunbower Forest (TLM icon site)	Murray	North Central CMA	1 2 3 4 5	Ramsar, JAMBA, CAMBA, ROKAMBA, BONN EVC 103 – riverine chenopod woodland - endangered. Large deep pools - drought refuge, triggers breeding EPBC Act, FFG Act, DSE listed Supports significant numbers of water dependent species.
Gunbower National Park (supply measure site)	Murray	North Central CMA	1 3 4 5	JAMBA, CAMBA, ROKAMBA, BONN Large deep pools - drought refuge, triggers breeding. EPBC Act, FFG Act, DSE listed Supports significant numbers of water dependent species. EVC 103 – riverine chenopod woodland - endangered
Guttrum and Benwell Forests (supply measure sites)	Murray	North Central CMA	1 3 4	Semi-permanent wetlands, or swamps, are characterised by open water, marshland, reed bed and herbland vegetation, fringed with river red gum. EPBC Act, FFG Act, DSE listed Supports significant numbers of water dependent species

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[1]	Asset Characteristics
Pig Swamp	Murray	North Central CMA	1 2 4	JAMBA, CAMBA, ROKAMBA, BONN EVC 103 riverine chenopod woodland - endangered EPBC, FFG, DSE
Richardsons Lagoon	Murray	North Central CMA	1 3 4	CAMBA 803pPlains woodland, 103 riverine chenopod woodland -endangered FFG Act, DSE listed
Murray floodplain between Lake Hume and Lake Mulwala	Murray	North East CMA	4	EPBC Act, FFG Act, DSE listed
Loddon River catchment				
Loddon River (lower)	Loddon	North Central CMA	1 2 3 4 5	JAMBA, CAMBA, ROKAMBA, Bonn Convention High instream woody habitat values - critical habitat component for river blackfish Deep pools – critical drought refuge Provides connectivity to facilitate migration, movement and dispersal EPBC Act, FFG Act, DSE list Supports significant levels of native biodiversity Endangered EVCs
Lake Cullen (Kerang Lakes)	Loddon	North Central CMA	1 4 5	Ramsar, JAMBA, CAMBA, ROKAMBA, BONN FFG Act, EPBC act, DSE listed
Lake Elizabeth (Kerang Lakes)	Loddon	North Central CMA	1 4	Ramsar, JAMBA, CAMBA, ROKAMBA, BONN FFG Act, EPBC act, DSE listed
Hird Swamp (Kerang Lakes)	Loddon	North Central CMA	1 3 4 5	Ramsar, RCW, JAMBA, CAMBA, Deep freshwater marsh - critical drought refuge FFG Act, EPBC act, DSE listed Range of habitats through Hird Swamp, including open water, reed dominated areas and lignum habitats - highly valued and important wetland
Johnson Swamp (Kerang Lakes)	Loddon	North Central CMA	1 4	Ramsar, JAMBA, CAMBA, ROKAMBA, BONN, FFG Act, EPBC act, DSE listed
Lake Murphy	Loddon	North Central CMA	1 3 4 5	JAMBA, CAMBA, ROKAMBA, Bonn Convention Significant waterbird breeding & feeding habitat EPBC Act, FFG Act, Vic advisory list 9 EVCs

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[1]	Asset Characteristics
McDonalds Swamp	Loddon	North Central CMA	1 4	JAMBA, CAMBA, ROKAMBA, BONN FFG Act, EPBC act, DSE listed
Wirra-Lo Wetlands	Loddon	North Central CMA	1 2 4 5	JAMBA, CAMBA, ROKAMBA, Supports a diversity of threatened flora and fauna species as well as vulnerable and depleted vegetation communities FFG Act, EPBC act, DSE listed The Wirra-Lo Wetland Complex is ecologically significant due to the high diversity of water dependent flora and fauna it supports

Notes:

[1] Numbers in the asset characteristics refer to Schedule 8 Criteria.

[2] These assets now receive HEW and will be assessed for inclusion as priority environmental assets.

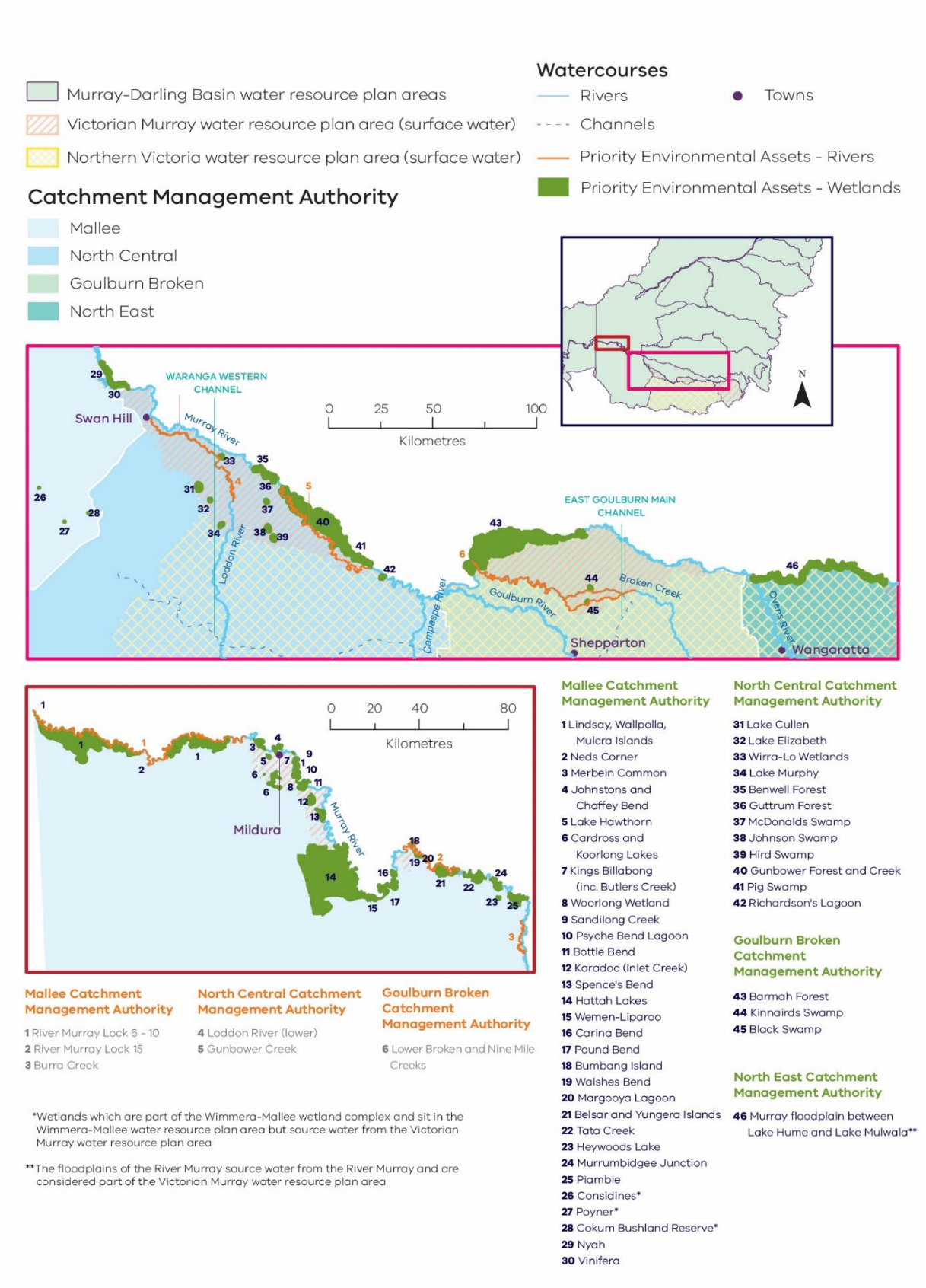


Figure 9: Priority environmental assets within the Victorian Murray water resource plan area

2.5 Priority ecosystem functions in the Victorian Murray water resource plan area

Two ecosystem functions are prioritised for the Victorian Murray water resource plan area longitudinal connectivity and water quality (Table 6), derived from those identified at the asset scale through EWMP objective setting for environmental watering. This is not a comprehensive list of all possible functions that may exist, either at the asset or the water resource plan area scale. Future iterations of Victoria's LTWPs will better integrate the environmental values and outcomes at the asset scale with those at the landscape scale (single or multiple water resource plan area), providing a broader picture of priority ecosystem functions.

The priority ecosystem functions in Table 6 can be managed with environmental water and meet the criteria in Basin Plan schedule 9. The individual assets associated with these functions are listed in Table 9 of Section 3.

Table 6: Priority ecosystem functions in the Victorian Murray water resource plan area

Ecosystem Function	Schedule 9 criteria	Function characteristics
Longitudinal hydrological connectivity (between floodplains, anabranches and wetlands)	2	Supports the transportation and dilution of nutrients, organic matter and sediment
	4	Provides connections across floodplains, adjacent wetlands and billabongs (lateral connections)
Water quality (that allows for ecosystem processes)	1	Supports the creation and maintenance of vital habitats and populations
	2	Supports the dilution of carbon and nutrients from the floodplain to the river system

3. Environmental watering requirements for priority environmental assets and ecosystem functions

This section outlines environmental objectives and targets, with watering requirements, for priority environmental assets and functions in the Victorian Murray water resource plan area.

3.1 Approach to developing objectives, targets and watering requirements

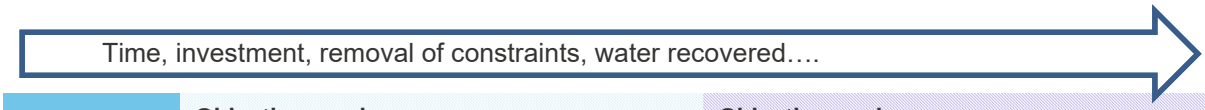
The objectives for this LTWP have been developed from the EWMPs, environmental flow studies and watering guides prepared by CMAs for priority environmental assets across the Victorian Murray. LTWP objectives and their targets show the overall alignment of EWMPs with Basin Plan objectives and how they will be met. They show the alignment with management goals developed for the Basin (see Section 1.1) and for the Victorian Murray (see Table 7). Objectives may be set in terms of ecological outcomes (e.g. specific biota or ecological functions) or the hydrological requirements (e.g. flow, depth, timing) of specific biota or functions. Only when objectives have been set can an appropriate watering regime be developed.

The approach to developing LTWP objectives, targets and watering requirements is described in Appendix C. The approach builds on the asset-scale information from EWMPs, which include site-specific environmental objectives (Appendix E) and watering requirements (Appendix F). These were categorised, analysed and regrouped to build a set of objectives suitable for the water resource plan area scale.

Targets developed for this LTWP are designed to be 'SMART': Specific, Measurable, Attainable, Relevant and Time-bound. Targets were only set for objectives which are sensitive to environmental water, had available indicators and were relevant to the water resource plan area. From there, targets were developed using a standard framework.

Watering requirements for the objectives and targets are provided in Section 3.5. At the regional scale, this is done by linking the objectives and targets to the relevant flow components. The EWMPs, and Seasonal Watering Plans (developed each year), provide further detail on the watering requirements at an asset scale (VEWH, 2020). More detail on watering requirements from the EWMPs is provided in Appendix F.

This LTWP has been developed with objectives and targets aimed at a 10-year planning horizon. While aspirational statements can provide some indication of the long-term outcome for assets and resources, they do not provide a good basis for target setting in the short-term. Longer-term aspirational outcomes have been balanced with the more certain shorter-term in setting the objectives and targets in this LTWP, as illustrated in Figure 10.



	Objectives and Targets		Objectives only	
Certainty of achievement	**1 – can meet now**	**2 – can meet under BP implementation timeframe**	**3 – can meet under BP implementation if constraints removed / decreased**	**4 – beyond the scope of BP implementation**
timeline	1-5 years	5-10 years	TBC	TBC

Figure 10: Certainty of achievement has been used in setting objectives and targets in this LTWP. Longer-term aspirational objectives have not had targets set, due to uncertainty in future conditions and ability for associated targets to be met

3.2 Management goals for the Victorian Murray water resource plan area

The North East, Goulburn Broken, North Central and Mallee CMAs developed site-specific environmental water management goals in consultation with communities through the EWMP process. During development of the Victorian Murray LTWP, these were summarised into management goals for the Victorian Murray water resource plan area (see Table 7). Management goals for individual assets are presented in Appendix E. These goals also help to support a range of valuable co-benefits such as improved health of culturally significant species and sites.

Table 7: Management goals for the Victorian Murray water resource plan area

Management goals
Maintain or improve populations of threatened species and communities that are dependent upon waterways and wetlands in the region.
Improve lateral connectivity and enhance floodplain productivity
Restore and maintain a mosaic of healthy floodplain communities across the region which will ensure that indigenous plant and animal species and communities survive and flourish throughout the site
Create and maintain a range of wetland types, with water regimes that vary from permanently inundated through to occasionally inundated.

3.3 Environmental objectives for the Victorian Murray water resource plan area

Twenty-four environmental objectives have been developed for the Victorian Murray water resource plan area and are set out in Table 8 below. The objectives are grouped into themes that correspond to those used in the MDBA Ecological Assets and Functions Database. How these LTWP objectives contribute to Basin Plan objectives is shown in the cross-referencing to relevant objectives from the BWS's Expected Environmental Outcomes (EEOs), and Basin Plan environmental watering plan (EWP) (both listed in Appendix K, Table 34 and Table 35).

Table 8: Environmental objectives for the Victorian Murray water resource plan area

Theme	No.	Objectives	BWS EEOs	EWP Objectives
Connectivity	VM1	Improve connectivity between floodplains, anabranches and wetlands	B1.1, B1.2, B4.1, B4.3, B4.4, B4.6, B4.8, B4.9, B4.10	8.06,3(a), 8.06,3(b)(i) 8.06,3(b)(ii), 8.06,3(f) 8.06,6(b), 8.07,6

Theme	No.	Objectives	BWS EEOs	EWP Objectives
Vegetation	VM2	Improve the species richness of aquatic vegetation in wetlands	B2.13	8.05,3(b), 8.06,3(a) 8.06,5, 8.06,7
	VM3	Improve the species richness of in-channel aquatic vegetation	B2.12	8.05,3(b), 8.06,3(a) 8.06,5, 8.06,7
	VM4	Improve the extent of aquatic vegetation	B2.11, B2.12, B2.13	8.05,3(b), 8.06,2 8.06,3(a), 8.06,5 8.06,6(a), 8.06,7
	VM5	Improve the condition of river red gum dominated EVCs	B2.1, B2.2, B2.8, B2.9	8.05,3(b), 8.06,3(b)(ii) 8.06,5, 8.06,6(a) 8.06,6(b), 8.06,7
	VM6	Maintain the condition of black box dominated EVCs	B2.1, B2.2, B2.7, B2.8, B2.9	8.05,3(b), 8.06,3(b)(ii) 8.06,5, 8.06,6(a) 8.06,6(b), 8.06,7
	VM7	Maintain the extent of black box dominated EVCs	B2.1, B2.2, B2.7, B2.8, B2.9	8.05,3(b), 8.06,5 8.06,7
	VM8	Improve the condition of shrub and lignum dominated EVCs	B2.10	8.05,3(b), 8.06,5 8.06,7,
	VM9	Successful growth and flowering of Moira grass plants	B2.13	8.05,3(b), 8.06,5 8.06,7
Waterbirds	VM10	Improve breeding opportunities for colonial-nesting waterbirds	B3.1, B3.2, B3.3	8.06,6(a), 8.06,6(b)
	VM11	Improve breeding opportunities for waterbirds	B3.1, B3.2, B3.4	8.06,6(a)
	VM12	Improve habitat for waterbirds	B3.1, B3.2, B3.3, B3.4	8.06,6(b)
	VM13	Improve feeding areas for waterbirds	B3.1, B3.2, B3.3, B3.4	8.06,6(b)
Fish	VM14	Improve the abundance of large-bodied native fish	B4.1, B4.2, B4.6, B4.8	8.06,6(a), 8.06,6(b) 8.07,3
	VM15	Maintain the abundance of small-bodied native fish in wetlands	B4.1, B4.6, B4.10	8.06,5, 8.06,6(a)
	VM16	Maintain distribution of threatened small-bodied native fish in wetlands	B4.1, B4.6, B4.10	8.05,3(a), 8.06,3(b)(i) 8.06,3(b)(ii), 8.06,6(a) 8.06,6(b)
	VM17	Improve habitat for native fish	B4.1-10	8.06,6(b)
	VM18	Maintain species richness of native fish	B4.1-10	8.06,6(a)
Other Fauna	VM19	Improve habitat of frog communities	N/A	8.06,6(b), 8.07,3
	VM20	Maintain species richness of frog communities	N/A	8.06,6(b), 8.07,3
	VM21	Improve habitat of turtle and crayfish communities	N/A	8.06,6(b), 8.07,3
Macroinvertebrates	VM22	Improve abundance of macroinvertebrates	B4.1-10	8.06,6(b), 8.07,3

Theme	No.	Objectives	BWS EEOs	EWP Objectives
	VM23	Improve number of macroinvertebrate functional groups present	B4.1-10	8.06,6(b), 8.07,3
Water Quality	VM24	Maintain water quality within an appropriate range to allow for ecosystem processes	B4.1-10	8.06,2, 8.07,5

Note: EWP Objective codes are the Basin Plan Chapter 8 Environmental Watering Plan objectives (Appendix K Table 34). BWS EEO codes are the Basin-wide environmental watering strategy Expected Environmental Outcomes (Table 35). Themes are from the MDBA Ecological Assets and Functions Database (MDBA, 2021).

These objectives relate to specific assets across the water resource plan area, as set out in Table 9. The location of the assets is shown in Figure 9 (Section 2.4) and the objectives for each asset can be found in Appendix E.

3.4 Targets for environmental watering in the Victorian Murray water resource plan area

Targets have been developed for a subset of the objectives developed for this water resource plan area (Table 9). The process for the development of the targets is set out in Appendix C (original set of targets) and Appendix D (revised targets based on the LTWP monitoring and evaluation plan). The aim was to make them more measurable, unambiguous, time-bound and set clear thresholds for success.

The targets have been developed to measure progress towards the objectives. They are designed to enable reporting at a Basin level and as a consequence, while targets have been developed for only a selection of objectives, it is expected that water will be provided to meet all objectives set out in this LTWP. Like the development of environmental objectives, the targets have been developed based on a set of common terms and definitions:

- ‘Maintain’ means to prevent further decline (this does not discount an improvement as an acceptable outcome)
- ‘Improve’ is a general term based on the objectives in the EWMPs. The term refers to an increase in the nominated attributes of the target
- ‘Habitat’ refers to water-based/instream/riparian habitat
- Waterbird guilds are based on feeding and habitat requirements. The main guilds in the Victorian Murray water resource plan area are piscivores (e.g. pelicans and cormorants), waterfowl (e.g. ducks and coots), rallids (e.g. rails and crakes) and waders and shorebirds (e.g. spoonbills and ibis)
- EVC benchmarks have a list of "typical" species and lifeforms (e.g. shrub, herb) found in each EVC in a particular bioregion. EVCs with trees (usually terrestrial and riparian EVCs) have standards for tree size and density, organic litter, recruitment and presence of large logs. The condition score for an EVC benchmark is the sum of the ratings for each component of the benchmark (large trees, tree canopy cover, understorey composition, weeds, recruitment, organic litter and large logs), as outlined in the Vegetation Quality Assessment Manual (DSE, 2004) for terrestrial vegetation. For wetland vegetation, the biota sub-index is used, as outlined in the Index of Wetland Condition assessment procedure (DEPI, 2013a).

Refinement of targets is an ongoing process, and this will be reflected in future iterations of this LTWP. Monitoring of the Victorian Murray LTWP is discussed in Section 8.

Table 9: Targets for the Victorian Murray water resource plan area and relevant assets

Theme	Objective	Previous Target	Revised Target	Assets
Connectivity	Improve connectivity between floodplains, anabranches and wetlands.	Meet required watering regime at 80% of wetland sites that have water delivered through anabranch connections	At least 50% of environmental watering events in these assets over a ten-year period are delivered via channels that provide hydraulic connectivity to the source waterway.	Kinnairds Swamp; Bottle Bend; Bumbang Island; Butlers Creek; Karadoc; McDonalds Swamp; Wirra-Lo; Black Swamp; Belsar and Yungera; Heywood Lake; Carina Bend; Lindsay, Mulcra and Wallpolla Islands ; Johnson Swamp; Lake Elizabeth; Lake Murphy; Murrumbidgee Junction; Wemen-Liparoo; Lock 15 (wetlands/floodplain); Lock 6 to 10 (wetlands/floodplain); Loddon River (lower); Bottle Bend; Spences Bend; Tata;; Broken and Nine Mile Creek; Johnson Swamp; Pig Swamp; Hird Swamp
Vegetation	Improve the species richness of aquatic vegetation in wetlands			Hird Swamp; Cardross Lakes; Merbein Common; Heywood Lake; Kings Billabong; Margooya Lagoon; Nyah & Vinifera; Piambie; Pound Bend; Psyche and Woorlong; Spences Bend; Tata; Walshes Bend; McDonalds Swamp; Pig Swamp; Lake Elizabeth; Murrumbidgee Junction; Neds Corner; Wemen-Liparoo; Hattah Lakes; Lindsay, Mulcra and Wallpolla Islands
	Improve the species richness of in-channel aquatic vegetation			Loddon River (lower)
	Improve the extent of aquatic vegetation			Hird Swamp; Lake Cullen; Richardson Lagoon; Loddon River (lower); Bottle Bend; Bumbang Island; Burra Creek floodplain; Carina bend; Psyche and Woorlong; McDonalds Swamp; Wirra-Lo; Johnson Swamp; Pig Swamp; Lake Murphy; Broken and Nine Mile Creek; Gunbower Forest; Hattah Lakes; Lakes Hawthorn and Ranfurly; Merbein Common; Lindsay, Mulcra and Wallpolla Islands
	Improve the condition of river red gum dominated EVCs	A positive trend in the condition score of river red gums dominated (EVC) benchmarks at 80% of sites over the ten year period to 2025	The condition or riparian EVCs in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets: - health of adult trees - recruitment and survival of juvenile trees - native species richness - native species cover/abundance - recruitment of understorey vegetation	Belsar and Yungera Islands; Bumbang Island; Margooya Lagoon; Nyah Vinifera; Kings Billabong; Carina Bend; Johnsons and Chaffey Bends; Murrumbidgee Junction; Wemen-Liparoo; Loddon River (lower); Burra Creek floodplain; Karadoc; Piambie; Pound bend; Spences Bend; Tata; Walshes Bend; Wirra-Lo; Gunbower Forest; Pig Swamp; Kinnairds Swamp; McDonalds Swamp; Barmah Forest; Neds Corner; Hattah Lakes; Lindsay, Mulcra and Wallpolla Islands

		In Gunbower Icon site, at least 30% of river red gum Water Regime Classes in healthy condition by 2025	No Change	
	Improve the condition of black box dominated EVCs	A positive trend in the condition score of black box dominated EVC benchmarks at 50% of sites over the 10 year period to 2025	The condition of black box dominated EVCs in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets: – health of adult black box trees – recruitment and survival of juvenile trees – recruitment of understorey vegetation – native species cover/abundance – native species richness	Bottle Bend; Heywood Lake; Johnsons and Chaffey; Wemen-Liparoo; Burra Creek floodplain; Karadoc; Spences Bend; Tata; Wirra-Lo; Gunbower Forest; Johnson Swamp; Hattah lakes; Sandilong Creek; Walshes Bend; Hattah Lakes; Lindsay, Mulcra and Wallpolla Islands
	Maintain the extent of black box dominated EVCs			Bottle Bend; Burra Creek floodplain; Heywood Lake; Johnsons and Chaffey; Lake Cullen; Richardson Lagoon; Lake Murphy; Sandilong Creek; Spences Bend; Tata; Walshes Bend; Hattah Lakes; Lindsay, Mulcra and Wallpolla Islands
	Improve the condition of Shrub and Lignum dominated EVCs	A positive trend in the condition score of shrub and lignum dominated EVC benchmarks at 50% of sites over the 10 year period to 2025	The condition of canegrass or lignum dominated EVCs is better at the end than at the start of a ten-year monitoring program as measured by the following sub-targets: – condition of lignum – cover of canegrass (there is no recognised condition assessment method for canegrass) – native species cover/abundance – native species richness	Carina Bend; Wemen-Liparoo; Burra Creek floodplain; Karadoc; Piambie; Murrumbidgee Junction; Psyche and Woorlong; Spences Bend; Tata; Wirra-Lo; Johnson Swamp; Pig Swamp; Lake Murphy; Lindsay, Mulcra and Wallpolla Islands ; Pound Bend; Hird Swamp; Neds Corner; Sandilong Creek; Hattah Lakes
	Successful growth and flowering of Moira Grass plants			Barmah Forest
Waterbirds	Improve breeding opportunities for colonial-nesting waterbirds	Water required for successful colonial waterbird breeding delivered in at least 2 years in 10 by 2025	The minimum water regime required for colonial nesting waterbird breeding is met over a ten-year monitoring period.	Gunbower Forest; Hattah Lakes; Barmah Forest; Lock 15 (wetlands/floodplain); Lock 6 to 10 (wetlands/floodplain)

	Improve breeding opportunities for waterbirds			Kinnairds Swamp; Bottle Bend; Bumbang Island; Karadoc; Lakes Hawthorn and Ranfurly; McDonalds Swamp; Wirra-Lo; Black Swamp; Lindsay, Mulcra and Wallpolla Islands ; Johnson Swamp; Lake Elizabeth; Lake Murphy; Loddon River (lower); Spences Bend; Broken and Nine Mile Creek; Johnson Swamp; Pig Swamp; Hird Swamp; Hattah Lakes; Barmah Forest
	Improve habitat for waterbirds	Appropriate water regime to support feeding and habitat areas for guilds of waterbirds delivered at 50% of sites, 8 years in 10	The minimum water requirement for waterbird feeding and/or breeding is met in the ten-year period to 2025.	Hird Swamp; Bottle Bend; Bumbang Island; Karadoc; Lakes Hawthorn and Ranfurly; Johnson Swamp; Pig Swamp; Lake Elizabeth; Lake Murphy; Gunbower Forest
	Improve feeding areas for waterbirds			Kinnairds Swamp; Bottle Bend; Karadoc; Lakes Hawthorn and Ranfurly; Lock 15 (wetlands/floodplain); Lock 6 to 10 (wetlands/floodplain); Hattah Lakes; Johnson Swamp; Lake Elizabeth; Lake Murphy
Fish	Improve abundance of large-bodied native fish	A positive trend in the catch per unit effort (CPUE) of large bodied native fish over the 10 year period to 2025	A) The mean number of sites where large-bodied native fish species are detected is the same or higher in the last five years than the first five years of a ten year monitoring program B) For annual age classes up to five years, the number of cohorts is the same or higher in the last year than the first year of a ten year monitoring program	Loddon River (lower), Bumbang Island; Broken River and Nine Mile Creek (Reaches 1-4); Lock 6 to 10 (wetlands/floodplain); Lindsay, Mulcra and Wallpolla Islands
	Maintain abundance of small-bodied native fish in wetlands	No negative trend in the abundance of small-bodied wetland specialist native fish in 2025	In small wetlands, maintain the presence of small-bodied native fish every year in the ten year monitoring period *and;* in large or network wetlands, the average number of sites where small-bodied native fish species are detected in the first five years is not less than in the last five years of a ten year monitoring program.	Walshes Bend; Gunbower Forest; Lindsay, Mulcra and Wallpolla Islands ; Hattah Lakes; Margooya Lagoon; Bottle Bend; Karadoc; Lakes Hawthorn and Ranfurly; Barmah Forest
	Maintain distribution of threatened small-bodied native fish in wetlands	Maintain current distribution of threatened small-bodied native fish in 2025.	In small wetlands, maintain the presence of threatened small-bodied native fish every year in a ten year monitoring period *and*	Gunbower Forest; Lake Elizabeth; Bottle Bend; Karadoc; Lakes Hawthorn and Ranfurly; Bambung Island; Spences Bend; Walshes Bend; Margooya Lagoon; Hattah Lakes

			in large or network wetlands, the average number of sites where threatened small-bodied native fish species are detected in the first five years is not less than in the last five years of a ten year monitoring period.	
	Improve habitat for native fish			Bottle Bend; Karadoc; Lakes Hawthorn and Ranfurly; Spences Bend; Hattah Lakes; Lock 6 to 10 (wetlands/floodplain); Broken River and Nine Mile Creek (Reaches 1-4)
	Maintain species richness of native fish	Maintain the number of native fish species recorded in Sustainable Rivers Audit (SRA) list, in 80% of years to 2025	The ratio of fish species observed to expected (using pre-European Reference Condition - PERCH) is the same in the first three years as the last three years of a ten year monitoring period	Lindsay, Mulcra and Wallpolla Islands ; Loddon River (lower); Gunbower Forest; Bambung Island; Lock 15; Lock 6 to 10; Walshes Bend
Other Fauna	Improve habitat of frog communities			Bottle Bend; Karadoc; Barmah-Millewa; Pig Swamp; Lake Murphy; Wirra-Lo
	Maintain species richness of frog communities	Maintain the number of native frog species recorded in 80% of years to 2025	The number of frog species observed in eight in a ten year period must be more than 75% of the highest diversity recorded in any one year.	Carina Bend; Kinnairds Swamp; Lock 15 (wetlands/floodplain); Margooya Lagoon; McDonalds Swamp; Gunbower Forest; Nyah & Vinifera; Psyche and Woorlong; Johnson Swamp, Black Swamp
	Improve habitat of turtle and crayfish communities			Barmah Forest
Macroinvertebrates	Improve abundance of macroinvertebrates			Loddon River (lower); Lake Elizabeth; Johnson Swamp; Pig Swamp;
	Improve number of macroinvertebrate functional groups present			Loddon River (lower); Lake Elizabeth; Johnson Swamp
Water Quality	Maintain water quality within an appropriate range to allow for ecosystem processes			Merbein Common; Loddon River (lower); Bumbang Island; Lock 15 (wetlands/floodplain); Lock 6 to 10 (wetlands/floodplain); Psyche and Woorlong; Spences Bend; Walshes Bend; Broken and Nine Mile Creek; Lake Elizabeth

3.5 Watering requirements of the objectives

This section describes the key components of the flow regime needed to meet objectives. Asset specific watering requirements are documented in EWMPs, seasonal watering proposals, and the VEWH's seasonal watering plan. Each of these uses the seasonally adaptive approach (DSE, 2009), where priorities for environmental watering, works and complementary measures in any given year vary according to climatic conditions and water availability.

3.5.1 Watering requirements of river assets

Watering requirements for rivers are specified in terms of flow components – low flow, freshes, high flow and overbank flow (Figure 11). In regulated rivers, many of the flow components that are needed can be provided through HEW (see Section 4) provided sufficient water is available. It is relatively straightforward to deliver baseflows and to return some of the small and medium-sized freshes that are critical in the life cycles of various native plants and animals. Baseflows provide the basic habitat for in-stream biota, while freshes can trigger fish migration and spawning, move sediment and nutrients through river systems, connect habitats and improve water quality. However, very high flows (including bankfull and overbank flows) are generally not feasible (due either to the volume of water required, infrastructure constraints or potential flooding issues), although natural flows can be "topped up" to meet critical depth or duration requirements. Figure 11 shows the benefits of different environmental flow components in rivers.

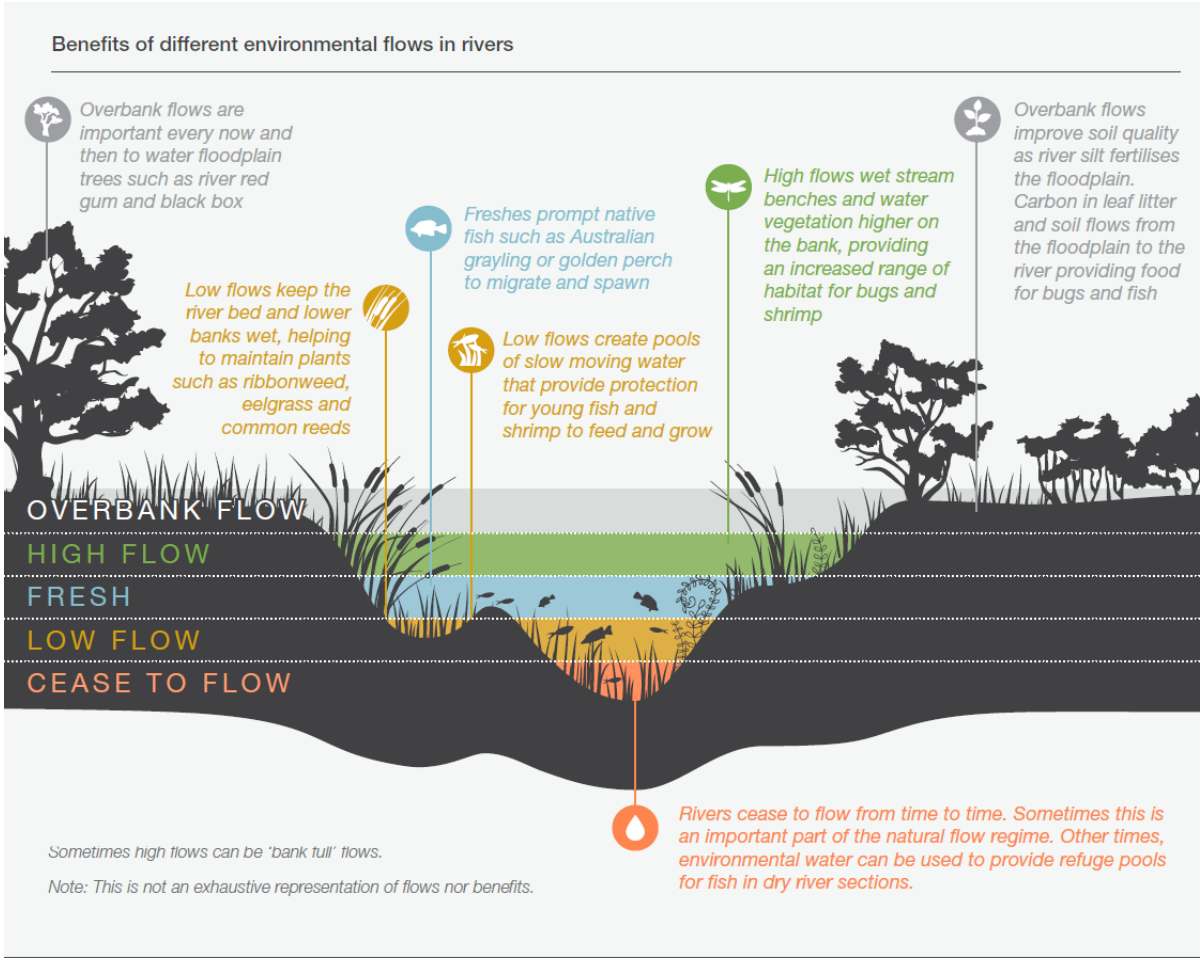


Figure 11: Benefits of different environmental flow components in rivers (VEWH, 2015)

Table 10 and Table 11 link specific flow components to the environmental objectives for river assets. While the flow components apply across all river assets, the details (flow rate, timing, frequency and duration) will be asset specific. An example of the flow components required to meet environmental objectives for Gunbower Creek is presented in Table 12 (NCCMA, 2015).

In addition to watering recommendations in flow studies for rivers and EWMPs for wetlands, the environmental watering requirements of priority ecosystem assets have been captured in the Environmental Assets and Functions Database (EAFD) (MDBA, 2021). This database contains the objectives, targets and associated watering regime for all priority environmental assets receiving environmental water across the Murray Darling Basin. It is a valuable resource for all environmental water delivery partners (i.e. CEWH, VEWH, state agencies and water corporations) and can be used to interrogate watering requirements at varying scales, from single environmental assets up to CMA and water resource plan scales. An example of the information contained in the database is presented in Table 13.

Table 10: Flow components required to meet native fish and vegetation objectives related to river-based assets

	Native fish objectives				Vegetation objectives				
Flow component	Improve abundance of large-bodied native fish	Improve abundance of small-bodied native fish	Improve movement of native fish	Maintain species richness of native fish	Improve condition of riparian EVCs	Improve abundance of aquatic vegetation	Maintain extent of aquatic vegetation	Maintain the species richness of in-channel aquatic vegetation	Maintain the condition of black box dominated EVC communities
Low flow	✓	✓	✓	✓		✓	✓	✓	
Freshes	✓	✓	✓	✓		✓	✓	✓	
High Flow				✓	✓				
Overbank flow					✓				✓
Explanation (based on conceptual models)	Low flows all year for habitat; July to November fresh for breeding trigger	Low flows all year for habitat; summer fresh for habitat quality	Winter low flow for widespread movement; summer fresh for local movement; July to November fresh for movement trigger	Low flows for habitat; freshes and high flows for channel maintenance, habitat quality, movement and breeding	Overbank flows for watering managed floodplain	Low flows for habitat; summer fresh for dispersal of propagules into disturbed habitats	Low flows for habitat; summer fresh for dispersal of propagules into disturbed habitats	Low flows for habitat; summer fresh for dispersal of propagules	Overbank flows for watering managed floodplain

Note: volume, timing, duration and frequency for each of these elements is asset specific.

Table 11: Flow components required to meet functions and 'other' objectives related to river-based assets

	Functions			Other objectives		
Flow component	Improve connectivity between river reaches to facilitate movement of native fish	Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	Maintain refuges for native fish species	Maintain the quality of geomorphic habitat	Improve habitat for Platypus	Maintain habitat for crayfish communities
Low flow	✓	✓	✓	✓	✓	✓
Freshes	✓	✓	✓	✓		
High Flow				✓		
Overbank flow						
Explanation (based on conceptual models)	Summer freshes and winter low flows provide adequate depth for fish movement	Low flows to prevent water quality decline; freshes to flush pools	Low flows to keep watered habitat present; freshes to prevent water quality decline	Winter low flow to prevent stream bed colonisation; freshes to maintain channel form and clean substrates	Low flow for habitat	Low flow for habitat

Note: volume, timing, duration and frequency for each of these elements is asset specific.

Table 12: Environmental flow recommendations for Gunbower Creek (NCCMA, 2015)

Flow component	Flow magnitude at target location				Duration	Timing	Frequency	Daily flow variability	Additional info including critical tolerances	Environmental objectives
	Reach 1 Headworks	Reach 2 Gunbower Weir	Reach 3a Cohuna Weir	Reach 3b Koondrook Weir						
Winter base flow	No prescribed flow as targeting flows in lower reaches If flows are >300 ML/day open lagoon regulators to facilitate throughflow	>250-300 ML/day If flows are >300 ML/day open lagoon regulators to facilitate throughflow	250-500 ML/day If forest inundated, open lower landscape regulators to facilitate bidirectional flow	>150 ML/day	Approx. 3 months	Between 15 May to 15 Aug	1 event per year each year (opening of lower landscape regulators is opportunistic) Max. 2 in 3 years for opening lagoon regulators (to maintain aquatic community structure)	(+/-) 50-100 ML/day including ramp up at start of Aug to integrate with spring-autumn low flow/ irrigation demand 15 ML/day bidirectional flow per lower landscape regulator	Magnitude to vary depending on conditions (i.e. lower end of range if delivering to forest) however flows to occur in all years. Close lagoon regulators if levels in the creek begin to drop to maintain >1 metre depth in critical lagoons	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8
Winter-spring high flow	No prescribed flow as targeting flows in lower reaches	1,200 ML/day N.B. during forest water years majority of flow may be diverted @ Hipwell Road	Pass flow through reach to return to Murray River or if watering forest maintain winter base flow conditions D/S Hipwell Road (see *winter base flow* for Reach 3a and Reach 3b)		Up to 3 months	Between June and Nov	1 event per year every 2 in 3 years	(+/-) 50-100 ML/day Including ramp up and down to integrate with preceding and proceeding flows		1.1, 1.2, 1.5, 1.6
Spring-autumn base flow	No prescribed flow as targeting flows in lower reaches		>400 ML/day If forest inundated, open lower landscape regulators to facilitate bidirectional flow	>150 ML/day	Up to 8 months	Between 15 Aug to 15 May	1 event per year each year Opportunistic opening of regulators depending on conditions	(+/-) 50-100 ML/day where possible ~15 ML/day bidirectional flow per regulator	Flow likely to be exceeded due to irrigation demand. Flow can be adjusted to dilute water entering creek from a forest watering event (i.e. to maintain habitable DO in creek D/S Cohuna Weir)	1.2, 1.4

Flow component	Flow magnitude at target location				Duration	Timing	Frequency	Daily flow variability	Additional info including critical tolerances	Environmental objectives
	Reach 1 Headworks	Reach 2 Gunbower Weir	Reach 3a Cohuna Weir	Reach 3b Koondrook Weir						
Spring-summer modified fresh	No prescribed flow as targeting flows in lower reaches	400-700 ML/day	400-500 ML/day	Pass entire flow through reach	10-15 days to ramp up --- 3.5 months hold phase --- <1 month to ramp down	Aug-Oct to ramp up --- Oct-Jan for hold phase --- Jan-Feb to ramp down	1 event per year every 2 in 3 years	<100 ML/day rate during ramp up and down to integrate with preceding and proceeding flows. Ramp up needs to provide a pulse larger than that of the preceding flow (i.e. if base flows is 250 ML/day pulse may be >450 ML/day) to trigger objective --- Hold to not exceed 50 cm/day fall D/S Cohuna Weir	Flow to occur in alternative watering years to forest due to flow volume required D/S of Hipwell Road.	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8
Autumn ramp down	Slow recession in flow rate to meet winter base flow targets (see *winter base flow*)				Approx. 2 weeks	Start early May	1 event per year each year	Recommended to not exceed 25-50 ML/day rate of fall	Integrate with winter low flow	1.1, 1.2, 1.3, 1.4
Opportunistic flow components										
Recolonisation flow *Triggered by pulse @ Torrumbarry*	No prescribed flow as targeting flows in lower reaches		~600-800 ML/day	~600-800 ML/day	5-15 days	Between late October and April	Opportunistic events	100 ML/day rate during ramp up and down to integrate with preceding and proceeding flows	Flow in response to Murray River pulse (i.e. piggyback on rain rejection event)	1.1, 1.2, 1.3

Flow component	Flow magnitude at target location				Duration	Timing	Frequency	Daily flow variability	Additional info including critical tolerances	Environmental objectives
	Reach 1 Headworks	Reach 2 Gunbower Weir	Reach 3a Cohuna Weir	Reach 3b Koondrook Weir						
Winter fresh *Triggered by <15,000 ML/day unregulated flow @ Torrumbarry*	No prescribed flow as targeting flows in lower reaches. However if flows are >300 ML/day open Gunbower Lagoon regulators to allow freshening flows and facilitate throughflow. Maintain at least 1 metre of depth at Phyland, Turner, Upper Gunbower, Gum and Cockatoo lagoons			50-750 ML/day	Estimated to be approx. 30 days	Between 15 May and 25 Aug	Opportunistic events. Max of 2 in 3 years for opening of lagoon regulators (to maintain aquatic community structure)	(+/-) 50-100 ML/day including ramp up and down to integrate with preceding and proceeding flows	Close regulators if levels in the creek begin to drop to maintain >1 metre depth in critical lagoons	1.1, 1.2, 1.3, 1.4, 1.5, 1.6
Winter fresh *Triggered by >15,000 ML/day unregulated flows @ Torrumbarry*	~250 ML/day	No prescribed flow as targeting flows in lower reaches	Approximately 20-50 ML/ day release from forest through Yarran Regulator	Pass entire flow through reach	Estimated to be approx. 30 days	Between 15 May and 25 Aug	Opportunistic events	(+/-) 50-100 ML/day including ramp up and down to integrate with preceding and proceeding flows	Management under this scenario needs to take into consideration the watering regime of forest	1.1, 1.2, 1.3, 1.4, 1.5, 1.6

Table 13: Example output from the MDBA Environmental assets and functions database (MDBA, 2021)

EnvAssetName	StartWatPer	EndWatPer_S	Condition	FlowMagnitı	FlowUnit_De	WateringFrequency_Original	WateringDuration_Original
Gunbower Creek	May	August	Opportunistic	See Flow_Origi		Opportunistic events	Estimated to be approx. 30 days
Gunbower Creek	August	October		400-500	ML/d	1 event per year, every 2 in 3 years	10–15 days to ramp up
Gunbower Creek	October	January		400-500	ML/d	1 event per year, every 2 in 3 years	3.5 months hold phase
Gunbower Creek	January	February		400-500	ML/d	1 event per year, every 2 in 3 years	< 1 month
Gunbower Creek	May	May		250-500	ML/d	1 event per year, every year	approx. 2 weeks
Gunbower Creek	October	April	Opportunistic	~600-800	ML/d	Opportunistic events	5–15 days
Gunbower Creek	May	August		250-500	ML/d	1 event per year each year (opening of l	Approx. 3 months (mid-May to mid-Aug
Gunbower Creek	June	November		See Flow_Origi		1 event per year, every 2 in 3 years	Up to 3 months
Gunbower Creek	August	May		> 400	ML/d	1 event per year, each year. Opportunis	Up to 8 months
Gunbower Creek	May	August	Opportunistic	See note		Opportunistic events. Max of 2 in 3 year	approx. 30 days
Gunbower Creek	May	August	Opportunistic	See note		Opportunistic events	approx. 30 days
Gunbower Creek	May	August	Opportunistic	See Flow_Origi		Opportunistic events. Max of 2 in 3 year	Estimated to be approx. 30 days
Gunbower Creek	May	August	Opportunistic	~20-50	ML/d	Opportunistic events	Estimated to be approx. 30 days
Gunbower Creek	August	October		See Flow_Origi		1 event per year, every 2 in 3 years	10–15 days to ramp up
Gunbower Creek	October	January		See Flow_Origi		1 event per year, every 2 in 3 years	3.5 months hold phase
Gunbower Creek	January	February		See Flow_Origi		1 event per year, every 2 in 3 years	< 1 month
Gunbower Creek	May	May		>150	ML/d	1 event per year, every year	approx. 2 weeks
Gunbower Creek	October	April	Opportunistic	~600-800	ML/d	Opportunistic events	5–15 days
Gunbower Creek	May	August		> 150	ML/d	1 event per year each year (opening of l	Approx. 3 months (mid-May to mid-Aug
Gunbower Creek	June	November		See Flow_Origi		1 event per year, every 2 in 3 years	Up to 3 months
Gunbower Creek	August	May		> 150	ML/d	1 event per year, each year. Opportunis	Up to 8 months
Gunbower Creek	May	August	Opportunistic	50-750	ML/d	Opportunistic events. Max of 2 in 3 year	approx. 30 days
Gunbower Creek	May	August	Opportunistic	50-100	ML/d	Opportunistic events	approx. 30 days
Gunbower Creek	May	August	Opportunistic	50-750	ML/d	Opportunistic events. Max of 2 in 3 year	Estimated to be ~30 Days
Gunbower Creek	May	August	Opportunistic	See Flow_Origi		Opportunistic events.	Estimated to be ~30 Days
Loddon River (lower)	December	May		60-100	ML/d	Annually: Dec-May. Vary the magnitude	6 months
Loddon River (lower)	December	May		220	ML/d	3 events per season: 1 between Dec and	2–3 days at peak. Ramp up to peak over
Loddon River (lower)	March	April	Wet/Average	900	ML/d	1 event in March – April in wet and aver	10 days at peak. Ramp up over 5 days an
Loddon River (lower)	June	November		200-220	ML/d	Vary the magnitude of flow within the p	6 months
Loddon River (lower)	September	October	Wet/Average	900	ML/d	1 event in September-October in wet ar	Ramp up over 5 days and ramp down ov
Loddon River (lower)	N/A	N/A		2000	ML/d	3–4 per decade, but no more than 1–2 e	3–4 days at peak
Loddon River (lower)	December	May		200	ML/d	Annually: Dec-May. Vary the magnitude	6 months
Loddon River (lower)	December	May		0		3 events per season: 1 between Dec and	2–3 days at peak. Ramp up to peak over
Loddon River (lower)	March	April	Wet/Average	900	ML/d	1 event in March – April in wet and aver	10 days at peak. Ramp up over 5 days an
Loddon River (lower)	June	November		200	ML/d	Vary the magnitude of flow within the p	6 months
Loddon River (lower)	September	October	Wet/Average	900	ML/d	1 event in September-October in wet ar	10 days as peak.Ramp up over 5 days and
Loddon River (lower)	N/A	N/A		0		3–4 per decade, but no more than 1–2 e	3–4 days at peak

3.5.2 Watering requirements for wetland assets

The Victorian Murray water resource plan area contains a considerable diversity of wetland types (see Section 0), although, based on area, the priority ecosystem assets are predominantly *temporary river red gum swamp*, *black box woodland riparian zone or floodplain* or *river red gum forest riparian zone or floodplain wetlands*. Historically, wetland assets would typically receive water from high river flows in wet winter/spring periods, although very heavy rainfall in summer/autumn can lead to substantial inflows into wetlands. Land and water resource development since European settlement has altered the frequency, timing and duration of river flows, putting at risk the ecological values of priority wetland assets. Environmental water can be used to reinstate a more natural watering regime, including a wetting and drying cycle where appropriate.

In wetlands, phases of the watering regime include (Figure 12):

- Drying – declining water levels due to outflows, seepage and evaporation.
- Dry – no water in wetland.
- Filling – inflow of water and increasing water levels; can be a trigger for watering events.
- Full – the wetland is filled to the natural outflow or "sill" level and only evaporation and recharge to groundwater will subsequently reduce volume. May be topped up to increase the duration of inundation.
- Flooded – water level is higher than the natural sill; occurs during floods or watering events that target the surrounding areas (e.g. fringing vegetation).

Table 14 and Table 15 describe phases of the wetting and drying cycle that contribute to achieving the environmental objectives for **wetland** assets. The environmental watering regime for each priority ecosystem asset is described in EWMPs. An example of the wetland watering requirements is presented in Table 16, which shows the requirements for Hattah Lakes.

While the water regime components apply across all wetland assets, the details (timing, duration and frequency) will be site-specific and will vary year to year depending on antecedent conditions and the availability of environmental water. These factors are considered annually as part of development of the VEWH's Seasonal Watering Plan. Another consideration when deciding which wetlands receive environmental water in any year is maintaining a mosaic of wetland habitat types across the region. This will increase habitat availability over time for waterbirds and allow other water dependent plants and animals to disperse across the landscape (Morris, 2012).

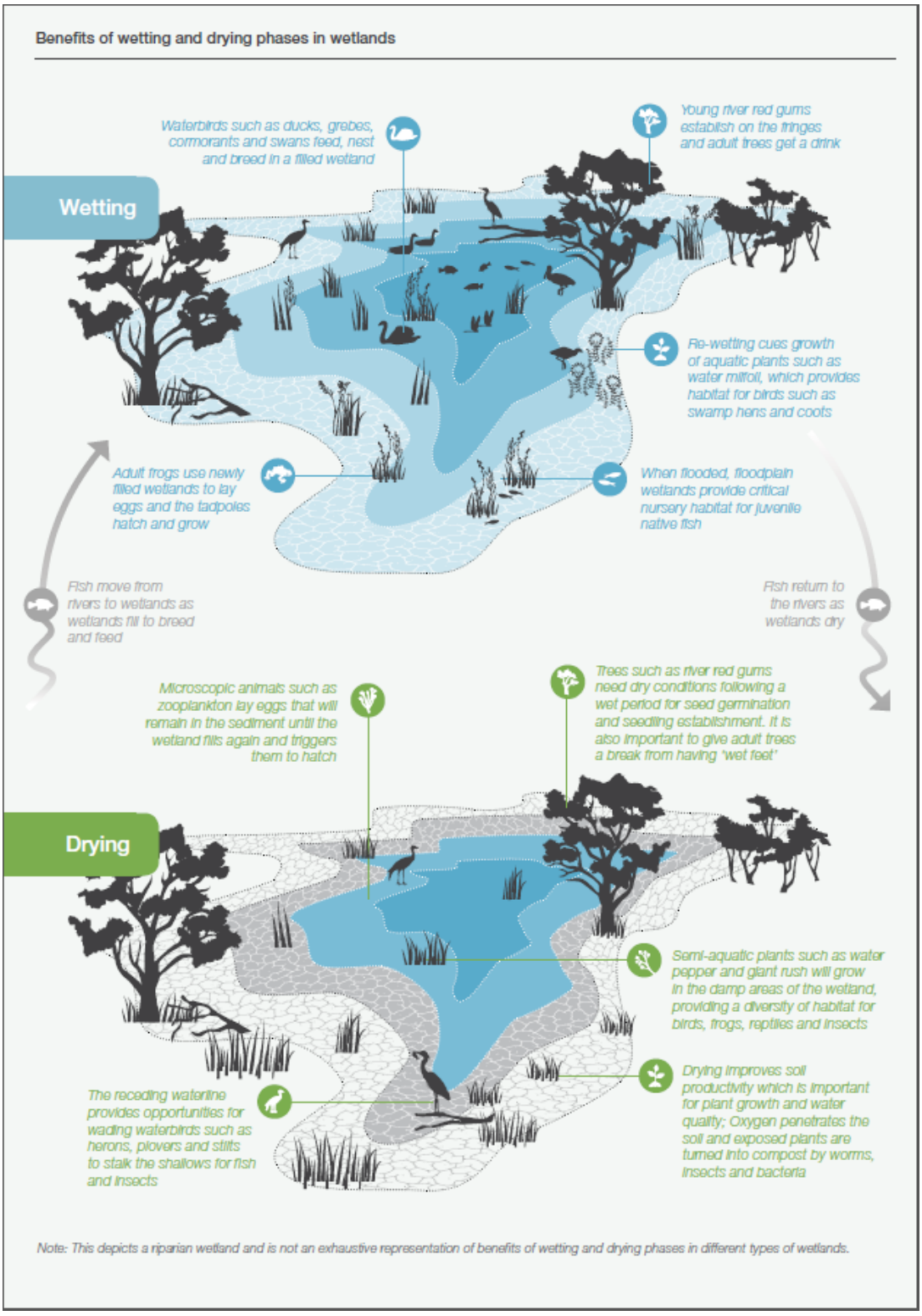


Figure 12: Benefits of wetting and drying phases in wetlands (VEWH, 2015)

Table 14: Elements of the wetting/drying cycle required to meet waterbird and vegetation objectives for wetland-based assets

	Waterbird objectives		Vegetation objectives						
Cycle component	Improve breeding opportunities for waterbirds	Improve habitat for waterbirds	Maintain the extent of aquatic vegetation	Improve the abundance of aquatic vegetation	Maintain the species richness of aquatic vegetation in wetlands	Improve condition of Wetland EVCs	Maintain extent of Wetland EVCs	Maintain the condition of black box dominated EVC communities	Reduce extent of exotic vegetation
Regional mosaic		✓				✓			
Dry					✓	✓			✓
Filling	✓			✓		✓			✓
Full	✓	✓	✓	✓	✓	✓		✓	✓
Flooded						✓	✓	✓	
Drying		✓		✓	✓	✓		✓	✓
	Timing of filling important; full level determines duration	Mosaic provides different habitats across region; full level determines area of habitats and duration; drying wetlands provide additional habitat types	Full level represents the maximum extent of wetted area	Filling and natural drying promotes germination and diversity of habitats	Filling and natural drying promotes germination of different functional groups and diversity of habitats	Different EVCs will have different watering requirements at a local level	Managed floodplain level represents the maximum extent of communities	Flooding to manage wetland extent then reducing to full level will water adult trees, but prevent waterlogging	Drying a wetland may reduce aquatic weeds, filling may reduce terrestrial weeds

Note: volume, timing, duration and frequency for each of these elements is asset specific.

Table 15: Elements of the wetting/drying cycle required to meet frog, turtle and crayfish objectives for wetland-based assets

	Other objectives		
	Maintain habitat for frog communities	Maintain habitat for turtle communities	Maintain habitat for crayfish communities
Cycle component			
Regional mosaic	✓	✓	
Dry			
Filling	✓		
Full	✓	✓	✓
Flooded			
Drying			
Explanation (based on conceptual models)	Mosaic provides different habitats across region; frog breeding triggered by filling; full level to allow time for metamorphosis	Mosaic provides different habitats across region; full level provides maximum available habitat	Full level provides maximum available habitat

Note: volume, timing, duration and frequency for each of these elements is asset specific.

Table 16: Watering requirements for the Hattah Lakes icon site environmental objectives (MDBA, 2012b)

Refined environmental objectives	Vegetation community	Flow Rate (ML/d)	Duration	Timing	Frequency (years in 10)	Maximum time between events	Works or other measures to assist meeting objectives	Area flooded with works (ha)
Restore a mosaic of hydrological regimes Maintain and restore ecological character of the Ramsar site Restore the macrophyte zone around at least 50% of the lakes Improve the quality and extent of deep freshwater Maintain habitat for the freckled duck, grey falcon and white-bellied sea-eagle Successful breeding events for colonial waterbirds at least two years in 10 Provide habitat for migratory bird species Increase distribution, number and recruitment of wetland fish Maximise use of floodplain habitat for fish recruitment	Semipermanent wetlands	>37,000	90 days	Spring	6	4 years	Pumping station and regulators/stop banks	1,127
	Temporary wetlands	>50,000	30 days	Winter–Spring	4			
	Episodic wetlands	>150,000	7 days	Winter–Spring	1 year in 8	10 years	Pumping station and Kramen regulator	To be confirmed
Restore a mosaic of hydrological regimes Maintain and restore ecological character of the Ramsar site Maintain habitat for the freckled duck, grey falcon and white-bellied sea-eagle Successful breeding events for colonial waterbirds at least two years in 10 Provide habitat for migratory bird species Maximise use of floodplain habitat for fish recruitment	Fringing river red gum	>45,000	60 days	Winter–Spring	4–6	7 years	Pumping station and regulators/stop banks	1,563

Refined environmental objectives	Vegetation community	Flow Rate (ML/d)	Duration	Timing	Frequency (years in 10)	Maximum time between events	Works or other measures to assist meeting objectives	Area flooded with works (ha)
Restore a mosaic of hydrological regimes Maintain habitat for the freckled duck, grey falcon and white-bellied sea-eagle Successful breeding events for colonial waterbirds at least two years in 10 Provide habitat for migratory bird species Maximise use of floodplain habitat for fish recruitment	River red gum woodland (flood-tolerant understory)	>75,000	30 days	Winter–Spring	2–4	7 years	Pumping station and regulators/ stop banks	1,396
Restore a mosaic of hydrological regimes Successful breeding events for colonial waterbirds at least two years in 10 Maximise use of floodplain habitat for fish recruitment	Black box woodland	>120,000	14 days	Winter–	1:3	10 years	Pumping station and regulators/stop banks, Lake Kramen regulator	1,272

4. Provision of environmental water

In Victoria, all water that is available for the preservation of the environmental values and health of water ecosystems is defined and protected as the Environmental Water Reserve (EWR) under the *Water Act* 1989 (Vic).

This section describes the provision of the EWR in Victoria's regulated and unregulated water systems.

Across all Victorian water resource plan areas, environmental objectives are met through:

1. Environmental water entitlements (bulk entitlements and environmental entitlements) and water shares that are held or managed by the Victorian Environmental Water Holder or Commonwealth Environmental Water Holder (CEWH) (see Section 4.2.1).
2. Passing flow requirements specified for environmental purposes under bulk entitlements or water supply protection area water management plans (see Section 4.2.2).
3. Other water managed through water system management rules, including passing flows not specified as having an environmental purpose, and unregulated river diversion rules. This includes water which remains in the system after consumptive and environmental entitlements are taken out - referred to as 'above cap' water – and water used primarily for consumptive purposes, but which can also have a benefit for the environment.

4.1 Water management in regulated and unregulated systems

The approach to meeting environmental objectives in Victoria's surface water systems depends on whether the water resources are unregulated or regulated.

In northern Victoria, the unregulated systems are generally tributaries of the larger regulated rivers or upper reaches of regulated rivers, upstream of reservoirs. Many unregulated rivers and streams in the Victorian Murray water resource plan area have high environmental values. As there are no major storages on these rivers and streams, flows in these unregulated systems are largely unmodified. While this is positive, the absence of large storages means that there is no HEW in these systems that can be released to target specific flow components. Environmental objectives in unregulated systems therefore are to protect the existing conditions (habitat), rather than provide a specific flow to meet an environmental objective for example, trigger fish spawning or water a particular vegetation community. No priority environmental assets or priority ecosystem functions have been identified in unregulated systems.

In unregulated systems, the impact on the environment is managed by specifying limitations on the timing and the rate of take in bulk entitlements and take and use licences. The volume of water which can be extracted by consumptive users can be further limited by restricting or banning take for take and use licence holders during times of low flow. Note that the domestic and stock take is still permitted even during bans which apply to use for irrigation and industry.

Regulated systems contain structures such as dams or major diversion weirs which exert significant control over the flow of water in the river for consumptive users. The impact of regulation on the environment will depend upon the size and number of storages and weirs, the level of consumptive use, and the overall volume of flow the river receives. For example, the Ovens system has two relatively small reservoirs, and receives relatively high annual river flows and is sometimes called semi-regulated, while the Goulburn River has two large storages and high consumptive demand, so the impact on the environment from regulation is much less in the Ovens River than in the Goulburn River.

Regulation of river systems has a significant impact on the environmental values of the system. Storages capture water during naturally high flow periods and retain it, to be released to meet consumptive demands during drier times of the year, creating unnaturally high flows during summer. Storages create barriers to flow connectivity and biota migration. Environmental water can reduce the impact of river regulation and water

extraction by providing flows at the right time of year for priority environmental assets and priority ecosystem functions (see Appendix E).

In regulated systems, environmental water requirements can be met with HEW and through planned environmental water (see Section 4.2.2) and other water (see Section 4.2.3). Other water in the system also supports environmental water outcomes. This includes passing flows requirements that meet multiple objectives, and delivery of water from reservoirs to downstream users, delivery of water from inter-valley trade accounts, or transfers from storages.

4.2 Held and planned environmental water

The *Water Act 2007* (Cth) identifies two types of environmental water: held and planned. HEW is defined under Section 4 of the *Water Act 2007* (Cth) as water available under a water access right, water delivery right or irrigation right for the purposes of achieving environmental outcomes, including water that is specified in a water access right to be for environmental use.
Planned environmental water is defined in Section 6 of the *Water Act* 2007 (Cth) and has three components:

- Water committed or preserved by an instrument.
- Water committed or preserved for the purpose of achieving an environmental outcome or other environmental purposes as specified in an instrument.
- Water that cannot, to the extent it is committed or preserved, be taken for any other purpose.

4.2.1 Held environmental water in Victoria

In the Victorian context, HEW is any water held under an entitlement for an environmental purpose. This water includes:

- Environmental entitlements or bulk entitlements issued to the Victorian Environmental Water Holder (VEWH) to provide water to be used for environmental purposes.
- Entitlements such as take and use licences or water shares held by the VEWH or CEWH.
- A passing flow specifically allocated to the holder in an environmental entitlement for environmental benefit or purpose.

This water is considered HEW under the Commonwealth definition because it is water specifically committed to environmental purposes under a water access right.

HEW is protected by Victoria's water entitlement framework, which provides security to all entitlement holders, regardless of use. It provides for:

- Secure and enduring entitlements.
- The limits on take through sustainable diversion limits and permissible consumptive volumes.
- The clear consultative process for changing entitlements.
- The annual process to allocate water to entitlements.
- The ability to trade.
- Ministerial intervention only during extreme events to ensure supplies for critical human water needs.
- A regime for compliance and enforcement.

HEW can be equivalent to high-reliability entitlement or low-reliability entitlement, or it can be provisional and have reliability as described in the bulk or environmental entitlements. All entitlements in Victoria are recorded on the Victorian Water Register (https://www.waterregister.vic.gov.au/water-entitlements). Information about the holder of the entitlement, where the water may be taken and used, and the volumes authorised by the entitlement, are described in this register.

Section 3.5 describes how environmental watering objectives are achieved through the use of HEW and supported by planned environmental water or water not otherwise allocated in the system, including minimum passing flows for system water. Protection and rules for passing or minimum flow obligations are outlined in the respective bulk or environmental entitlement instrument for each system.
The use of HEW is often closely integrated with other types of water use. The VEWH works closely with catchment management authorities and storage managers and, where practical, seeks opportunities to

adjust the timing and route for delivering consumptive water to achieve environmental objectives efficiently. This can include 'piggy-backing' delivery of environmental water on the delivery of consumptive water or passing flow obligations to maximise ecological outcomes.

HEW in the Victorian Murray water resource plan area is summarised in Table 17.

4.2.2 Planned environmental water in Victoria

Section 10.09(1) of the Basin Plan requires the identification of planned environmental water. A review of Victoria's bulk entitlements and statutory management plans in Victoria's North and Murray water resource plan area was undertaken to determine where planned environmental water was in northern Victoria. The review looked for water that met the *Water Act 2007 (Cth)* requirements that:

- The water is committed or preserved.
- The commitment or preservation is specifically set aside for achieving environmental outcomes either for a specific environmental purpose or environmental purposes more generally.
- The water that is committed or preserved cannot be taken for another purpose because it is protected from other forms of take or use.

In Victoria, these conditions are not met in some bulk entitlements and systems as:

- Minimum passing flows are generally not preserved exclusively for an environmental purpose or outcomes as specified in section 6 of the *Water Act 2007* (Cth). Passing flow requirements tend to serve multiple outcomes as shared benefits and are rarely identified as being solely for an environmental purpose.
- Where water is committed or preserved or required to exist within the system, such as a minimum passing flow for a specified environmental purpose or to meet a specific environmental outcome, the Commonwealth definition deems that committed or preserved water cannot be taken for any other purpose. In Victoria, this requirement cannot be met where a water user has a right to take water for domestic and stock purposes and it is not accounted for in measuring passing flow.

There are three instances in Victoria's North and Murray water resource plan areas where instruments meet the Basin Plan definition of planned environmental water. These are:

- Minimum passing flows available under the Bulk Entitlement (Broken System – Goulburn-Murray Water) Conversion Order 2004.
- Minimum passing flows available under the Bulk Entitlement (Ovens System – Goulburn-Murray Water) Order 2004.
- Minimum passing flows available under the Upper Ovens River water supply protection area water management plan (GMW, 2012).

Planned environmental water in Victoria's North and Murray water resource plan areas is protected in two ways:

- Through the instruments that establish planned environmental water and the instruments that regulate water resource management in Victoria under the *Water Act 1989* (Vic); and
- Measures under the *Water Act 1989* (Vic) such as the Environmental Water Reserve and offences for taking water without authorisation.

These are considered 'rules and arrangements' relating to the planned environmental water and are identified in Table 2 of Appendix E of the Victoria's North and Murray water resource plan (DELWP, 2020). The water resource plan also provides further details on planned environmental water in Victoria.

Table 17. Summary of environmental water holdings relevant to the Victorian Murray water resource plan area as of 30 April 2021

System	Entitlement	Volume (ML)	Class	Holder	Notes
Broken	CEWH water shares	534	High	CEWH	
		4	Low		
	VEWH water shares	90	High	VEWH	
		19	Low		
Campaspe	Environmental Entitlement (Campaspe River – Living Murray Initiative) 2007	126	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA
		5,048	Low		
	Campaspe River Environmental Entitlement 2013	20,652	High	VEWH	
		2,966	Low		
	CEWH water shares	6,624	High	CEWH	
		395	Low		
Goulburn	Goulburn River Environmental Entitlement 2010	26,555	High	VEWH	
		5,792	Low		
	Environmental Entitlement (Goulburn System – Living Murray) 2007	39,625	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA.
		156,980	Low		
	Environmental Entitlement (Goulburn System – NVIRP Stage 1) 2012	N/A	Provisional	VEWH	Water is allocated to VEWH annually in line with procedure for determining mitigation water in Schedule 3 of the Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 2005
	Silver and Wallaby Creeks Environmental Entitlement 2006	N/A	Passing flow only	VEWH	
	CEWH water shares	317,557	High	CEWH	
		42,467	Low		
	The Living Murray - water shares	5,559	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA
Loddon	Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005	10,970	High	VEWH	The entitlement includes passing flows in addition to a volumetric entitlement.
		2,024	Low		

System	Entitlement	Volume (ML)	Class	Holder	Notes
		N/A	Passing flow only		
	Environmental Entitlement (Birch Creek – Bullarook System) 2009	100	Provisional	VEWH	The entitlement includes passing flows in addition to a volumetric entitlement. Allocation to these entitlements is made subject to specific triggers, as specified in the entitlement.
	CEWH water shares	3,356	High	CEWH	
		527	Low		
Ovens	CEWH water shares	123	High	CEWH	
Murray	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999	45,267	High	VEWH	
		8,523	Low		
		49,000	Provisional		Rules allow 40,000 ML of this entitlement to be borrowed to support high-reliability entitlements.10,000 ML must be made available for low-level watering at Barmah Forest.
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – River Murray Increased Flows	N/A	Provisional	VEWH	Rules in the Bulk Entitlement (River Murray - Flora and Fauna) Order 1999 describe access rights for RMIF.
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah-Millewa Forest Environmental Water Allocation	50,000	Provisional	VEWH	
		25,000	Provisional		
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray	9,589	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA.
		101,850	Low		
		34,300	Provisional		
	Environmental Entitlement (River Murray – NVIRP Stage 1) 2012	N/A	Provisional	VEWH	Water is allocated to VEWH annually in line with procedure for determining mitigation water in Schedule 3 of the *Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 2005*
	CEWH water shares	362,360	High	CEWH	
		35,413	Low		
	The Living Murray – water shares	12,267	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA

Note: The Northern Victorian and Victorian Murray water resource plan areas are highly connected allowing water sourced in one water resource plan area to be used in another. Water trading allows VEWH to move water to the systems where it is most needed and manage some of the variability within systems. In some systems, environmental water delivered through upstream sites can be used at downstream sites – the water credited to VEWH accounts at downstream sites is called return flows.

4.2.3 Other water that contributes to environmental outcomes

The previous section (and Victoria's North and Murray Water Resource Plan (DELWP, 2020)) explains what planned environmental water is, and is not. Although there is other non-held water in Victoria's waterways that also contributes to environmental objectives for priority environmental assets and ecosystem functions, this water does not fall under the definition of planned environmental water as it is not specifically committed for environmental purposes and provides shared benefits. For example, system operating water (the water released from storages to operate river and distribution systems) benefits the environment but also allows delivery of water to other users. Similarly, above-cap water (the water left over after the upper limits on diversions have been reached, including unregulated flows that cannot be kept in storage) provides significant benefits to the environment but also to recreational users of waterways.

Water for Victoria (2016) sets out Victoria's position on optimising the use of limited water resources to meet some of the objectives of key groups in the community, such as Traditional Owners and Aboriginal Victorians, and recreational users. CMAs and the VEWH are required to consider shared benefits when making environmental watering decisions.

Environmental water managers work with river operators to identify how all types of water can be best utilised to meet multiple objectives, including those for the environment. They coordinate the delivery of HEW with above cap and system water, as well as planned environmental water and consumptive water *en route*, to meet environmental objectives. Sometimes the timing and route for delivery of consumptive water can be altered to achieve environmental objectives without using environmental water.

4.3 Regulated systems of the Victorian Murray water resource plan area

There are two main regulated systems in the Victorian Murray water resource plan area, the Victorian Murray and Lower Broken Creek (Table 18).

Table 18: Regulated systems in the Victorian Murray water resource plan area

System	Description	Comments
Victorian Murray	Flows are regulated by Lake Dartmouth on the Mitta Mitta River and Lake Hume on the River Murray. Releases from Lake Dartmouth flow down, meeting local irrigation demands along the Mitta Mitta River and then entering the Lake Hume storage. Releases from Lake Hume supply urban, rural and environmental demands from Lake Hume to the SA border.	Lake Dartmouth and Lake Hume are managed by the MDBA under the terms of the MDB Agreement to supply water to NSW, SA and Victoria. They are operated in conjunction with a number of locks and weirs on the River Murray system to meet the water requirements of these jurisdictions. Further water resources are also available from MDBA managed storages on the Darling River in NSW (Menindee Lakes) and on the River Murray near the SA border (Lake Victoria). Additional supplements can also be provided from Victorian regulated tributaries. The Victorian Murray regulated system also supplies water into a number of irrigation systems. These include the Murray Valley and Torrumbarry Irrigation Areas, and the Tresco, Nyah, Robinvale, Red Cliffs, Mildura and Merbein Irrigation Districts.
Lower Broken Creek	Flows are primarily regulated by transfers of water into the Lower Broken Creek from the Goulburn regulated river system via the East Goulburn Main channel but there are also other Goulburn outfalls. Flow is also supplied from the Murray Valley Irrigation Area to meet system demands. The regulated reach of the Lower Broken Creek extends from Katandra Weir on the Broken Creek downstream to its confluence with the River Murray	Supply into the Lower Broken Creek is reliant on the Murray Valley and Shepparton Irrigation areas. Supply of water over the non-irrigation period (15 May – 15 August) is intermittent and dependant on works being undertaken.

4.4 Unregulated surface water systems of the Victorian Murray water resource plan area

In the Victorian Murray water resource plan area, a range of water management arrangements have been developed for unregulated streams. Local management rules have been developed and published for virtually all significant unregulated streams in the water resource plan area.

4.5 Groundwater systems

Groundwater in Victoria is managed through statutory Groundwater Management Plans and non-statutory local management plans. Such plans apply caps (or 'permissible consumptive volumes' (PCVs)) on extraction within a groundwater management area and, through licences that share water amongst users, ensure protection of environmental values. These plans particularly protect values associated with groundwater-dependent ecosystems (GDEs) that rely on groundwater for all or part of their water needs (e.g. river reaches that gain or lose groundwater, wetlands that rely on shallow aquifers, or terrestrial vegetation that relies on shallow or deeper aquifers).

In addition to planning processes for managing unregulated surface water entitlements, the Ministerial Guidelines for Groundwater Licensing and the Protection of Groundwater Dependent Ecosystems (DELWP, 2015) oblige water corporations to undertake a structured assessment of the risks to GDEs associated with the issue or transfer of a groundwater licence. For medium or high-risk proposals, suitable risk mitigation treatments must be developed and incorporated in licence conditions; a licence application may be refused if suitable mitigations are not available. These guidelines support and complement the objectives of the surface water management processes in unregulated catchments to protect and enhance environmental conditions.

4.5.1 Groundwater dependency of priority environmental assets

The hydrogeology of the Victorian Murray water resource plan area is situated on the northern floodplain of the Ovens, Broken, Goulburn, Campaspe and Loddon rivers, as well as the Victorian portion of the River Murray (DELWP, 2020). It includes the Upper Tertiary Quaternary Aquifer (UTQA) of the Shepparton formation of layered clay, sands and silt that runs from near Seymour north to Nathalia, Barmah and Numurkah. Along the River Murray, the UTQA overlies the Calivil Formation Upper Tertiary Aquifer fluvial, containing fluvial sand, gravel and clay. Other formations include the Lower Tertiary Aquifers of the Renmark formation near Nathalia and Barmah, and Cretaceous Permian sediments made of fractured rock, sand and minor coal near Shepparton to parts of the north near Nathalia and Numurkah.

Victoria's North and Murray Water Resource Plan (DELWP, 2020) identified the groundwater-dependent priority environmental assets in the Victorian Murray water resource plan area (Table 19 for riverine assets and Table 32 in Appendix I for wetland assets). In addition, Groundwater Logic (2019) assessed risks to ecosystem values associated with groundwater resource use and considered whether the priority environmental assets are sufficiently protected from such risks by the provisions of existing groundwater management plans.

Whilst the confidence assigned to groundwater dependence varied from high to low, the level of risk posed by groundwater resource use across northern Victoria was generally assessed as low for each of the priority environmental assets (Groundwater Logic, 2019). Four river reaches across northern Victoria were classified as moderate risk GDEs (including parts of Broken and Nine Mile Creek in the Victorian Murray water resource plan area), but all are in areas with existing water management protections in place (e.g. ongoing groundwater usage restriction triggers in place under the Local Management Plan, or where there are baseflow-related targets for environmental watering). Overall, existing measures were considered sufficient to protect priority environmental assets from excessive groundwater resource use.

Table 19: Groundwater dependent riverine assets in the Victorian Murray water resource plan area (from DELWP, 2020)

PEA name	PEA reach	Index of Stream Condition Basin-Reach	Surface water SDL resource unit	Groundwater dependent features (confidence)
Gunbower Creek	Gunbower Creek R38	14062	SS2 (Victorian Murray)	M
	Gunbower Creek R39	14427	SS2 (Victorian Murray)	M
River Murray - Lock 6-10	River Murray Lock 6 - 10 R13	14-13	SS2 (Victorian Murray)	M
	River Murray Lock 6 - 10 R14	14-14	SS2 (Victorian Murray)	M
	River Murray Lock 6 - 10 R15	14-15	SS2 (Victorian Murray)	M
	River Murray Lock 6 - 10 R16	14-16	SS2 (Victorian Murray)	M
	River Murray Lock 6 - 10 R17	14-17	SS2 (Victorian Murray)	M
River Murray - Lock 15	River Murray US of Lock 15 R6	43265	SS2 (Victorian Murray)	M
	River Murray US of Lock 15 R7	43295	SS2 (Victorian Murray)	M
Tullah Creek	Tullah Creek R36	13241	SS2 (Victorian Murray)	L
Broken and Nine Mile Creeks	Broken and Nine Mile R24	45383	SS5 (Broken)	Non-GDE
	Broken and Nine Mile R28	46844	SS5 (Broken)	M
	Broken and Nine Mile R30	11049	SS5 (Broken)	M
	Broken and Nine Mile R23	45017	SS5 (Broken)	L
	Broken and Nine Mile R21	44287	SS5 (Broken)	H
Loddon River (lower)	Loddon River lower R1	43107	SS8 (Loddon)	L
	Loddon River lower R2	43138	SS8 (Loddon)	Non-GDE
	Loddon River lower R50	18445	SS8 (Loddon)	Non-GDE

5. Cooperative arrangements

Environmental water management involves a range of people and organisations. This section describes these partnerships and identifies the processes by which collaboration occurs between agencies and across regions.

5.1 Context

There are strong cooperative arrangements in place to support delivery of Victoria's environmental watering program, between environmental water holders (VEWH, CEWH, TLM), managers of water regulations (water corporations), managers of priority environmental assets (water corporations, CMAs, land management agencies) and community members. Environmental water holders, water corporations, CMAs and land management agencies partner with the relevant Traditional Owner groups to deliver Victoria's environmental watering program.

The Victorian government has established these arrangements, in consultation with delivery partners and communities, and participates in inter-jurisdictional arrangements, through the Southern Connected Basin Environmental Watering Committee (SCBEWC) and the Environmental Watering Committee (EWC, formed in 2021). The arrangements are underpinned by a range of policy, regulatory and governance frameworks.

5.2 Responsible organisations

Public and private authorities collaborate to deliver environmental water in Victoria. These authorities, referred to as program partners, are listed in Appendix G along with their respective roles and responsibilities, which are summarised as follows:

- **Waterway managers (CMAs)** are responsible for identifying, planning and implementing regional priorities for environmental waterway management, this includes identifying objectives and assessment of water regimes needed for priority environmental values, Aboriginal cultural values and uses, social and recreational uses and values and economic values. They consult with local communities, develop proposals for environmental watering in rivers and wetlands in their region, order environmental water from storage managers, and monitor the outcomes. In the Victorian Murray water resource plan area, the responsible CMAs are Mallee, North Central, Goulburn Broken, and North East CMAs.
- **Storage managers** (water corporations) deliver water for all water users, including for waterway managers / environmental water holders. In the Victorian Murray, Goulburn-Murray Water and Lower Murray Water are the responsible water corporations.
- **Environmental water holders** commit environmental water to different rivers and wetlands. They work together to ensure the coordinated delivery of water available under different environmental entitlements, and often must prioritise across large regions or water resource plan areas. In the Victorian Murray, the environmental water holders are VEWH, CEWH and TLM.
- **Public land managers** are closely involved in environmental water planning and delivery for public land such as state forests or national parks. They may have a variety of responsibilities including operating infrastructure (such as pumps, outlets, gates and channels) and ensuring appropriate public signage during an event. In the Victorian Murray, the public land managers are Parks Victoria, DELWP, and Traditional Owner land management boards.
- **Traditional Owner groups** in the Victorian Murray water resource plan area include the First Peoples of the Millewa-Mallee Aboriginal Corporation and the Yorta Yorta Nations Aboriginal Corporation. In Victoria, there are currently three different processes for groups to become formally recognised as Traditional Owners of Country. This includes Registered Aboriginal Party (RAP) under the *Aboriginal Heritage Act 2006*, Native Title Determination under the *Commonwealth Native Title Act 1993* and Recognition and Settlement Agreement under the Victorian *Traditional Owner Settlement Act 2010*. Waterway managers, storage managers and environmental water holders

partner with formally recognised Traditional Owners and work with other Traditional Owner groups to support recognition of Aboriginal values and uses in waterway management.

- **MLDRIN and the Federation of Victorian Traditional Owner Corporations** also play important roles in advising on diverse matters related to water management.

5.3 Coordination processes

Coordination of environmental watering in the surface water systems in Victorian Murray water resource plan area, and across Victoria's state borders, is done through cooperative arrangements. The VEWH leads annual environmental water planning and coordination for Victorian waterways at a water resource plan area scale, in close consultation with CMAs as the local environmental water managers.

The VEWH represents the Victorian priorities and objectives at interstate and Commonwealth environmental watering coordination forums to help align and coordinate objectives and outcomes at the broader Murray-Darling Basin scale.

The VEWH works closely with the CEWH in areas where Commonwealth water holdings may be used in Victoria. The VEWH and CEWH have an agreement to collaborate and coordinate their activities (DELWP, 2020). The VEWH also collaborates closely with CMAs and water corporations (e.g. Goulburn-Murray Water) in the planning and delivery of environmental water at local and regional scales as part of its annual watering planning process.

The VEWH's annual seasonal watering plan outlines the annual watering priorities of the entire State. The process for development of the seasonal watering plan is shown in Figure 13.

This process works year-round as follows:

- **December-March:** CMA planning and consultation to begin preparation of Seasonal Watering Proposals for the coming water year. Waterway managers prepare seasonal watering proposals before the preceding season. These are informed by their regional waterway strategies, environmental flow studies, and environmental water management plans. The proposals are developed in consultation with the community, Traditional Owners and other partners.
- **April-May**: The CEWH and VEWH prepare a seasonal watering plan based on seasonal watering proposals. This involves consultation with MDBA and the jurisdictions (e.g. through SCBEWC – see below) prior to the preceding season.
- **June**: Release of Seasonal Watering Plan for the upcoming water year.
- **July-June** (year-round): Program partners coordinate delivery of environmental water. Throughout the season, the VEWH issues seasonal watering statements to waterway managers to authorise water use and communicate environmental watering decisions.

Seasonal watering statements issued to the Mallee, North Central, Goulburn Broken and North East CMAs are available online at http://www.vewh.vic.gov.au/news-and-publications/seasonalwateringstatements.

Ongoing and regular communication between environmental water holders, storage managers and environmental water managers provides opportunities to discuss priorities, negotiate watering commitments, review watering actions, report on outcomes and to integrate environmental watering into system operations to optimise outcomes, for example in planning to reuse return flows for watering at multiple sites. This is often achieved through Operational Advisory Groups that bring together site managers, river operators and environmental water holders to coordinate water use.

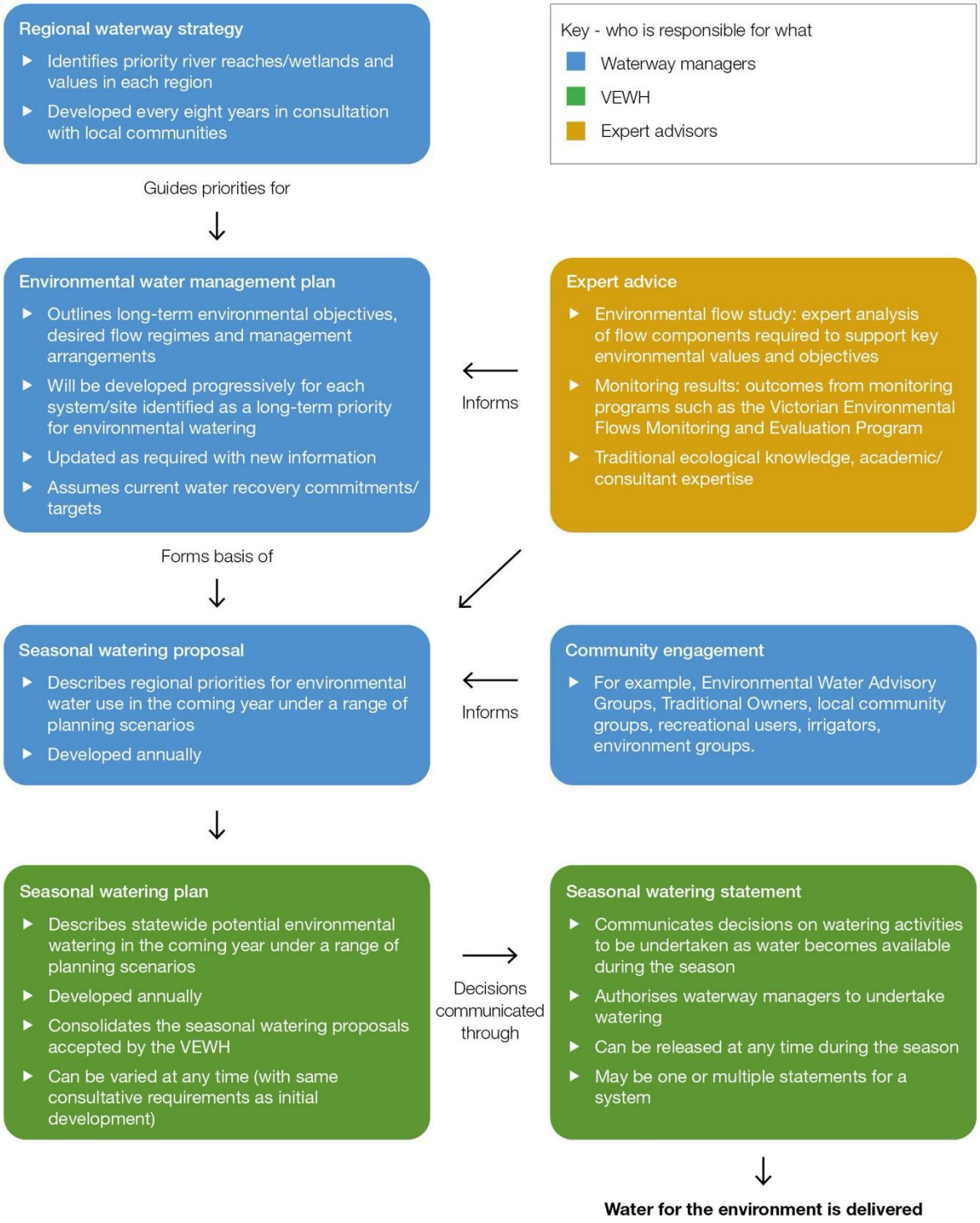


Figure 13: Victoria's annual environmental water planning process (VEWH, 2020)

Inter-jurisdictional cooperation occurs through the Southern Connected Basin Environmental Watering Committee (SCBEWC). The SCBEWC was established in 2014 to coordinate and integrate the delivery of environmental water in the southern connected Basin and oversee the planning and delivery of TLM environmental water. SCBEWC has a particular focus on the River Murray System, including the allocation and management of TLM portfolio, consistent with Basin Plan Environmental Water Plan and its objectives, in order to meet the overall Basin Plan targets (outlined in Section 1.1). Members include the MDBA (including River Murray Operations); Commonwealth Department of Agriculture, Water and the Environment; CEWH; NSW Office of Environment and Heritage; NSW Office of Water; SA Department for Environment and Water; VEWH; and Victorian DELWP. SCBEWC meets at least four times each year to coordinate environmental water planning, approximately:

- February-March: start of environmental water holders planning for the following water year

- April-May: towards the end of water year once Basin and Catchment annual environmental water proposals and priorities have been drafted – to evaluate watering actions undertaken to date and develop an operational strategy for the following water year that seeks to coordinate environmental water delivery for system outcomes.
- June: at the end of the water year to consider water actions for the following water year that contribute to these priorities and system wide benefits
- August: to re-evaluate proposed watering actions based on actual flow conditions; and consider actions for the remainder of the water year.

Additional meetings are held to coordinate watering activities in the southern connected system, inform decisions during watering events and/or make decisions on the use of TLM portfolio.

The MDBA's 2017 evaluation of the Basin Plan found that by 2016-17, over a third (37%) of all environmental watering events in the basin were coordinated events involving multiple environmental water holders. Increased collaboration is seeing environmental water managers combine their water to deliver larger and more effective events than would otherwise be possible.

The effectiveness of these cooperative coordination processes is demonstrated by the southern winter-spring flow of 2019 when environmental water releases from Lake Hume and Lake Eildon were coordinated to deliver large spring flows in the Murray and Goulburn rivers and through six Living Murray icon sites including the Coorong and Lower Lakes in South Australia. The initial flow commenced in August 2019 and was timed to coincide with natural seasonal increases in river flow. Carefully watching weather events, waterway managers halted the flow when high rainfall in the Ovens and Kiewa catchments provided large natural flows to the Murray River. A second release of environmental water commenced in September 2019 and, through careful planning, storage managers and waterway managers were able to time the release to meet with a flow delivery in the Goulburn River.

5.4 Traditional Owners

The Basin Plan requires that environmental water planning maximises benefits and effectiveness by including Traditional Owner values, uses and aspirations for water in planning and management. Sections 10.53 and 10.54 require Basin States to identify objectives and outcomes of water based on Aboriginal values and uses of water and have regard to the views of Aboriginal organisations.

To deliver on this requirement, DELWP engaged with local Traditional Owner groups during 2018 and 2019 to document their water-related aspirations during the development of Victoria's North and Murray Water Resource Plan (DELWP, 2020). Groups consulted with an interest in this water resource plan area included Bangerang, Barapa Barapa, Dhudhuroa, Waywurru, Yaitmathang, Dja Dja Wurrung, First Peoples of Millewa Mallee (Nations of the Nyeri Nyeri, Ngintait and Latji Latji), Tati Tati Wadi Wadi, Taungurung, Wadi Wadi, Wamba Wemba, Weki Weki and Yorta Yorta.

Engagement was staged and tailored to consider and respect the preparedness, prioritisation and resourcing of each individual Traditional Owner group. Different mechanisms were used, depending on individual preferences, including workshops, meetings, Nation meetings, community gatherings and information sharing on Country. The engagement process aimed to identify objectives and desired outcomes for water resources, support celebrating and sharing culture and traditional practices within Traditional Owner groups, discuss economic development opportunities and build relationships and Traditional Owner organisational and community capacity. The engagement process and feedback from Traditional Owners is documented in Chapter 8 and Appendix D of the Victoria's North and Murray Water Resource Plan (DELWP, 2020).

The Victorian Government has also taken steps over the past few years to increase participation of Traditional Owners and Aboriginal Victorians in water management across the state, through legislative changes and the introduction of new programs. In 2019, the *Water Act 1989* (Vic) and *Catchment and Land Protection Act 1994* (Vic) were amended (*Water and Catchments Amendment Bill* 2019) to establish a greater recognition and involvement of Aboriginal Victorians in the planning and management of waterways and catchments. The amendment requires relevant statutory agencies to:

- include, where possible, Aboriginal Victorians in consultative committees and on the Victorian Catchment Management Council;
- consult with Traditional Owner groups for the preparation of management plans and strategies for waterways and catchments; and

- incorporate Aboriginal values and traditional ecological knowledge in the management of waterways and catchments.

Funding is also provided directly to Traditional Owners and Aboriginal Victorians to support self-determination in water management through DELWP's Water, Country and Community Program (formerly called the Aboriginal Water Program). The program funds self-determined water related projects and Aboriginal Water Officers (or their equivalents) in Traditional Owner organisations and CMAs across Victoria. This approach aims to provide Traditional Owners and Aboriginal Victorians with the necessary resources to be involved in the environmental water program and broader water management, planning processes and decisions.

Importantly, Traditional Owners are increasingly involved in all aspects of Victoria's environmental watering program, including the annual and long-term planning process. In the past two years DELWP has been strengthening this involvement by engaging with Traditional Owners across northern Victoria about the LTWP and EWMP processes. Groups engaged to date with an interest in this water resource plan area have included the Barapa Barapa, First Peoples of the Millewa-Mallee (Nations of the Nyeri Nyeri, Ngintait and Latji Latji), Tati Tati Wadi Wadi, Wadi Wadi, Wamba Wemba, Weki Weki and Yorta Yorta. Due to COVID-19 restrictions during 2020, engagement was largely online and via phone and email. Grants were offered to assist Traditional Owner groups to make submissions on the EWMP guidelines and were taken up by several groups.

This work is ongoing, and feedback will be integrated into the EWMP guidelines to support increased participation of Traditional Owners and provide the opportunity for cultural exchange during the EWMP planning process. For example, traditional knowledge, place names and cultural objectives may be included in EWMPs, where this is desired by Traditional Owners. The Aboriginal Waterway Assessment[8] tool can be used to facilitate this process. Further involvement of Traditional Owners at the regional level via the LTWPs will be facilitated, where desired, by Traditional Owners.

The VEWH has undertaken a number of steps to increase Aboriginal participation in the environmental watering program, this includes updating the SWP Guidelines in 2020 to better reflect CMAs responsibilities to engage with Traditional Owners in the development of individual SWPs under the *Water and Catchments Amendment Bill* 2019. The VEWH has also released a position statement on Traditional Owner involvement and how they are supporting self-determination.

TLM includes an Indigenous Partnership Program that funds the employment of four Indigenous Facilitators in Victoria, one for each of Victoria's four icon sites (Barmah Forest, Gunbower Forest, Hattah Lakes, Lindsay-Mulcra-Wallpolla Islands), as well as funding priority projects and on-Country visits. The priority projects can include collecting information to support and inform environmental watering (e.g. data on the status of totem species), and monitoring outcomes of environmental watering events.

8.The Aboriginal Waterways Assessment tool is a methodology in use to identify key cultural and environmental values, provide a basis for informed management objectives, guide capture and recording of knowledge about the cultural values, uses and health of waterways and assist Aboriginal people to be more meaningfully involved in water planning processes on their Country.

6. Constraints

Environmental water delivery is subject to physical or operational (and management) barriers that limit the flows that can be delivered down rivers and the outcomes that can be achieved. This section identifies the key constraints in the Victorian Murray water resource plan area and strategies to manage or overcome these.

'Bank full' and overbank flows that connect rivers to their floodplains are critical to support a healthy river and floodplain ecosystem. These higher flows are needed to restore the health of floodplain vegetation and reconnect wetlands, rejuvenating habitat for the diverse range of animals that depend on these areas, and also provide an important productivity boost for rivers. The ability to deliver higher flows will contribute to achieving many of the ecological objectives and targets for the priority ecological assets of the Victorian Murray water resource plan area and are linked to the Basin Plan's Environmental Watering Plan objectives and the system-wide targets.

Modelling indicates that the additional environmental water recovered through the Basin Plan will allow low-lying floodplains to be watered, provided that physical and operational constraints are addressed to avoid impacts to private land, businesses, and public infrastructure. Watering the mid to upper floodplain would require more water and have greater third-party impacts. In many cases, the only way to water these areas will be by using environmental works to target high value sites (see Section 7.4).

Physical and operational (or management) constraints to environmental water delivery are defined below:

- **Physical constraints** are a natural formation or a physical structure, for example a pipe or channel, that limit the volume of water that can pass a given location (refer to Basin Plan, p. 8). Physical constraints also include things like roads, bridges and private land that would be inundated at higher flows, causing potential damage to crops or fences and affecting access.
- **Operational (or management) constraints** arise from the operating practices employed to manage water resources across the Basin, such as channel sharing, water accounting and the ability to order water from specific locations. Unlike physical constraints, these constraints cannot simply be resolved through infrastructure works, but require policy and procedural changes. An example of overcoming an operational constraint is where water accounting frameworks in Victoria have been updated to allow crediting of return flows from environmental water use, permitting achievement of multi-site watering from a single water release.

6.1 Constraints Management Strategy 2013 to 2024

The MDBA's Constraints Management Strategy (CMS) 2013 to 2024 (MDBA, 2013a) identified and prioritised physical and operational constraints across the Murray-Darling Basin, focusing on seven key areas including:

- Hume to Yarrawonga (Murray River)
- Yarrawonga to Wakool Junction (Murray River)
- Goulburn River (Victoria)
- Murrumbidgee River (NSW)
- Lower Darling River (NSW)
- Gwydir River (NSW)
- Lower Murray (SA).

The CMS (MDBA, 2013a) looked at ways to address these constraints, including raising the height of bridges to maintain access at higher flows, improving flood warning systems and purchasing flood easements to enable private land to be watered. The process carried out to inform the development of the CMS (MDBA, 2013a) is described further in Figure 14.

The outcomes that can be achieved in each reach will depend on the extent to which constraints can be addressed, and the links and interdependencies across these focus reaches. Projects to relax or overcome constraints in all key focus areas, except the Gwydir, are being delivered by the relevant Basin state governments. These projects, called 'constraints measures', are exploring the potential impacts of delivering

higher flows and how these can be addressed to support system-wide environmental outcomes through the reconnection of rivers to their floodplains. Working closely with affected communities will be critical to success. Further information about Victorian constraints measures is provided below (see Section 6.3.2).

In 2014, the MDBA, working with Basin states and communities, completed the first phase of the CMS — the pre-feasibility phase. This identified and prioritised important operational and management constraints, including their relationship to physical constraints, and set out to define and agree between the MDBA and each of the Basin governments the respective roles and responsibilities to progress priority operational and management constraints.

The CMS identified nine types of operational and management constraints for further consideration, and identified four that were considered to make the most significant difference to achieving environmental outcomes. These nine constraints are listed below, with the four priority constraints shown in bold:

1. **delivery of environmental water on top of other instream flows**
2. **channel capacity sharing**
3. timing of water availability
4. planned environmental water
5. **environmental water can be used throughout the length of a river**
6. **protection of environmental flows from extraction and re-regulation**
7. substitution of held environmental water with other water
8. coordinated planning and delivery of water delivery
9. current river management practices.

Figure 14: **Pre-feasibility assessment of operational and management constraints in the CMS (MDBA, 2013a)**

6.2 Constraints affecting the Victorian Murray water resource plan area

The operational and management constraints affecting the Victorian Murray water resource plan area can be broadly grouped into the following types, associated with:

- Channel/watercourse capacity (i.e. the constraints due to insufficient flow capacity to meet both environmental and consumptive demands at key watering times).
- Consumptive water entitlement framework (i.e. the constraints imposed by the procedures and policies of the water supply system (which was designed to supply water for consumptive use)).
- Co-operative management (i.e. the constraints due to existing governance arrangements that have often been developed independently of environmental watering arrangements).
- Excess consumptive demand (i.e. the constraints preventing environmental water managers from reducing stream flow to environmental desirable levels at the expense of fulfilling consumptive demands).
- Geomorphic impacts (i.e. the constraints controlling rates of rise and fall which are designed to prevent degradation of the physical form of waterways).
- Travel time and attenuation (i.e. the long travel time and attenuation experienced by environmental flows, which constrains the ability to readily 'piggy-back' on other flows in the target reach).
- Flooding (i.e. the constraints arising from inundation of private land or public infrastructure).
- Outlet release capacity (i.e. constraints due to insufficient flow capacity through reservoir release valves).
- Storage capacity (i.e. constraints due to insufficient storage in weir pool to store, re-regulate and later release flows).

- Availability of irrigation assets during the non-irrigation period (when works are being undertaken on infrastructure, delivery of water may not be possible or limited between 15 May and 15 August each year).

Of the types of constraints listed above, those associated with outlet release capacity and the consumptive water entitlement framework are most numerous (DELWP, 2020).

6.3 Strategies to manage or overcome constraints

6.3.1 Policy measures

According to the CMS, the most notable operational constraints affecting the southern connected Basin were the policy measures outlined in the Basin Plan (c7.15 (2)) to:

- Credit environmental return flows for downstream environmental use.
- Allow the call of HEW from storage during unregulated flow events.

The MDBA considered that implementation of these two policy measures would resolve a number of operational and management constraints and would be required to achieve the desired objectives of the Basin Plan and this LTWP. Provisions in the VEWH's bulk and environmental entitlements and obligations on Goulburn-Murray Water in its bulk entitlements now enable the above two policy measures and addresses these constraints. These arrangements allow use of environmental water to get the best environmental outcomes without impacting the security of supply to other entitlement holders. The MDBA has accepted that implementation of these policy measures is enduring, operational and transparent now that Victoria's water resource plans are accredited.

6.3.2 Victoria's Constraints Measures Program (CMP)

Victoria's Constraints Measures Program (CMP) includes two separate constraints measures:

- the Hume to Yarrawonga project, a joint proposal with NSW; and
- the new Goulburn project.

Victoria will also lead the engagement with potentially affected Victorian landholders as part of NSW's Yarrawonga to Wakool project, which primarily impacts upon NSW landholders as higher flows enter the Edward-Wakool River system.

The new Goulburn project targets in-channel flows and is part of the Northern Victoria WRP area. It aims to improve the ability to meet local environmental watering objectives and also to supply flows from the Goulburn River and its tributaries to the main stem of the River Murray.

The flows being targeted as part of the CMP are below minor flood level but will still affect people's lives and business and must be done sensibly together with landowners and local communities. Victoria recognises that any relaxation of constraints will pose third-party flooding related risks which can impact public and private land, infrastructure, stock and people.

The Victorian Constraints Measures Program, in line with Basin Ministers direction, will adopt a community-centric engagement approach to work at both a regional and system-scale to assess what is practical to deliver; the benefits and risks including under climate change, and whether there is likely community and Traditional Owner support for implementation. Proceeding beyond this stage will depend on the outcomes of this feasibility study to be completed in late 2022.

6.3.3 Enhanced Environmental Water Delivery project

The Enhanced Environmental Water Delivery (EEWD) project is being jointly delivered by Victoria, NSW and SA, working closely with the MDBA. It complements all constraints measures and aims to make the most efficient and effective use of available environmental water. The project will develop a coordinated delivery strategy, improvements to forecasting and planning tools as well as streamlining administrative process to improve the ability to respond to flow triggers. These products will support a longer-term approach to environmental water planning and delivery at the reach and system scale, to improve outcomes across the southern connected Basin.

The EEWD project will investigate the feasibility of coordinating managed flows throughout the southern connected Basin. While the changes described above will be important to optimise environmental outcomes without constraints relaxation, benefits will be greater if higher flows can be delivered. However, even with constraints relaxed to targeted levels, many high value sites are located even higher on the floodplain and cannot be watered effectively without using environmental works (see Section 7.4).

7. Complementary actions

Environmental water is only one component of the activities and works required to achieve the environmental objectives and targets, and overall waterway health. Complementary actions are vital to support the priority environmental assets and functions, and to meet the ecological targets of this plan.

The essential complementary actions to accompany the provision of a suitable watering regime in this water resource plan area can be categorised under the following themes:

- Riparian land management
- Supporting native fish
- Pest plants and animal management
- Works and measures
- Community connections
- Traditional Owners delivering complementary actions
- Climate change adaptation.

7.1 Riparian land management

The success of environmental watering programs is reliant on complementary riparian land management, such as controlling stock grazing and other potentially damaging activities. Where vegetation has been destroyed or removed, revegetation with appropriate species may also be required.

The VWMS (DEPI, 2013b) establishes a framework to maintain and improve priority public and private riparian land. The main approach for achieving this is for government to provide incentives to landholders, principally through voluntary agreements with catchment management authorities, to assist landholders to undertake riparian management activities including fencing, revegetation and vegetation enhancement, weed management and the provision of off-stream stock watering infrastructure.

Regional priorities for riparian activities are detailed in CMA Regional Catchment Strategies (RCS) and Regional Waterway Strategies (RWS) which were developed in close consultation with catchment communities.

The VWMS also contains a range of other actions relating to the management of riparian land. This includes a number of actions regarding the administration and management of Crown frontages, fire behaviour and riparian land, development of guidelines for controlled grazing and floodplain fencing, and managing stock in waterways upstream of potable water offtakes. A major program for promoting riparian management across Victoria has been the Regional Riparian Action Plan (DELWP, 2015b). This has help to deliver improved riparian management across each of the CMA areas of this LTWP.

7.2 Supporting native fish

Success of fish outcomes is reliant on a variety of complementary measures.

The VWMS emphasises that high quality instream habitat is essential to support healthy populations of native fish, as well as for aquatic plants and other animals. While many aspects of instream habitat (e.g. channel form, instream vegetation) can be addressed with environmental water, large wood in rivers provides shelter, food sources and breeding sites for a variety of instream animals. Under the VWMS, large wood in streams will not be removed unless it is demonstrated to pose a serious risk to public safety or public infrastructure. In some cases, large wood may be reinstated into rivers to improve habitat conditions.

Instream barriers, such as weir and dams, are another key threat to native fish. They prevent native fish from moving upstream for spawning and recruitment, and larvae from drifting downstream to new habitats. The loss of fish to irrigation channels is also a major concern, as diversions for irrigation flows lure fish into channels taking them out of rivers and creeks and getting them effectively lost from the breeding population. Several threatened native fish species are affected including silver perch, flat-headed galaxias, trout cod, Macquarie perch and Murray cod. The VWMS outlines the management approach and issues associated with the river channel. This includes policies and actions related to the provision of fish passage in the river channel. The intent is that passage for native fish will be maintained or improved by minimising further loss of connectivity and improving fish passage at priority sites.

In line with the policies and actions included in the VWMS to provide suitable fish passage, the Victorian government has invested $17 million on five major projects to enable fish movement and improve connectivity at priority sites. In the Victorian Murray water resource plan area, this investment will remove the highest priority remaining barriers to fish passage in Gunbower Creek and the Lower Loddon River to improve flows, habitat and connectivity to support recovery of regional native fish populations.

Native fish populations can also be supported by translocation of endangered species to new viable locations. Stocking of appropriate native species may also support this. The Victorian Fisheries Authority manages the stocking of waterways with recreational fishing species such as Murray cod, golden perch and silver perch, which can assist in meeting the objectives and targets outlined in this plan. Between December 2020 and March 2021 for example, golden perch have been released in the Ovens, Broken, Goulburn, Campaspe and Loddon river systems, Murray cod have been released in the Broken Creek system, and trout cod and Macquarie perch have been released in the Goulburn River system (see vfa.vic.gov.au) (VFA, 2021) .

7.3 Pest plant and animal management

The management of invasive species (plants or fauna) is a common environmental watering objective recognised by CMAs in EWMPs. Appropriate hydrological regimes can be used to dry out, flush or flood a species from a wetland or river, with varying degrees of success. However, some exotic species (e.g. carp) also can benefit from environmental flows and require other specific management actions.

The key actions in the VWMS that are closely linked to the LTWP are to develop an information system for planning, delivering and recording invasive species management activities, to provide results and outcomes that supply consistent data for performance and investment reporting, and to identify high-risk pathways for the spread of invasive species in waterways. Improvements in environmental conditions through various complementary actions, in addition to provision of appropriate flow regimes, will help native species to prosper over invasive species.

The management of existing and potential invasive species in Victoria is addressed under the ***Invasive Plants and Animals Policy Framework*** under Agriculture Victoria.

The CMA waterway strategies provide further information on management of invasive species. For example, the Goulburn Broken Waterway Strategy (GBCMA 2014) identifies priority invasive species including introduced fish (e.g. carp (*Cyprinus carpio*), mosquito fish *(Gambusia affinis*)) and plant species (e.g. blackberry (*Rubus fruticosus*), and arrowhead (*Sagittaria* sp.)). Management actions are also outlined in waterway strategies, consistent with the VWMS (MCMA, 2014), (NCCMA, 2014), (NECMA, 2014).

7.4 Environmental works and measures

Natural flooding patterns can often be restored to fringing wetlands along the river and low-lying floodplain, but it is not possible to reinstate flooding to higher parts of the floodplain. This would require large volumes of water and could cause flooding that damages private land and public infrastructure, such as bridges and roads (refer to Section 6).

In many cases, environmental works like flow regulators, pumps and channels are the only way to get water to many of the sites that need it. This approach works when there is not enough water to flood wetlands naturally. Environmental works can enable ecological outcomes to be achieved with much smaller volumes of water than would be required to create a natural flood.

Works include infrastructure like pumps to supply water to disconnected wetlands, and regulators, channels and bunds to direct, retain or exclude flows. Other measures may also be needed, such as flood easements to allow for overbank flows or altering river operations to improve environmental outcomes. This approach ties closely in with constraints measures to improve overall environmental outcomes (see Section 6.3.2).

Large-scale environmental works have been completed through TLM and are already delivering results at three of Victoria's TLM icon sites in the Victorian Murray water resource plan area (see Section 2.3.2). New works proposals are being developed for nine sites in the Victorian Murray water resource plan area, through the Victorian Murray Floodplain Restoration Project (https://www.vmfrp.com.au/). This will enable another 14,000 ha of high-value wetlands and floodplain to be watered, effectively drought proofing these areas under climate change.

7.5 Community connections – recreational opportunities and better water literacy

Communities value their waterways. Waterways provide places to relax, holiday, exercise, fish, bird watch, hike and swim. Waterway managers are experiencing increased interest in nature-tourism in watered areas. Impacts from recreational activities are occurring and can be demonstrated. Nature based tourism, getting people out in nature, is part of the Victorian Government's Biodiversity Strategy titled 'Protecting Victoria's Environment – Biodiversity 2037' (DELWP, 2017).

To support enhanced community awareness regarding environmental watering, the Victorian government invests in a number of actions identified in:

- *Our Catchments Our Communities* strategy 2016-2019 (Goal 1 Effective community engagement in catchment management) (DELWP, 2019);
- The *Victorian Waterway Management Strategy* 2013 (2.4.6 Strengthening community partnerships in waterway management); and
- Chapter 7 (Recognising recreational values) of ***Water for Victoria*** *2016* (DELWP, 2016, pp. 111 - 122)

Complementary actions to support environmental watering include but are not limited to; community rehabilitation on riparian land and increased education and engagement to support local nature, tourism and recreational fishing opportunities.

7.6 Traditional Owners delivering complementary actions

Traditional Owners have cared for and sustainably managed Victoria's cultural landscapes for thousands of years. Traditional Owners have both a cultural obligation and a legal right to be custodians of their traditional land and waters and protect the unique natural and cultural values that they contain.

The Victorian Government is committed to enabling self-determination for Traditional Owners and Aboriginal Victorians through overarching policies and frameworks such as the Victorian Aboriginal Affairs Framework 2018 -2023 (Aboriginal Victoria, 2019) and Chapter 6 of Water for Victoria (DELWP, 2016, pp. 98 - 109).

CMAs are required under the *Water and Catchments Amendment Act 2019 to* recognise Aboriginal cultural values and knowledge in water and catchment planning and management and to include Traditional Owners in these processes. The 2016 Aboriginal Participation Guidelines for Victorian CMAs detail principles and commitments to engage and work with Traditional Owners and Aboriginal communities to manage and improve the health of lands and waters as well as supporting aspirations of rights, reconciliation, participation, employment and economic development through natural resource management.

An example of a complementary action is the 'A Healthy Coliban Catchment' project. North Central CMA in partnership with Dja Dja Wurrung Clans Aboriginal Corporation, Coliban Water, Landcare and North Central Waterwatch are working to protect the highly valued waterways and future water supplies of the Coliban Catchment by boosting habitat connectivity and building cultural and lifestyles values. This includes the Coliban River (PEA in the Northern Victoria water resource plan area). The project included: 300 kilometres of fencing to control stock adjacent to key waterways, revegetating the riverbanks, creating biodiversity corridors, off-stream watering alternatives for livestock and controlling invasive weeds including willows, blackberry and gorse (NCCMA, 2019).

7.7 Climate change adaptation

The potential impacts of climate change and future land use change present major challenges to natural resource managers because they affect the environmental condition and values of ecosystems but are generally difficult to control. We know that climate change has the potential to affect environmental condition and the values that waterways support. There are many predictions about the effects of climate change, ranging from relatively low climate change effects to a continuation of the low streamflows seen during the extended drought between 1997 and 2009.

Protecting climate change refugia that can provide the opportunity for biota to weather the impacts of extended dry periods in localised, healthy systems from which they may expand from following drought is a necessary and pragmatic backstop. Without refugia, a severe drought would put at risk achievement of any ecological outcomes from watering.

Victoria's Water Sector Climate Change Adaptation Plan (WSAAP) is a pilot and was prepared in 2018, the purpose of the plan is to test the process of developing an Adaptation Action Plan. The Victorian Government is updating the pilot WSAAP and also leading the development of other relevant plans including the Natural Environment Sector Adaptation Action Plan under the *Victorian Climate Change Act 2018.*

This program ties closely in with constraints indicated in Section 6, along with the CMS, and supply measure projects to gain environmental outcomes using less water.

Further information about complementary actions in the Victorian Murray water resource plan area is detailed in the relevant CMA regional waterway strategies (e.g. NECMA, 2014, GBCMA, 2014, NCCMA, 2014, MCMA, 2014).

8. Demonstrating outcomes

This section outlines how the targets set in Section 3 are measured. Wherever possible, monitoring draws upon existing programs to report on the objectives and targets for this water resource plan area.

8.1 Monitoring programs in Victoria

Victoria has two main environmental water monitoring programs, the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP), and the Wetland Monitoring and Assessment Program for environmental water (WetMAP). Both programs include monitoring that relates to the objectives and targets outlined in Victoria's long-term watering plans. This has direct links to objectives outlined in the EWMPs, as well as the objectives listed in both the BWS and in the Murray-Darling Basin Plan in Chapters 5 and 8, Schedules 7 and 8. The four-way alignment of objectives is laid out in section 3.3, Table 8.

Other programs with monitoring relevant to Basin Plan outcomes include TLM, Victoria's Native Fish Report Card, and the CEWO's Monitoring, Evaluation and Research Program (Flow-MER that replaced the Long-Term Intervention Monitoring program in 2020; note: the only site in Victoria is the Goulburn River). Various parameters are measured under TLM at icon sites of Hattah Lakes, Lindsay, Mulcra and Wallpolla Islands, Gunbower Forest, and Barmah-Millewa Forest. TLM contains an annual condition monitoring component, as well as intervention projects which address certain questions around responses to environmental water, addressing risk or undertaking statutory functions.

A range of these monitoring results were used by Victoria to report on Schedule 12 Matter 8, the 'achievement of environmental outcomes at an asset scale' (DELWP, 2020).

VEFMAP was established by the Victorian Government in 2005 to monitor and assess ecosystem responses to environmental watering in priority rivers across Victoria. Results from the program help inform decisions about environmental flow management by CMAs, Melbourne Water and the VEWH. VEFMAP has just completed its sixth stage of delivery (2016-2020), which included a strong focus on 'intervention' or 'flow-event' style questions related to vegetation and native fish. The approach used for VEFMAP Stage 6 provided much-needed information to support adaptive flow-management decisions in Victorian rivers. Stage 7 will adopt a similar approach, building on current knowledge and filling key gaps in understanding, leading to improved management outcomes that maximise our use of environmental water.

WetMAP was established in 2014 to investigate responses of wetland biota to environmental water management in Victorian wetlands. Monitoring for WetMAP Stage 3 (2016-2020) started in 2017 and focussed primarily on responses of vegetation, waterbirds, frogs and fish to environmental water deliveries in northern Victorian wetlands. WetMAP is now entering Stage 4 (2020-24), with planning focussed on identifying priority knowledge gaps for wetland water management.

The broad objectives for VEFMAP and WetMAP are to:

- Enable DELWP and its water delivery partners to clearly demonstrate the ecological value of environmental water management to the community and water industry stakeholders.
- Fill knowledge gaps to improve planning, delivery and evaluation of environmental water management in rivers and wetlands across Victoria.
- Identify ecosystem outcomes from environmental water to help meet Victoria's obligations under the Murray-Darling Basin Plan (Schedule 12, Matter 8).

Compliance monitoring is also undertaken. Where targets involve monitoring hydrological outcomes (flow or water quality), data collected through Victoria's Regional Water Monitoring Partnerships' program and the MDBA's water quality and flow monitoring programs can be used. Under these programs, surface water data is collected from approximately 780 monitoring sites across the State.

Community-based organisations conduct monitoring that are also used to evaluate environmental watering outcomes. These include Birdlife Australia monitoring, Waterwatch and Frogwatch.

There are also broader programs run by the MDBA aimed at the Basin scale, such as the Integrated Monitoring and Evaluation Program funded through Joint Programs and the Murray Darling Basin Fish Survey (see MDBA's annual reports for more detail; https://www.mdba.gov.au/publications/mdba-reports/mdba-annual-report).

8.2 Improving outcomes

An adaptive management cycle has been adopted in Victoria to provide appropriate watering regimes for the environment and improve outcomes. This cycle (a simple version at an asset scale is illustrated in Figure 15) includes:

- Ensuring environmental water is protected – this includes having appropriate policy and legislation in place (note this is higher level background to everything shown in Figure 15)
- Ensuring environmental water needs are understood and met (note this is not shown in Figure 15, but would consist of a parallel branch of learnings coming out from the monitoring and evaluation, and feeding into the planning)
- Ensuring the water regime is managed to meet environmental objectives (planning and delivering water for the environment)
- Overcoming physical or operational constraints to enable best use of the water and maximise outcomes for the environment
- Monitoring environmental flows and ecological responses to assess their effectiveness for meeting environmental objectives outlined in EWMPs
- Reviewing the process to adapt and improve as required.

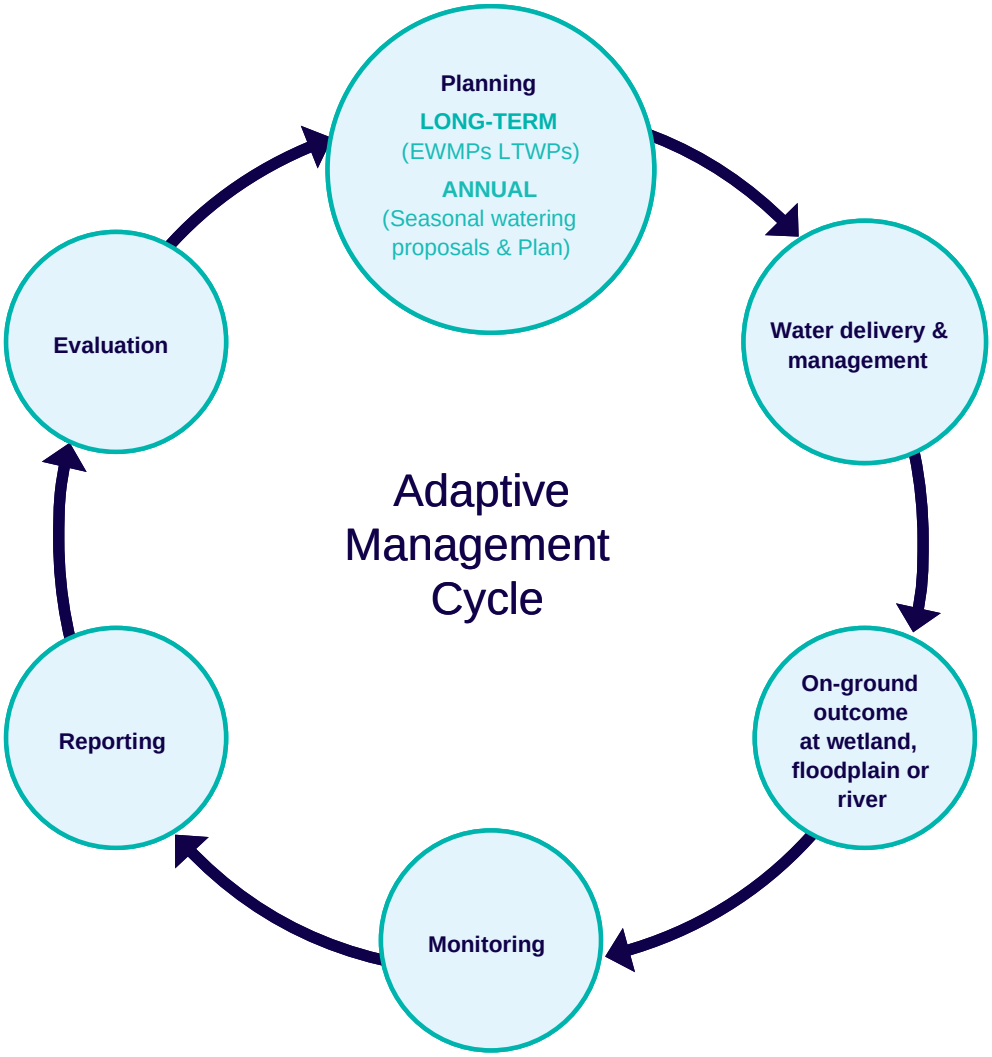


Figure 15: Adaptive management cycle

Specific policy and processes currently operate in Victoria that facilitate this cycle, for example the VWMS and Regional Waterway Strategies that guide regional prioritisation of waterways. Research projects also support this cycle by improving understanding of environmental flow outcomes, for example with development, review and updating of FLOWS studies for rivers (DEPI, 2013). FLOWS studies are a key information source in Victorian environmental water management, developed by expert scientists with input from CMAs, VEWH, DELWP and other key stakeholder and community representatives. Traditional Owners are also becoming increasingly involved in the development and update of FLOWS studies, an example of this was the recent update of the Lower Goulburn (Kaiela) Environmental Flows Study, where GBCMA engaged Yorta Yorta and Taungurung (Horne, et al., 2020). This collaborative work identifies the priority environmental values and objectives for each river system, and then uses the best available scientific knowledge to determine the specific water regime required to support these. This water regime information includes defining essential flow components for the suite of environmental objectives such as defining minimum and/or maximum flows to maintain water quality or geomorphology, and specifying the volumes, durations, seasonality and frequencies of other flow components such as fresh flows to trigger reproduction of valued species or other environmental events or cues. These assessments are used to help decide how much water needs to be recovered for the environment. Environmental flow studies using the FLOWS method have been completed for more than 50 rivers across Victoria. These technical inputs feed directly into development of the EWMPs and the planning step of the adaptive management cycle. For wetlands, a less proscribed process is followed as part of EWMP development itself, as the needed technical understanding of wetland water regime needs is not as developed as for rivers.

The water regimes in the EWMPs are used in seasonal watering proposals and so feed into seasonal watering plans, and then into on-ground management and delivery. Monitoring and evaluation assesses

whether the expected environmental outcomes are being achieved and the results and learnings (in particular from VEFMAP, WetMAP and TLM) are fed into decisions and management of the respective waterways. Results from monitoring at each site are communicated immediately after surveys to the CMAs' environmental water reserve managers. Managers then adjust their planning for the delivery of environmental water as necessary (e.g. see (Tonkin, 2020), in particular Figure 1.1.1, for more details). These learnings are then included when there are longer term adaptive updates to work such as FLOWS studies and EWMPs.

8.3 Monitoring of the long-term watering plan targets and objectives

Monitoring is important to evaluate whether environmental water is supporting the objectives and targets set in section 3 of this plan. The development of the targets has drawn upon several research projects, designed to elucidate cause and effect relationships across Victoria. These projects are conducted by the ARI, Melbourne University, the Centre for Freshwater Ecosystems (formerly the Murray-Darling Freshwater Research Centre) and CSIRO Australia. Outputs from these and other projects also provide data to assess progress to targets. The specific targets for environmental outcomes that were set to support this LTWP were originally set in 2015, and updated in 2017 (see section 3.4 and Appendix D). Table 20 shows the monitoring programs and assets monitored to assess progress towards meeting these targets.

Two important caveats to Table 20 are:

- Not all current monitoring is considered adequate to assess progress towards targets, generally due to funding limitations.
- Targets will continue to be refined as more information is gathered.

For more information on both these caveats, see (Cooling, 2017). Iterative and adaptive management as described in Section 8.2 is ongoing to improve monitoring and target alignment.

Table 20: Objectives, targets and monitoring in the Victorian Murray water resource plan area. TLM = The Living Murray, NFRC = Native Fish Report Card, WetMAP = Wetland Monitoring and Assessment Program for environmental water

Theme	Objective	Revised Target**	Recommended Assets	Potential Sources of Monitoring
Fish	Improve abundance of large-bodied native fish	A) The mean number of sites where large-bodied native fish species are detected is the same or higher in the last five years than the first five years of a ten year monitoring program B) For age classes up to five years, the number of cohorts is the same or higher in the last year than the first year of a ten year monitoring program	Loddon River (lower); Bumbang Island; Broken River and Nine Mile Creek (Reaches 1-4); Lock 6 to 10 (wetlands/floodplain), Lindsay, Mulcra and Wallpolla Islands	TLM, NFRC
	Maintain abundance of small-bodied native fish in wetlands	In small wetlands, maintain the presence of small-bodied native fish every year in the ten year monitoring period *and;* in large or network wetlands, the average number of sites where small-bodied native fish species are detected in the first five years is not less than in the last five years of a ten year monitoring program.	Walshes Bend; Gunbower Forest; Lindsay, Mulcra and Wallpolla Islands; Hattah Lakes; Margooya Lagoon; Bottle Bend; Karadoc; Lakes Hawthorn and Ranfurly; Barmah Forest	TLM, WetMAP
	Maintain distribution of threatened small-bodied native fish in wetlands	In small wetlands, maintain the presence of threatened small-bodied native fish every year in a ten year monitoring period *and* in large or network wetlands, the average number of sites where threatened small-bodied native fish species are detected in the first five years is not less than in the last five years of a ten year monitoring period.	Gunbower Forest; Lake Elizabeth; Bottle Bend; Karadoc; Lakes Hawthorn and Ranfurly; Bambung Island; Spences Bend; Walshes Bend; Margooya Lagoon; Hattah Lakes	TLM, WetMAP
	Maintain species richness of native fish	The ratio of fish species observed to expected (using pre-European Reference Condition - PERCH) is the same in the first three years as the last three years of a ten year monitoring period	Lindsay, Mulcra and Wallpolla Islands; Loddon River (lower); Gunbower Forest; Bambung Island; Lock 15; Lock 6 to 10; Walshes Bend	TLM, WetMAP

Theme	Objective	Revised Target**	Recommended Assets	Potential Sources of Monitoring
Waterbirds	Improve breeding opportunities for colonial-nesting waterbirds	The minimum water regime required for colonial nesting waterbird breeding is met over a ten-year monitoring period.	Gunbower Forest; Hattah Lakes; Barmah Forest; Lock 15 (wetlands/floodplain); Lock 6 to 10 (wetlands/floodplain)	TLM, WetMAP
	Improve habitat for waterbirds	The minimum water requirement for waterbird feeding and/or breeding is met in the ten year period	Hird Swamp; Bottle bend; Bumbang Island; Karadoc; Lakes Hawthorn and Ranfurly; Johnson Swamp; Pig Swamp; Lake Elizabeth; Lake Murphy; Gunbower Forest	TLM, WetMAP
Vegetation	Improve the condition of river red gum dominated EVCs	The condition or riparian EVCs in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets: - health of adult trees - recruitment and survival of juvenile trees - native species richness - native species cover/abundance - recruitment of understorey vegetation	Belsar and Yungera Islands; Bumbang Island; Margooya Lagoon; Nyah Vinifera; Kings Billabong; Carina bend; Johnsons and Chaffey; Murrumbidgee Junction; Wemen-Liparoo; Loddon River (lower); Burra Creek floodplain; Karadoc; Piambie; Pound bend; Spences Bend; Tata; Walshes Bend; Wirra-Lo; Gunbower Forest; Pig Swamp; Kinnairds Swamp; McDonalds Swamp; Barmah Forest; Neds Corner; Hattah Lakes; Lindsay, Mulcra and Wallpolla Islands	TLM, WetMAP
	Improve the condition of black box dominated EVCs	The condition of black box dominated EVCs in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets: – health of adult black box trees – recruitment and survival of juvenile trees – recruitment of understorey vegetation – native species cover/abundance – native species richness	Bottle Bend; Heywood Lake; Johnsons and Chaffey; Wemen-Liparoo; Burra Creek floodplain; Karadoc; Spences Bend; Tata; Wirra-Lo; Gunbower Forest; Johnson Swamp; Hattah lakes; Sandilong Creek; Walshes Bend; Hattah Lakes; Lindsay, Mulcra and Wallpolla Islands	TLM, WetMAP

Theme	Objective	Revised Target**	Recommended Assets	Potential Sources of Monitoring
	Improve the condition of shrub and lignum dominated EVCs	The condition of canegrass or lignum dominated EVCs is better at the end than at the start of a ten-year monitoring program as measured by the following sub-targets: – condition of lignum – cover of canegrass (there is no recognised condition assessment method for canegrass) – native species cover/abundance – native species richness	Carina Bend; Wemen-Liparoo; Burra Creek floodplain; Karadoc; Piambie; Murrumbidgee Junction; Psyche and Woorlong; Spences Bend; Tata; Wirra-Lo; Johnson Swamp; Pig Swamp; Lake Murphy; Lindsay, Mulcra and Wallpolla Islands; Pound Bend; Hird Swamp; Neds Corner; Sandilong Creek; Hattah Lakes	TLM, WetMAP
Connectivity	Improve connectivity between floodplains, anabranches and wetlands.	At least 50% of environmental watering events in these assets over a ten-year period are delivered via channels that provide hydraulic connectivity to the source waterway.	Kinnairds Swamp; Bottle Bend; Bumbang Island; Butlers Creek; Karadoc; McDonalds Swamp; Wirra-Lo; Black Swamp; Belsar and Yungera; Heywood Lake; Carina Bend; Lindsay, Mulcra and Wallpolla Islands; Johnson Swamp; Lake Elizabeth; Lake Murphy; Murrumbidgee Junction; Wemen-Liparoo; Lock 15 (wetlands/floodplain); Lock 6 to 10 (wetlands/floodplain); Loddon River (lower); Spences Bend; Tata; Broken and Nine Mile Creek; Johnson Swamp; Pig Swamp; Hird Swamp	TLM, WetMAP, Matter 9.3 annual Basin Plan reporting
Other values	Maintain species richness of frog communities	The number of frog species observed in eight in a ten-year period must be more than 75% of the highest diversity recorded in any one year.	Carina Bend; Kinnairds Swamp; Lock 15 (wetlands/floodplain); Margooya Lagoon; McDonalds Swamp; Gunbower Forest; Nyah & Vinifera; Psyche and Woorlong; Johnson Swamp, Bottle Bend; Karadoc; Barmah Forest; Pig Swamp; Lake Murphy; Wirra-Lo	TLM, WetMAP

** Note: Revisions were made to the 2014 LTWP targets by Ecological Associates (Cooling, 2017). See Appendix D.

9. Long-term risks

This section describes the long-term risks associated with providing for the environmental watering requirements outlined in Section 3. These risks fall into two broad categories: failure to achieve (or demonstrate achievement of) environmental objectives and adverse impacts stemming from environmental water.

9.1 Processes for identifying risks

Environmental risk is commonly assessed as the product of the *likelihood* of a threat or threatening process occurring and the *consequence* in terms of the impact of a threat (or threats) on 'asset' values, condition or environmental outcomes. Victoria has a number of existing annual and longer-term processes in place for identifying and managing risks associated with environmental watering events, including:

- **Annual:** In the lead up to the development of the seasonal watering proposals each year, the VEWH coordinates annual shared risk identification and assessment workshops with CMAs across Victoria, held in mid-late February. The workshops are attended by relevant program partners such as environmental water holders, water corporations, Traditional Owners and public land managers. Partners jointly assess risks and commit to mitigation actions.
- **Long-term:** CMAs across Victoria, in collaboration with communities and partner agencies, identify key risks that may impact on the ability to achieve environmental watering objectives in preparing Environmental Water Management Plans (EWMPs) for priority environmental assets, and as part of water resource plans and Regional Waterway Strategies. These are documented in the CMA's EWMPs, along with risk management measures.

Both processes have been used to identify risks to include in this LTWP, considering the spatial and temporal scale of the plan.

9.2 Types of risks

The types of risks associated with providing environmental water requirements under this LTWP (see Section 3.5) fall into two broad categories:

- Failure to achieve the intended environmental objectives (or demonstrate their achievement).
- Adverse impacts in the provision of environmental water.

The risks associated with a failure to achieve the intended objectives are described in terms of the process by which they are generated and have been grouped into themes that reflect the consequence of the risk. The risks of adverse impacts arising from the provision of environmental water have been grouped by their impact on environmental, cultural, social and economic values. Management measures to address the risks identified in Figure 16 are presented in Appendix H. It should be noted that failure to provide sufficient water through the bulk entitlement process was addressed in Victoria's North and Murray Water Resource Plan (DELWP 2020, as per Basin Plan clause 10.41).

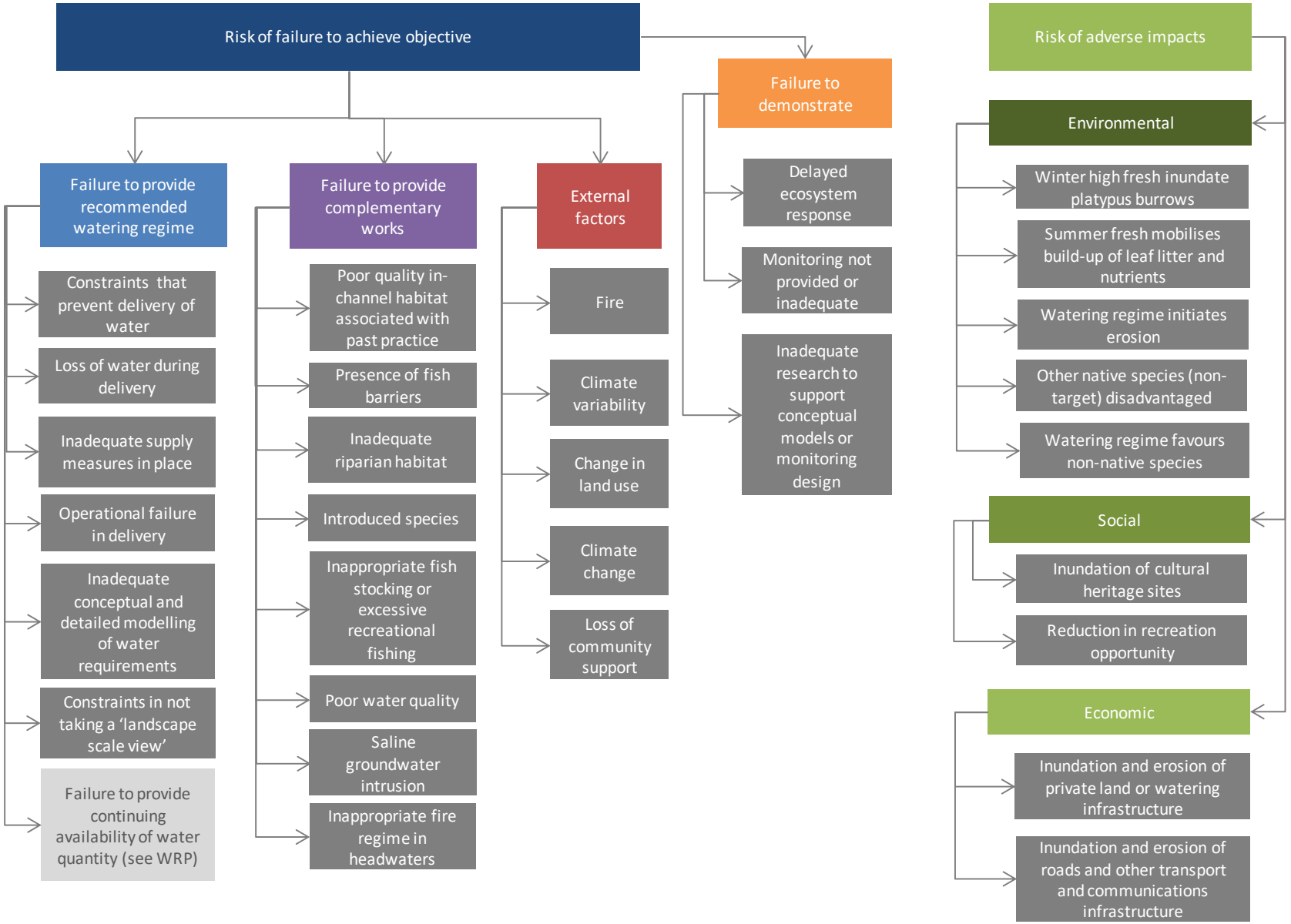


Figure 16: Risk types identified for this LTWP

9.3 Risk identification and assessment approach

While the characterisation of risk in Figure 16 and the management measures identified in Appendix H describe the suite of risks that may affect the benefits associated with environmental water management, they do not identify the relative importance of the risks or priorities for management. This has been addressed in Victoria's Northern and Murray Water Resource Plan (DELWP, 2020), which assigned levels of risk to events and their consequences in a manner consistent with AS/NZS ISO 31000:2009 Risk Management principles. This risk assessment was also undertaken in accordance with the provisions of the Basin Plan, which required that:

- Risks be examined in a consistent, structured and transparent way.
- Risk levels, ranging from very low to very high, be determined as a product of likelihood and the consequence of a risk occurring.
- Likelihood be assessed in terms of how each cause impacts on each threat, and consequence be assessed in terms of how each threat impacts on each beneficial use. The overall risk therefore represents how each cause will impact on each threat, and how that threat will in turn impact on each beneficial use.

The approach adopted in the Northern and Murray Water Resource Plan linked causal factors and their manifestation as threats, with limitations on the use and beneficial outcomes associated with the asset being considered (Figure 17). Threats were then ranked from very low to very high risk based on assessment rubrics of consequence and likelihood (Figure 18):

5 Very high risk

4 High risk

3 Medium risk

2 Low risk

1 Very low risk

0 Not plausible.

The assessment of risks was considered on a water resource plan scale, rather than on a local scale, and was applied to the following risk categories (DELWP, 2020):

- Water availability.
- Structural form (i.e. in relation to longitudinal and/or lateral connectivity, instream physical habitat).
- Water condition.

It should be noted that this consideration of risk at the water resource plan scale is not intended to replace the site-specific risk assessments that are included in EWMPs or Seasonal Water Proposals.

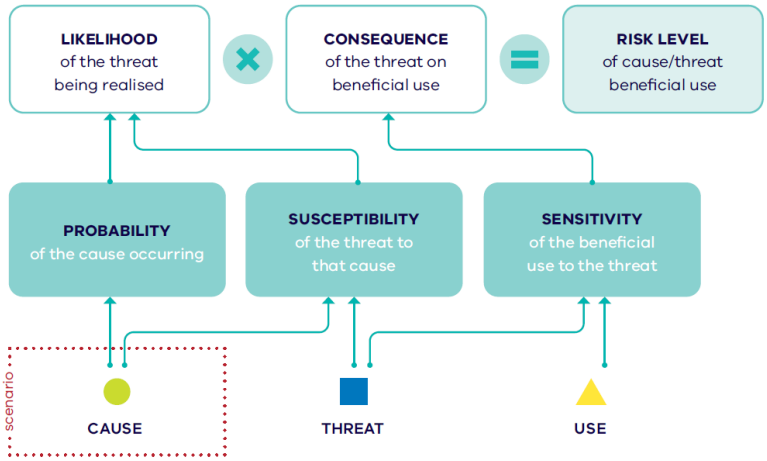
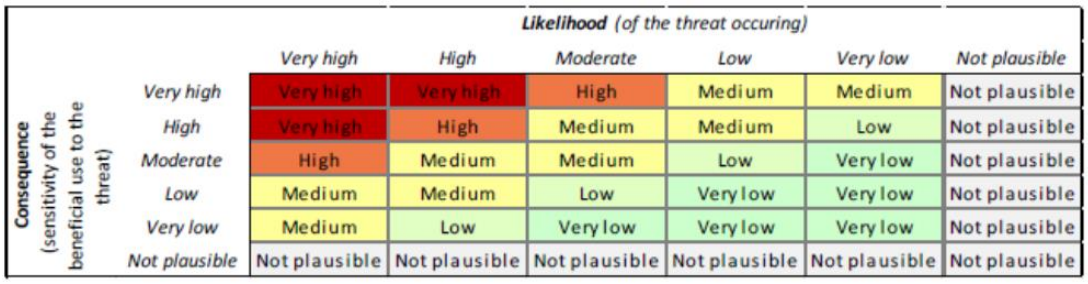


Figure 17: Overview of the risk assessment matrix, including cause-threat-use relationships for the Victorian Murray water resource plan area (from DELWP 2019)

The single high priority risk to address (i.e. causes and associated threats listed as 'very high' and 'high' risk to the environment in Table 21) for the Victorian Murray water resource plan area was considered to be changes to the timing and location of water demands (DELWP, 2020). All the other main threats were considered to pose a medium risk to achieving management objectives for priority environmental assets.



Consequence (sensitivity of the beneficial use to the threat)	Likelihood (of the threat occuring)					
	Very high	High	Moderate	Low	Very low	Not plausible
Very high	Very high	Very high	High	Medium	Medium	Not plausible
High	Very high	High	Medium	Medium	Low	Not plausible
Moderate	High	Medium	Medium	Low	Very low	Not plausible
Low	Medium	Medium	Low	Very low	Very low	Not plausible
Very low	Medium	Low	Very low	Very low	Very low	Not plausible
Not plausible	Not plausible	Not plausible	Not plausible	Not plausible	Not plausible	Not plausible

Figure 18: Risk matrix comprising the combination of likelihood and consequence (Alluvium, 2016)

Table 21: Victorian Murray water resource plan area summary of risks to priority environmental assets (DELWP 2020). For risk levels, see legend below.

Cause	Threat	Rivers	Wetlands
Climate change	Loss or decline in longitudinal connectivity		
	Loss or decline in lateral connectivity		
	Loss or decline in instream physical habitat		
Extreme drought	Loss or decline in longitudinal connectivity		
	Loss or decline in lateral connectivity		
	Loss or decline in instream physical habitat		
Failure to continue to invest in best practice land use initiatives	Loss or decline in longitudinal connectivity		
	Loss or decline in lateral connectivity		
	Loss or decline in instream physical habitat		
Earth resource development	Loss or decline in longitudinal connectivity		
	Loss or decline in instream physical habitat		
Pests and weeds	Loss or decline in longitudinal connectivity		
	Loss or decline in instream physical habitat		
Changes to the timing and location of demands	Loss or decline in instream physical habitat		

Legend			
	Very high risk	High risk	Medium risk

9.4 Strategies for management

Management actions to address the high priority risk listed above are presented in Table 22. These actions also relate to issues discussed elsewhere in this LTWP (namely, the provision of environmental water (Section 4), constraints management (Section 6), complementary actions (Section 7) and demonstrating outcomes (Section 8)).

While risk management will initially focus on preventing or mitigating the effects of the high priority cause(s)/threats, a 'watching brief' will be kept on causes and threats with a medium (or lower) level of risk. This will allow scope for opportunistic management of medium level cause(s)/threats and prevent them from progressing to being high level risks. Action on medium level risks to environmental watering outcomes, such as the effects of pests and weeds, can also provide mutual benefits by addressing threats that are high level risks to consumptive user, recreational and Aboriginal outcomes. For example, investment in best practice land use initiatives could help mitigate excessive sediment and contaminants in runoff before it reaches waterways and consumptive water supplies.

Table 22: Summary of high priority environmental risks and related management measures (adapted from DELWP 2020)

Risk level	Risk cause	Risk threat	Risk impact on uses	Confidence in risk assessment	Potential management actions
There is a very high risk	That the timing and locations of demands	Lead to a loss or decline in instream physical habitat	Which results in adverse impacts on environment - rivers water uses/users	This risk has a moderate level of confidence in its assessment.	Delivery of long-term watering plans Environmental water management in a changing climate Improving public reporting on water availability and use: • user-focused information and reporting Maximising the effectiveness of the grid and markets across the state
There is a very high risk	That the timing and locations of demands	Lead to a loss or decline in instream physical habitat	Which results in adverse impacts on environment - wetlands water uses/users	This risk has a moderate level of confidence in its assessment.	

10. Consultation

Consultation during preparation of this long-term watering plan has involved environmental water holders and managers, river operators, local communities and those materially affected by the management of environmental water.

Consultation on the original 2015 LTWP is described below. The consultation carried out for the review and update of this LTWP over 2019-21 is described in Section 10.4.

In 2015, consultation on this LTWP occurred through a three-part devolved approach. It aimed to:

- *Involve* local communities, who have worked directly with CMAs to ensure information and concerns were understood and considered (10.1 below)
- *Collaborate* with the VEWH and CMAs, who have provided material and guidance for the LTWP (10.2 below)
- *Consult* with the water corporations, land managers, the MDBA, CEWH, upstream and downstream states, and MLDRIN, who provided information where relevant and feedback on the content (10.3 below).

10.1 Local engagement

During the development of the EWMPs that inform this LTWP, CMAs worked with local communities and stakeholders in order to gain input and feedback on all or a selection of the following: identification of the asset's ecological values; the long-term management goal for environmental watering of the asset; the environmental objectives for environmental watering; and the environmental watering requirements.

CMAs have a well-established network of stakeholders from local communities and peak bodies that are engaged on a range of issues. These networks are an effective mechanism to engage with local communities. In more recent years, as the environmental water portfolio has expanded, some CMAs have established specific environmental watering advisory groups (EWAGs).

Others have conducted engagement on as 'as-needs' basis. Examples of those involved include: local landholders, Registered Aboriginal Parties, local Landcare or environment groups, interest groups (e.g. Field and Game, Birds Australia), local shires, local land managers, local representatives of water corporations and government agencies that manage relevant assets/infrastructure (such as roads, culverts, pipelines, and weirs), waterways and the environment, and representatives of CEWH and VEWH. Lists of those consulted can be found in individual EWMPs.

Examples of forums used in this tier include telephone interviews, site visits, workshops on water-dependent ecological values and review of the draft EWMP.

10.2 Working Group for the long-term watering plan

During the development of the original LTWPs in 2015, DELWP convened a working group to collaborate with key environmental water delivery partners. Members of the working group included the VEWH, Wimmera CMA, Mallee CMA, North Central CMA, Goulburn Broken CMA and North East CMA. Some of the working group members authored or coordinated the EWMPs relevant to this LTWP and gave priority environmental asset management and technical input to the LTWP. Advice and input were particularly sought on development of the environmental objectives and targets in this plan.

10.3 Stakeholder review

The working group plus further key environmental water stakeholders have provided input to the plan's development through review of the draft plan. The draft LTWP was released for comment on 1 September 2015 to representatives from VEWH, North East CMA, Goulburn Broken CMA, North Central CMA, Mallee CMA, CEWH, MDBA, NSW and SA Environmental Water Working Group members, Goulburn Murray Water, Lower Murray Water, MLDRIN, and Parks Victoria.

10.4 LTWP Review and Update

The MDBA has provided feedback on Victoria's 2015 LTWPs and have been consulted during preparation of this 2021 update. DELWP also commissioned a review of Victoria's LTWPs in 2019 (Peter Cottingham & Associates, Water's Edge Consulting, Hydro Geo Environmental Consulting, 2019). This update aims to address feedback from the MDBA and many recommendations from the 2019 review. Some recommendations will be addressed as part of the next update in 2023 (following the MDBA's update of the BWS).

As part of this update, DELWP held workshops with relevant CMA and VEWH staff during April-May 2021 and feedback on the draft was provided by these agencies. As described in Section 5.4, consultation on the LTWPs was carried out with Traditional Owner groups across northern Victoria during 2020.

11. Next Steps

This LTWP is one of many steps towards full implementation of Basin Plan. Monitoring and evaluation of the environmental objectives and targets is also required, to report on achievement of environmental outcomes at the asset scale (Basin Plan Matter 8). This requires continuation of relevant monitoring programs, as well as research and innovation programs aimed at better understanding of environmental flow needs of a river, wetland or landscape.

DELWP has recently updated EWMP guidelines to better align environmental objectives at the asset level with Basin Plan, to improve their adherence to SMART criteria and to guide partnership with Traditional Owner groups.

Further work will also be carried out to inform the next LTWP update, after the BWS is updated in 2023. This will progress knowledge and application of:

- Landscape scale (top down) approaches that can be integrated with the asset scale (bottom-up) approach taken in this LTWP iteration.
- Further asset-based technical work through development of EWMPs for new assets, EWMP reviews and EWMP updates where needed (in line with the revised EWMP guidelines). For example, updates to all Mallee EWMP environmental objectives were carried out in 2020 to improve their adherence to SMART criteria and alignment with Basin Plan.
- Use of the ANAE aquatic ecosystem classification V3 to refine the aquatic ecosystem types assigned to priority ecosystem assets.
- Further incorporation of Basin Plan principles and objectives in the VWMS renewal (due 2023).

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Appendix A. Basin Plan Compliance

a) Basin Plan Chapter 8 (environmental watering plan) obligations

The table below presents the details of each of the Basin Plan obligations related to long-term watering plans and how each of these obligations has been addressed within this plan.

Table 23: Basin Plan obligation compliance

Topic	Basin Plan obligations	Clause	Relevant sections of LTWP
Identification of environmental watering requirements	A long-term watering plan must identify • priority environmental assets in the water resource plan area; and • environmental objectives and ecological targets for those assets; and • environmental watering requirements needed to meet those targets in order to achieve those objectives; • using the method in section 8.49	8.19 (1)	Section 2.4 Sections 3.3, 3.4 Appendix F
	• A long-term watering plan must identify • priority ecosystem functions in the water resource plan area; and • environmental objectives and ecological targets for those functions; and • environmental watering requirements needed to meet those targets in order to achieve those objectives; using the method in section 8.50	8.19 (2)	Section 2.5 Sections 3.3, 3.4 Appendix F
	If the Basin-wide environmental watering strategy has identified particular assets or functions, and their requirements under subparagraph 8.14(2)(a)(i), a long-term watering plan must be consistent with that part of the Basin-wide environmental watering strategy.	8.19 (3)	
Identification of possible co-operative arrangements	A long-term watering plan must identify: • possible co-operative arrangements (for example, possible co-operative watering regimes) between holders of HEW, managers of planned environmental water, and owners or managers of environmental assets for the delivery of environmental water: • within the water resource plan area; and • between that area and upstream and downstream water resource plan areas; that will ensure that environmental water meets the environmental watering requirements identified above.	8.19 (4)	Section 5

Topic	Basin Plan obligations	Clause	Relevant sections of LTWP
Identification of long-term risks	A long-term watering plan must identify: • long-term risks to providing for the environmental watering requirements of priority environmental assets and priority ecosystem functions; and • the strategies to manage those risks having regard to the strategies in Chapter 4[9].	8.19 (5)	Section 9
Operational constraints	A long-term watering plan must: (a) identify any operational constraints in relation to environmental watering in the water resource plan area; and (b) include strategies to manage or overcome those constraints.	8.19 (6)	Section 6
Supporting Information	A long-term watering plan must include references to the information that informed its preparation.	8.19 (7)	Throughout & References Section
Consultation.	A Basin State must prepare a long-term watering plan in consultation with: • holders of HEW; and • managers of planned environmental water; and • river operators; and • local communities, including bodies established by a Basin State that express community views in relation to environmental watering; and • persons materially affected by the management of environmental water. Note: Under paragraphs (a) and (b), a Basin State may consult with any holder or manager whose environmental water could contribute to environmental watering in the water resource plan area, regardless of the location of the holder or manager, or of the location of the water.	8.20 (1)	Section 10
Matters to which Basin State is to have regard	When preparing a long-term watering plan, a Basin State must have regard to the Basin-wide environmental watering strategy (Division 2). A long-term watering plan must be developed consistently with the principles to be applied in environmental watering (Division 6).	8.20 (2)	Sections 2-3 Appendix A and Appendix E Throughout See Table 24
Consistency with international agreements	A long-term watering plan must not be inconsistent with relevant international agreements.	8.20 (5)	Section 2, in particular Section 2.3.1

[9] Strategies listed in Chapter 4 of Basin Plan: (1) the environmental watering plan; (2) water quality and salinity management plan; (3) water trading rules; (4) water resources planning

b) Basin Plan environmental watering plan Division 6 principles

The table below presents the details of each of the Division 6 principles of the environmental water plan (Chapter 8 of Basin Plan) and where they are addressed in this LTWP or elsewhere.

Table 24: Basin Plan Environmental Watering Plan Division 6 Principles

Principle	Where addressed in LTWP or elsewhere	Comment
Principle 1—Basin annual environmental watering priorities Environmental watering is to be undertaken having regard to the Basin annual environmental watering priorities. Note: There may be reasons why it is not possible in particular circumstances to undertake watering in accordance with these priorities. Section 8.44 then applies.	Annual watering priorities are established via seasonal watering proposals for individual assets, which in turn are prioritised through the annual VEWH Seasonal Watering Plan (see Sections 1.3.4 to 1.3.6).	Basin annual watering priorities are increasingly a consideration for asset managers when planning environmental water delivery to individual assets in accordance with EWMPs.
Principle 2—Consistency with the objectives in Part 2 Environmental watering is to be undertaken consistently with the objectives in Part 2.	Environmental objectives for the Victorian Murray assets, including their alignment with Basin Plan Chapter 8 objectives, are presented in Section 3.3.	The 3 overarching Basin Plan Objectives are: (a) to protect and restore water-dependent ecosystems of the Murray-Darling Basin; and (b) to protect and restore the ecosystem functions of water-dependent ecosystems; and (c) to ensure that water-dependent ecosystems are resilient to climate change and other risks and threats.
Principle 3—Maximising environmental benefits Subject to the principles in sections 8.33 and 8.34, environmental watering is to be undertaken in a way that: (b) maximises its benefits and effectiveness by: (i) co-ordinating environmental watering between all holders of HEW and managers of planned environmental water; and (ii) co-ordinating environmental watering with flows regulated for consumptive use; and (iii) utilising local knowledge and experience; and (iv) having regard to Indigenous values; and (v) having regard to social and economic outcomes; and	Described in detail as part of the environmental watering framework (see Section 1.3.3). Opportunities to achieve shared benefits from environmental watering will be considered, including contributions to social, cultural, recreational and economic benefits. However, the use of environmental water to provide shared benefits cannot be prioritised at the expense of achieving environmental objectives (see Section 1.3.7). See also the response to Principles 10 and 11 (below).	Other environmental water co-ordination mechanisms to which DELWP is a party includes: • Southern Connected Basin Environmental Water Committee (SCBEWC) • Environmental Water Improvement Group (EWIG).

Principle	Where addressed in LTWP or elsewhere	Comment
(c) enhances existing flow events, where possible, so as to ensure improvement in the delivery of a full range of flow conditions, including high flow events; and	Annual watering priorities are established via seasonal watering proposals for individual assets, which in turn are prioritised through the annual VEWH Seasonal Watering Plan (see Section 1.3.4 and 1.3.6). Delivery of a full range of flow conditions can require cooperative arrangements in the delivery of both environmental and consumptive water. Cooperative arrangements between water delivery partners are presented in Section 5.	Other environmental water co-ordination mechanisms to which DELWP is a party includes: • Southern Connected Basin Environmental Water Committee (SCBEWC) • Environmental Water Improvement Group (EWIG).
(d) takes into consideration the relative ecological benefits of applying environmental water to achieve one environmental outcome over another environmental outcome; and	See Principle 3c (above).	
(e) takes into consideration the variability of the natural flow regime, for example, by mitigating or avoiding seasonal inversion of flows; and	Addressed in EWMPs and Environmental watering plans for individual assets (see Section 3 and Appendix F).	
(f) incorporates strategies to deal with a variable and changing climate; and	Addressed in the Long-term Risk section (Section 9).	Risk characterisation and management actions have been aligned to that presented in Victoria's North and Murray Water Resource Plan.
(g) enables information to be shared between the Authority, the Commonwealth, Basin States, holders of HEW and managers of planned environmental water to ensure efficient and effective use of environmental water.	Victoria's two main environmental water monitoring programs, the Victorian Environmental Flows Monitoring and Assessment Program, and the Wetland Monitoring and Assessment Program for environmental water. Both programs include monitoring that relates to the objectives and targets outlined in Victoria's long-term watering plans, which have direct links to objectives outlined in the EWMPs, as well as the objectives listed in both the Basin-wide environmental water strategy and in the Murray-Darling Basin Plan in Chapters 5 and 8, Schedules 7 and 8 (see Section 8.1).	These, and programs such as the Long-term Intervention Monitoring program, contribute to Victoria's Schedule 12 Matter 8 reporting.

Principle	Where addressed in LTWP or elsewhere	Comment
Principle 4—Risks Environmental watering is to be undertaken having regard to: (a) potential risks, including downstream risks, that may result from applying environmental water and measures that may be taken to minimise the risks; and (b) risks arising from impediments to the delivery of water to water-dependent ecosystems, including risks of extraction of that water for other uses, and inadequate accounting of water flows.	Addressed in the Long-term Risk section (Section 9).	Risk characterisation and management actions have been aligned to that presented in the North and Murray Water Resource Plan.
Principle 5—Cost of environmental watering Environmental watering is to be undertaken having regard to the quantity of water and other resources required relative to the expected environmental benefits.	Addressed in the VEWH seasonal watering plan and its criteria for prioritising environmental watering actions.	Likely environmental benefits compared against: • Cost to deliver and manage water • Costs of interventions to manage external threats and risks
Principle 6—Apply the precautionary principle A lack of full scientific certainty as to whether there are threats of serious or irreversible environmental damage should not be used as a reason for postponing measures to prevent environmental degradation.	This principle is dealt with in Victoria's Waterway Management Strategy (DEPI, 2013b), in addressing Principle 3g (sharing of information) and Principle 4 (assessment and management of risks) (above). It is also addressed in Principle 8 (adaptive management) and Principle 9 (international agreements) (below).	
Principle 7—Working effectively with local communities Environmental watering should be undertaken having regard to the views of: (a) local communities, including bodies established by a Basin State that express community views in relation to environmental watering; and (b) persons materially affected by the management of environmental water.	Community engagement, including with First Nations and other Aboriginal parties, is addressed in Section 10.1 (local engagement) and 10.3 (stakeholder review).	
Principle 8—Adaptive management Adaptive management should be applied in the planning, prioritisation and use of environmental water.	Addressed in the Improving Outcomes (see Section 8.2).	

Principle	Where addressed in LTWP or elsewhere	Comment
Principle 9—Relevant international agreements Environmental watering should be undertaken in a way that is not inconsistent with relevant international agreements. Note: A purpose of the Basin Plan, including Chapter 8, is to give effect to relevant international agreements (see paragraph 20(a) and subsections 21(1), (2) and (3) of the Act). This provision is a further check to ensure that this purpose is achieved.	A management goal for the LTWP is to 'Maintain or improve wetlands of International, National or State significance' (see Section 3.2). International agreements are considered further as Ramsar-listed wetlands are included as priority environmental assets (see Section 2.5)	
Principle 10—Other management and operational practices River management and operational practices should be reviewed, and if necessary altered, to ensure that rivers can be managed to achieve multiple objectives, including the objectives in Part 2.	Under the *Water Act 1989* (Vic), HEW is managed as part of Bulk Entitlements, which specify the water available to users, including consumptive users and the environment (see Section 1.3). Water management to achieve multiple outcomes are also included in the Victorian Waterway Management Strategy (DEPI 2013b) and the Regional Catchment Strategies and Regional Waterway Strategies of the Wimmera, Mallee and North-Central CMAs. Increasingly, the delivery of consumptive and environmental water is being managed in a cooperative manner through such forums as the Southern Connected Basin Environmental Water Committee (SCBEWC), the Environmental Water Improvement Group (EWIG) and the Water Liaison Working Group (WLWG) - Victoria is party to each group.	
Principle 11—Management of water for consumptive use Management of water for consumptive use should, where possible, be undertaken in a way that is consistent with achieving the objectives in Part 2.	See Principle 10 (above).	

c) Ecological Assets and Functions Database Themes

Table 25: Ecological Assets and Functions Database Themes used in this LTWP

Theme	Matter 9 Theme ID
End of Basin Flows	1.3
Ecosystem processes (e.g. carbon and nutrient cycling)	6
Fish	4
Geomorphology (maintenance of)	1.4
Longitudinal connectivity	1.1
Lateral connectivity	1.2
Macroinvertebrates	7
Other fauna related	7
Other (e.g. resilience, ecosystem diversity, …)	7
Vegetation related	2
Wetland related	7
Waterbirds related	3
Water quality (Physico-chemical)	5

Appendix B. Environmental Water Management Plans

Environmental Water Management Plans (EWMPs) are developed to capture the long-term environmental watering requirements of priority Victorian wetlands and rivers that

- have environmental values at risk from altered water regimes, and
- can receive environmental water (DEPI, 2013b).

EWMPs have been completed across Victoria. EWMPs provide information to assist development of the Victorian Environmental Water Holder's (VEWH) Seasonal Watering Plan, as well as the Annual Watering Priorities and long-term watering plans for the Basin Plan.

An EWMP is a scientifically based management plan that documents:

- the natural versus developed hydrology of the site, indicating what changes have occurred, leading to why environmental water is needed
- priority environmental values (those that rely on flows or inundation for all or part of their life cycle) associated with the wetland or river
- the condition of the wetland or river and its environmental values, indicating why the wetland or river requires environmental watering action
- an overarching environmental water management goal for the wetland or river, relating to the important ecological values, that can be advanced through environmental watering
- long-term environmental objectives that help meet the management goal
- the watering requirements for each objective
- a watering regime that considers all watering requirements needed to meet the objectives
- constraints to watering at the site
- risks to meeting the objectives
- monitoring required to demonstrate whether the objectives have been met
- outcomes of community consultation that has occurred during development of the EWMP.

The watering requirements to meet the environmental objectives are based on established technical information including FLOWS studies (for Victorian rivers). The expected ecological benefits of managed watering and drying (Alluvium, 2016) underpin the watering requirements of the EWMP.

The use of expert advice in developing the hydrological regime is an important component to the development of EWMPs. Where known, the hydrological tolerances of the environmental objectives are included to help establish thresholds for watering/not watering.

The EWMP process, as undertaken by CMAs with external expert advice, assists in creating a robust and scientifically defendable management plan, which effectively identifies a plan to best manage environmental watering at designated sites.

Also important to the EWMP is input from community and from Traditional Owners regarding the ecological values present at a wetland or river reach ('the asset'), the management goal for the asset, the objectives, and the hydrological regime of the asset. The involvement of Traditional Owners has increased over recent years and as of 2021 the protocol is for them to be partners in EWMP development.

EWMPs from the Wimmera, Mallee, North Central, Goulburn Broken, and North East CMAs have been used as important input to the preparation of LTWPs for Victoria's Basin Plan requirements. In particular, EWMPs have been used in the development of LTWP environmental objectives and watering requirements.

EWMPs also provide important asset-based information for other LTWP requirements regarding constraints, risks and community consultation.

All Victorian Basin Plan EWMPs are available at https://www.water.vic.gov.au/waterways-and-catchments/rivers-estuaries-and-waterways/environmental-water/environmental-water-management-plans.

The table below lists the EWMPs for priority environmental assets in the Wimmera-Mallee water resource plan area where further details can be found on all aspects of management of environmental watering.

Table 26: EWMPs for priority environmental assets in the Victorian Murray water resource plan area

Asset Name	CMA	EWMP (or other document)
Barmah Forest	GBCMA	Barmah Forest EWMP
Belsar and Yungera Islands	MCMA	Belsar & Yungera Island EWMP. Note also Belsar-Yungera Environmental Watering Plan Addendum (to be finalised); required infrastructure under construction
Benwell Forest[1]	NCCMA	Benwell Forest Ecological Objectives & Hydrological Requirements Justification Paper; required infrastructure under construction
Black Swamp	GBCMA	Black Swamp EWMP
Bottle Bend	MCMA	Bottle Bend EWMP
Broken and Nine Mile Creeks	GBCMA	Lower Broken Creek and Nine Mile Creek EWMP
Bumbang Island	MCMA	Bumbang Island EWMP
Burra Creek[1]	MCMA	Burra Creek EWMP
Butler's Creek[3]	MCMA	Butler's Creek EWMP
Cardross Lakes	MCMA	Cardross and Koorlong Lake EWMP
Carina Bend	MCMA	Carina Bend EWMP
Cokum Bushland Reserve[2]	MCMA	Wimmera-Mallee Pipeline – Cokum BR EWMP
Considines[2]	MCMA	Wimmera-Mallee Pipeline – Considines EWMP
Gunbower Creek	NCCMA	Gunbower Creek System EWMP
Gunbower Forest	NCCMA	Gunbower Forest EWMP
Gunbower National Park	NCCMA	Gunbower National Park Ecological Objectives & Hydrological Requirements Justification Paper (to be finalised); required infrastructure under construction
Guttrum Forest[1]	NCCMA	Guttrum Forest Ecological Objectives & Hydrological Requirements Justification Paper (to be finalised); required infrastructure under construction
Hattah Lakes[1]	MCMA	Hattah Lakes EWMP. Note also Hattah North Environmental Watering Plan Addendum (to be finalised); required infrastructure under construction
Heywoods Lake	MCMA	Heywoods Lake EWMP
Hird Swamp	NCCMA	Hird Swamp EWMP
Johnson Swamp	NCCMA	Johnson Swamp EWMP
Johnstons and Chaffey Bend	MCMA	Johnstons and Chaffey Bend EWMP
Karadoc (Inlet Creek)	MCMA	Karadoc (Inlet Creek) EWMP
Kings Billabong	MCMA	Kings Billabong EWMP
Kinnairds Wetland	GBCMA	Kinnairds Swamp EWMP
Koorlong Lakes	MCMA	Cardross and Koorlong Lakes EWMP
Lake Cullen	NCCMA	Lake Cullen EWMP
Lake Elizabeth	NCCMA	Lake Elizabeth EWMP
Lake Hawthorn	MCMA	Lake Hawthorn EWMP
Lake Murphy	NCCMA	Lake Murphy EWMP

Asset Name	CMA	EWMP (or other document)
Lindsay, Wallpolla, Mulcra Islands[1]	MCMA	Lindsay, Wallpolla Islands EWMP. Note also Wallpolla Environmental Water Management Plan Addendum (to be finalised); required infrastructure under construction
Loddon River (lower)	NCCMA	Loddon River EWMP
Margooya Lagoon	MCMA	Margooya Lagoon EWMP
McDonalds Swamp	NCCMA	McDonalds Swamp EWMP
Merbein Common	MCMA	Merbein Common EWMP
Murray floodplain between Lake Hume and Lake Mulwala	NECMA	Victorian Murray Floodplain EWMP
Murrumbidgee Junction	MCMA	Murrumbidgee Junction EWMP
Neds Corner[3]	MCMA	Neds Corner EWMP
Nyah	MCMA	Nyah & Vinifera EWMP
Piambie	MCMA	Piambie EWMP
Pig Swamp	NCCMA	Pig Swamp EWMP
Pound Bend	MCMA	Pound Bend EWMP
Poyner[2]	MCMA	Wimmera-Mallee Pipeline – Poyner EWMP
Psyche Bend Lagoon	MCMA	Psych Bend Lagoon & Woorlong Wetland EWMP
Richardson's Lagoon	NCCMA	Richardson's Lagoon EWMP
River Murray – Lock 15	MCMA	Murray River – Lock 15 EWMP
River Murray – Lock 6-10	MCMA	Murray River – Lock 6-10 EWMP
Sandilong Creek	MCMA	Sandilong Creek EWMP
Spence's Bend	MCMA	Spences Bend EWMP
Tata Creek	MCMA	Tata Creek EWMP
Vinifera	MCMA	Nyah & Vinifera EWMP. Note also Vinifera Environmental Watering Plan Addendum (to be finalised); required infrastructure under construction
Walshes Bend	MCMA	Walshes Bend EWMP
Wemen-Liparoo	MCMA	Wemen-Liparoo EWMP
Wirra-Lo Wetlands Complex	NCCMA	Wirra-Lo Wetland Complex EWMP
Woorlong Wetland	MCMA	Psych Bend Lagoon & Woorlong Wetland EWMP

[1] *These assets are part of Victoria's Basin Plan Sustainable Diversion Limit supply project environmental works*

[2] *These assets are part of the 51 Wimmera-Mallee wetlands but receive their water from the River Murray via supply system #5.*

[3] *These assets now receive HEW and will be assessed for inclusion as priority environmental assets in the next LTWP update following the BWS update planned for 2023.*

Appendix C. Determining objectives, targets and watering requirements

This appendix describes the approach used to develop environmental objectives and targets for the Victorian Murray water resource plan area and this LTWP. The overall process is shown in Figure 19 below and is described in the following section. The green processes and products relate to objectives while the blue relates to targets, and the orange relates to watering requirements.

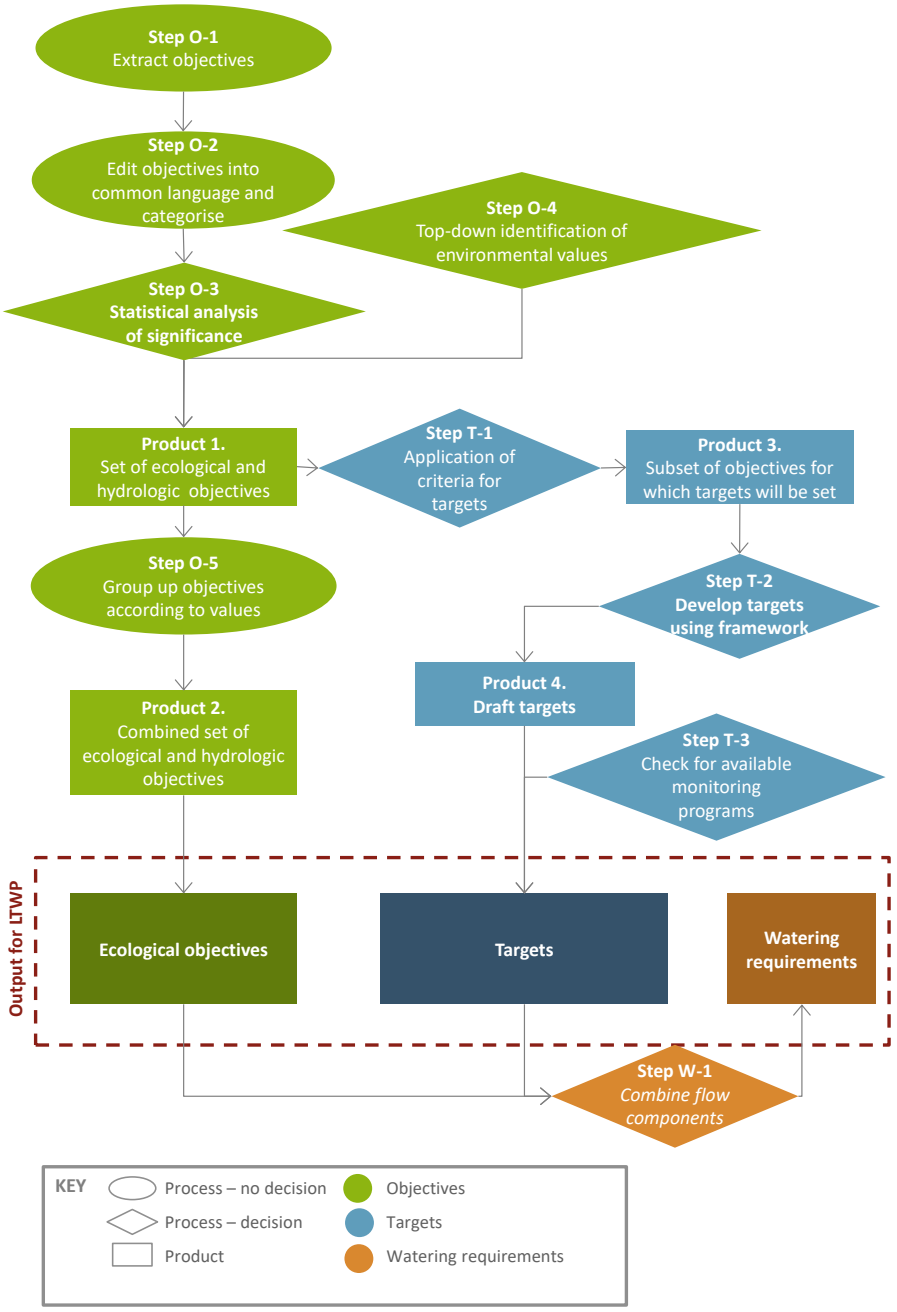

Figure 19: Overview of process for developing objectives and targets

The first step in process was to collate all available environmental objectives for environmental watering sites (assets) and ecological functions, as documented by Victoria's CMAs in Regional Waterway Strategies, EWMPs, SDL Business cases and TLM ecological watering guides. In all, for the three water resource plan areas, 70 individual plans were identified that covered over 100 assets. Some 600 individual objectives were identified within the 70 plans.

Step O-2

The list of extracted objectives contained a wide variety of terminology and level of detail. The next step in the process was to standardise each objective into a consistent suite of language and detail. Each objective was categorised according to Figure 20.

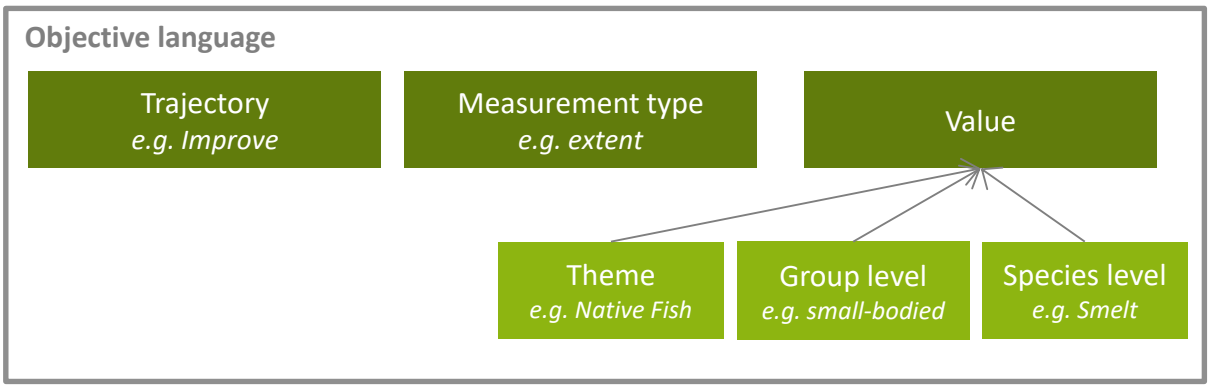

Figure 20: Objective language used to standardise objectives and categorise them

The **trajectory** represents the intended change (improve, maintain and reduce). The **measurement type** identifies in which particular aspect of the value the change should occur. This could include extent, abundance, species richness, condition, breeding, etc.

The **value** is the part of the ecosystem that is of interest, and split into 3 increasing levels of detail:

- Theme (native fish, vegetation, waterbirds, river flows and connectivity, other)
- Group-level (e.g. small-bodied fish, river red gum communities, colonial-nesting waterbirds)
- Species-level (e.g. brolga, Murray hardyhead, charophytes)

Some objectives included cross-theme components, or included many group level elements. These were split into separate themes or groups. For example, the following objective was split between the vegetation and the waterbird theme:

"*To provide a watering regime that supports a cane-grass/plains grassy wetland Complex and provides breeding opportunities for a diverse range of native wetland biota in particular brolga*"

Examples of the final list of objectives included:

- Improve abundance of short lived/ small-bodied fish.
- Maintain condition of river red gum communities.
- Improve feeding areas for waterbirds.

Step O-3

To achieve a set of objectives that are relevant at a regional scale (i.e. the water resource plan area scale), objectives were ranked within each water resource plan area based on the number of assets that had an objective related to each value (group level) measurement type and trajectory. This is the **bottom-up approach** to achieving a set of objectives that represent the region.

Note:

The production of a set of objectives for each water resource plan area in no way diminishes the importance of objectives at an individual asset scale. Some objectives that occur at only a few assets are not included in the Regional Objectives, but still remain valid for watering of the assets with that objective. Similarly, where the Regional Objective trajectory is "Maintain", and a particular asset trajectory is "Improve", any watering plan at the asset level should still be designed to improve the value.

It is recognised that there are no formal criteria for selecting how many assets need to have a particular value, measurement type or trajectory for inclusion, so there is a degree of subjectivity in the development of a regional set of objectives.

Step O-4

The sets of objectives were then cross-checked for gaps based on subjective assessments of the values in each water resource plan area. This subjective process was informed by guidance from the VEWH and DELWP, and expert ecologists (Alluvium team, Jane Roberts and Terry Hillman - LTWP reviewers).

This is the **top-down approach** at a regional scale to complement the bottom-up approach drawn from the objectives at an asset scale.

One identified objective that is not covered by individual asset objectives relates to the maintenance or improvement of the suite of wetland types (number and type based on water regime) across each water resource plan area.

Based on steps O-3 and O-4, a set of objectives was developed (in the format described in Step O-2). This feeds into the target setting process (from Step T-1).

Step O-5

To give the objectives more meaning and enhance readability, they were grouped according to the value (group level) they were focused on.

For example, where the following three objectives were included in the set of objectives (Product 1), they could be grouped into one objective about river red gum communities (the value).

Improve condition of river red gum communities

+

Maintain extent of river red gum communities

+

Improve species richness of river red gum communities

=

Maintain extent and improve species richness and condition of river red gum Communities

Based on this grouping process, a set of objectives was selected for each water resource plan area. This feeds directly into the LTWP.

Step T-1

Not all of the objectives will lead to good targets that can be used for reporting outcomes. Therefore, targets will be set for a subset of the objectives. This subset of objectives needs to be based on criteria for target setting. The subset of objectives should lead to targets being set that meet these criteria and also be significant to the water resource plan area. Therefore, the following criteria were adopted (Figure 21)

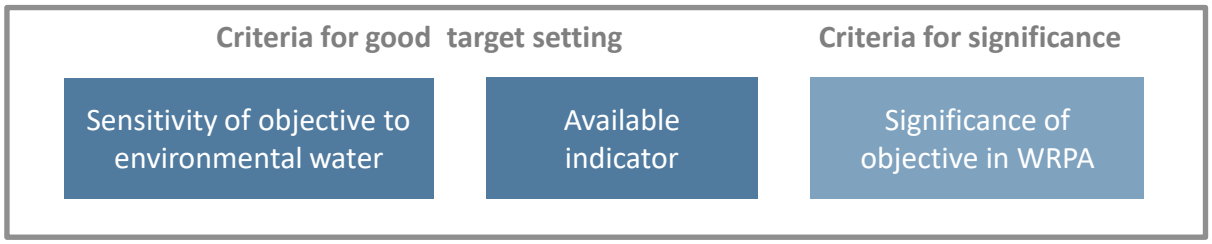

Figure 21: Criteria for target setting

The **sensitivity of the objective to environmental water** includes whether water delivery is the critical component that would lead to achieving the objective, or how dependent the value or asset associated with the objective is on water delivery. For example, successful bird breeding events are highly sensitive to flow duration, and are therefore sensitive to the delivery of environmental water. Conversely, there is not a strong link established between flow and species richness of macroinvertebrates.

In order to match a target against an objective and report on that target, there must be an **available indicator** that can be monitored. This indicator guides the target setting process and relates directly to the *measurement type* component of the objective. For example, for extent of vegetation an indicator could be area in hectares. Some objectives where it would be difficult to provide an indicator include:

Maintain the quality of geomorphic habitat.

Improve breeding opportunities for platypus and rakali communities

Given that only a subset of the objectives for each water resource plan area will have targets set, this subset should represent the most **significant objectives** for that region. This significance has been informed by the number of assets in the water resource plan area that relate to each objective and also expert opinion. Note this is similar to the process used for the objectives in steps O-3 and O-4.

Based on the described criteria, a subset of objectives was selected for each water resource plan area to be used in the remainder of the target setting process.

Step T-2

In order to compose the targets, the following framework was used. This framework is based on the principles for target setting in the LTWP and an understanding of what components are required to set good targets that can be monitored and used for reporting.

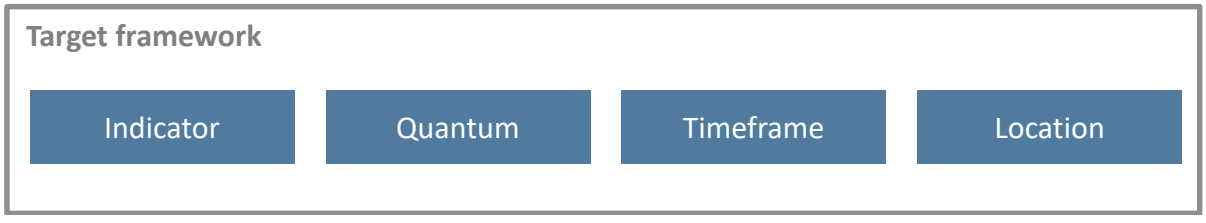

Figure 22: Framework for developing targets

The **indicator** was identified in Step T-1 (criteria for targets) and is the metric, that is, the item that will be measured. It relates directly to the objective type and value. For example, the **area** of Red Gum communities or **count per unit effort** (CPUE) of fish.

The **quantum** relates to the amount of the indicator that should be achieved. For example 3,000 ha or 10% increase. A target will include a **timeframe** within which the target should be achieved. Examples could include within 5 years or occurs in 90% of years. The **location** considers at which assets or type of assets the target should be achieved, for example, Tang Tang Swamp or priority river reaches.

For the subset of objectives (Product 3), draft targets were developed based on the framework for target setting. Any of these targets could be appropriate for inclusion in the LTWP.

Step T-3

Based on the draft targets, an extensive monitoring program would be required to report on every target. Given that limited resources are available for monitoring, DELWP has indicated a preference to use existing monitoring programs where possible. Therefore the list of draft targets was filtered for targets where there is an existing monitoring program already in place and/or can be replicated at increased spatial or temporal scales. This also impacts on whether baseline data will be available.

The output of step T-3 will be a finalised list of targets that will be incorporated into the LTWP.

Step W-1

The final step is to determine the watering requirements. At the regional scale, this is done by linking the objectives and targets to the relevant flow components. The EWMPs and Seasonal Watering Plan (SWP), which is developed each year, provide further detail on the watering requirements at an asset scale.

Appendix D. Updates to LTWP targets

Updates to the LTWP targets were made by Ecological Associates (Cooling, 2017) during the process of developing the monitoring and evaluation plan to measure progress towards achievement of the objectives.

The targets were amended to ensure that they were measurable, unambiguous, time-bound and set clear thresholds for success. Where possible, the targets were worded to more closely align with existing monitoring protocols. This appendix presents the original target wording from the LTWP and the rationale for the amended wording.

Further modifications and improvements to these targets are planned.

Fish Target 1, 3 and 5

Fish Target 1, 3 and 5 has two parts A and B.
Part A addresses the LTWP objective to "Improve abundance of large-bodied native fish". The target in the LTWP is:
Increase the spatial distribution of large-bodied native fish over a ten year period to 2025.
There are some points to clarify in the wording of this target.

- The target is evaluated by monitoring particular large-bodied species which are specified in the asset plans.
- Each species will be reported on, requiring sub targets in several assets.
- To measure an increase in spatial distribution it is necessary to monitor sites where the fish are not present but are expected to occur in the future.
- The target does not specify a baseline from which the increase will measured. Taking a single year as a baseline, such as 2015 can be problematic if it is not representative. Taking baseline data from other studies may not be comparable if the sampling effort is different.

The following amended wording was adopted.
The mean annual number of sites where large-bodied native fish species are detected is higher in the last five years than the first five years of a ten year monitoring program.
Part B addresses the LTWP objective to "Improve abundance of large-bodied native fish". The target in the LTWP is:
Increase size and/or age distribution of large-bodied native fish over a ten year period to 2025.
There are some points to clarify in the wording of this target.

- The target is evaluated by monitoring particular large-bodied species which are specified in the asset plans.
- Each species will be reported on, requiring sub targets in several assets.
- It is unclear what is meant by an 'increase' in size/or age distribution. It is expected that it refers a more even distribution of age classes across the population which indicates frequent recruitment and good survival.
- It is unclear how the target relates to the objective. Size distribution is likely to reflect mortality factors, including fishing pressure.
- The target allows either age or size to be measured which could create problems for consistency in data collection.
- The data will be in the form of frequency distributions which could be differentiated statistically or by expert interpretation.
- If data is collected from several sites within an asset (sub-populations), pooled data will not provide an accurate representation of the asset population. Instead each sub-population should be reported separately, or a single representative site should be sampled.

- The target does not specify a baseline from which the increase will measured. Taking a single year as a baseline, such as 2015 can be problematic if it is not representative. Taking baseline data from other studies may not be comparable if they used different methods.

The following amended wording was adopted.
For annual age classes up to five years, the number of cohorts is the same or higher in the last year than the first year of a ten year monitoring program.

Fish Target 2, 4 and 7

Fish Target 2, 4 and 7 addresses the LTWP objective to "Maintain species richness of native fish". The target in the LTWP is:
Maintain species richness of native fish in 80% of years between 2015 and 2025.
There are some points to clarify in the wording of this target.

- The target does not specify how the baseline fish diversity is defined. This could be the number of species observed in the first year of sampling using a specific method. A difficulty is that this may not be a representative year to observe fish. Alternatively the baseline could be the number of species observed over several years preceding 2015 from a range of sources. A difficulty with this approach is it could include more species than a single standardised method could detect.
- It would be less ambiguous to say that the number of species must not be less than the threshold of eight of the ten years to 2025.
- The number of species will increase with survey effort. It is important to use a consistent method.

The following amended wording was adopted.
The ratio of fish species observed to expected (using the pre-European Reference Condition - PERCH) is the same in the first three years as the last three years of a ten year monitoring period.

Fish Target 6

Fish Target 6 addresses the LTWP objective to "Maintain abundance of small-bodied native fish in wetlands" in the Victorian Murray WRPA. The target is:
Maintain spatial distribution of small-bodied native fish within large or network wetlands, or presence in small wetlands, over a ten year period to 2025.
There are some points to clarify in the wording of this target.

- Spatial distribution will be reported for each fish separately, creating sub targets.
- To detect a change in spatial distribution in large assets a range of sites across the assets must be sampled.
- It is not clear how the word 'maintain' translates into a measurable threshold. It is assumed that some variation from year to year is acceptable but a declining trend in distribution is not acceptable.
- The target does not define the baseline for spatial distribution. This could be the distribution observed in the first year of sampling using a specific method. A difficulty is that this may not be a representative year to observe fish. Alternatively the baseline could be the distribution observed over several years preceding 2015 from a range of sources. A difficulty with this approach is it could include more species than a single standardised method could detect.

An alternative wording is proposed.
In small wetlands, maintain the presence of small-bodied native fish every year in the ten year monitoring period
and;
in large or network wetlands, the average number of sites where small-bodied native fish species are detected in the first five years is not less than in the last five years of a ten year monitoring program.

Fish Target 8

Fish Target 8 addresses the LTWP objective to "Maintain distribution of threatened small-bodied native fish" in the Victorian Murray WRPA. The target is:
Maintain spatial distribution of threatened small-bodied native fish within large or network wetlands, or presence in small wetlands, over a ten year period to 2025.
There are some points to clarify in the wording of this target.

- Spatial distribution will be reported for each fish separately. If there is more than one threatened fish species in an asset this will create sub targets.
- To detect a change in spatial distribution in large assets a range of sites across the assets must be sampled.

> It is not clear how the word 'maintain' translates into a measurable threshold. It is assumed that some variation from year to year is acceptable but a declining trend in distribution is not acceptable.

> The target does not define the baseline for spatial distribution. This could be the distribution observed in the first year of sampling using a specific method. A difficulty is that this may not be a representative year to observe fish. Alternatively the baseline could be the distribution observed over several years preceding 2015 from a range of sources.

An alternative wording is proposed.
In small wetlands, maintain the presence of threatened small-bodied native fish every year in a ten year monitoring period
and
in large or network wetlands, the average number of sites where threatened small-bodied native fish species are detected in the first five years is not less than in the last five years of a ten year monitoring period.

Waterbirds Target 1

Waterbirds Target 1 addresses the LTWP objective to "Improve breeding opportunities for waterbirds" in the Wimmera Mallee WRPA. The target is:
Deliver water, if and as required, to complement natural flood events to complete breeding events in 1 out of 20 years.
This target relates to Lake Hindmarsh and Lake Albacutya.
There are difficulties with the wording of this target.

- The target involves a management response to natural flood in Lakes Hindmarsh and Albacutya that occur with a frequency of 1 in 20 years. These events occur stochastically, and over the long term they may be separated by intervals of several decades. It is impossible to evaluate this target within the 10 year lifespan of the LTWP.
- For the target to be met, the delivered water must result in waterbirds completing their breeding. However, it is impossible to know if breeding would have failed without the delivered water.

The following amended wording was adopted.
Deliver water to support waterbird breeding events in Lakes Hindmarsh and Albacutya.

Waterbirds Target 2 and 4

Waterbirds Target 2 and 4 address the LTWP objective to "Improve habitat for waterbirds" in the Northern Victoria and Victorian Murray WRPAs, respectively. The target is:
Appropriate water regime to support feeding and/or breeding habitat for waterbird guilds delivered at 50% of sites, 8 years in 10.
There are some points to clarify in the wording of this target.

- In general, asset plans only define one water regime for each wetland types. They do not usually provide water regimes for different waterbird guilds.
- Plans can specify different water regimes for different wetland types. Each of these water regimes must be evaluated.
- Asset plans can specify different water regimes for minimum, optimal and maximum water supply. It is not clear which of these regimes needs to be evaluated in the target.
- It is difficult to demonstrate a long-term frequency such as 8 years in 10 with only 10 years of data. Instead it is recommended that the target refers specifically to the number of years the target is met in a 10 year period.
- The target refers to providing appropriate water regimes in 50% of sites. This suggests that the assets have several sites within them where water regimes can be managed separately. Of the listed assets, only Lake Meran and Little Lake Meran comprises a complex (with three basins) but even here the water regime of the basins cannot be managed separately. Alternatively it could be using the term 'site' to mean 'asset' in which case it cannot report on the objective at the asset scale because it is based on multiple assets.
- The target requires that compliance with a long-term water regime (e.g. flooding 3 years in 10) is evaluated each individual year, which is impossible. It is recommended to use a threshold that can be evaluated in individual years.

An alternative wording is proposed.
The minimum water requirement for waterbird feeding and/or breeding is met in the ten year period to 2025.

This defines a specific threshold that must be achieved. All of the minimum water regime requirements must be met in every year. It applies to all sites within the asset.

Waterbirds Target 3

Waterbirds Target 3 addresses the LTWP objective to "Improve breeding opportunities for colonial nesting waterbirds" in the Victorian Murray WRPA. The original target was:

Water required for successful colonial waterbird breeding delivered in at least 2 years in 10 by 2025.

There are some points to clarify in the wording of this target.

- The target is met by delivering water 2 years in 10, without regard to natural inflows. This is a very modest target and for many assets it would not provide additional breeding opportunities. Therefore it is assumed that the intention is to augment existing breeding opportunities by 2 events every 10 years.
- It is difficult to demonstrate a long-term frequency such as 2 years in 10 with only 10 years of data. Instead it is recommended that the target refers specifically to the number of years the target is met in a 10 year period.
- The target requires that water delivery meets waterbird requirements, not that the waterbird breeding is successful.
- Some of the assets are large wetland complexes which have more than one colonial nesting waterbird breeding site. The target does not specify if water delivery is required to one, to all or to some of these sites. It is assumed that colonial waterbird breeding must be completed somewhere in the asset.
- The duration of flooding required for colonial nesting waterbirds to breed varies between species. The EWMPs provide target durations based on the species they support.

An alternative wording is proposed.

The minimum water regime required for colonial nesting waterbird breeding is met over a ten year monitoring period.

This target is met by the delivery of water which is currently monitored through water ordering and delivery systems and documented by CMAs. Water levels or flood extent must be monitored to confirm that the water delivered meets water requirements.

Vegetation Target 1

Vegetation Target 1 addresses the LTWP objective to "Improve condition of riparian EVCs". The target is:

Increase distribution, [species] richness and abundance of riparian vegetation in riparian EVCs.

There are some points to clarify in the wording of this target.

- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- An increase in the extent of the EVC is not necessarily desirable if it comes at the expense of other vegetation types.
- Measuring an increase in extent involves measuring areas where the vegetation is not currently present.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be 2015.
- The target does not specify when the thresholds must be achieved, but it is expected to be 2025.

An alternative target wording is proposed based on the vegetation condition monitoring developed in VEFMAP.

The condition of riparian EVCs in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets:

- *health of adult trees*
- *recruitment and survival of juvenile trees*
- *native species richness*
- *native species cover/abundance*
- *recruitment of understorey vegetation*

Vegetation Target 2

Vegetation Target 2 addresses the LTWP objective to "Maintain condition of aquatic vegetation in wetlands" in the Northern Victoria WRPA. The target is:

The 2009-2011 IWC biota score maintained at priority wetland assets in 2025.

There are some points to clarify in the wording of this target.

- It is not clear why assets are specified as 'priority'.
- The IWC biota score incorporates a number of broad indicators. It is likely to be too insensitive to detect vegetation responses to water management within the timeframe of the LTWP.
- 2009-2011 biota scores are not available for all the assets.
- It is recommended that the condition of aquatic vegetation is measured directly using protocols set out in WetMAP.

An alternative target wording is proposed based on the vegetation condition monitoring developed in WetMAP.
The condition of wetland vegetation in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets:

- *cover/abundance of native species*
- *native species richness*
- *recruitment of woody and non-woody understorey and survival of juvenile plants*

Vegetation Target 3
Vegetation Target 3 addresses the LTWP objective to "Maintain condition of river red gum dominated EVCs" in the Northern Victoria WRPA. The target is:
Maintain distribution, [species] richness and abundance of riparian vegetation in river red gum dominated EVCs.
There are some points to clarify in the wording of this target.

- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- An increase in the extent of the EVC is not necessarily desirable if it comes at the expense of other vegetation types.
- Measuring an increase in extent involves measuring areas where the vegetation is not currently present.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be 2015.
- The target does not specify when the thresholds must be achieved, but it is expected to be 2025.

An alternative target wording is proposed based on the vegetation condition monitoring developed in VEFMAP.
The condition of river red gum dominated EVCs in the asset improves over ten years as measured by the following sub-targets:

- *health of adult river red gum trees*
- *recruitment and survival of juvenile trees*
- *native species richness*
- *native species cover/abundance*
- *recruitment of understorey vegetation*

Vegetation Target 4A
Vegetation Target 4A addresses the LTWP objective to "Improve condition of river red gum dominated EVCs" in the Northern Victorian WRPA. The target is:
Increase distribution, [species] richness and abundance of riparian vegetation in river red gum dominated EVCs.
There are some points to clarify in the wording of this target.

- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- An increase in the extent of the EVC is not necessarily desirable if it comes at the expense of other vegetation types.
- Measuring an increase in extent involves measuring areas where the vegetation is not currently present.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be 2015.

- The target does not specify when the thresholds must be achieved, but it is expected to be 2025.

An alternative target wording is proposed based on the vegetation condition monitoring developed in VEFMAP and WetMAP.
The condition of river red gum EVCs in the asset is better at the end than at the start of a 10 year monitoring period as measured by the following sub-targets:

- *health of adult river red gum trees*
- *recruitment and survival of juvenile trees*
- *recruitment of understorey vegetation*
- *native species cover/abundance*
  native species richness

Vegetation Target 4B
No amendments were proposed to this target.
Vegetation Target 5
The Vegetation 5 target addresses the LTWP objective to "improve the condition of black box dominated EVCs" in the Victorian Murray WRPA. The target is:
Increase distribution, [species] richness and abundance of riparian vegetation in black box dominated EVCs.
There are difficulties with the wording of this target.

- black box EVCs rarely occur in riparian areas and this reference should be removed from the target.
- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- Due to the long response times involved, changes in the extent of black box EVCs are not realistic within the time frame of the LTWP.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be from 2015 to 2025.

An alternative target wording is proposed based on WetMAP.
The condition of black box dominated EVCs in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets:

- *health of adult black box trees*
- *recruitment and survival of juvenile trees*
- *recruitment of understorey vegetation*
- *native species cover/abundance*
- *native species richness*

Vegetation Target 6
Vegetation Target 6 addresses the LTWP objective to "Improve the condition of shrub and lignum dominated EVCs". The target is:
Increase distribution, [species] richness and abundance of riparian vegetation in shrub and lignum dominated EVCs.
There are some problems with the wording of this target.

- Shrub and lignum EVCs rarely occur in riparian areas and this condition should be removed from the target.
- To make the target relate more specifically to wetland shrubland species, it would be helpful to specify "Cane grass or Lignum dominated EVCs".
- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- An increase in the extent of the EVC is not necessarily desirable if it comes at the expense of other vegetation types.
- Measuring an increase in extent involves measuring areas where the vegetation is not currently present.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be from 2015 to 2025.

An alternative wording is proposed based on WetMAP and VEFMAP:
The condition of Cane grass or Lignum dominated EVCs is better at the end than at the start of a ten year monitoring program as measured by the following sub-targets:

- condition of Lignum
- cover of canegrass (there is no recognised condition assessment method for canegrass)
- native species cover/abundance
  native species richness

Connectivity Target 1
Connectivity Target 1 addresses the LTWP objective to "Improve longitudinal connectivity between river reaches and with the River Murray" in the Northern Victoria WRPA. The target is:
Meet baseflow and fresh flow requirements as specified in each asset, in 90% of years by 2025, in order to connect and contribute flows to the River Murray.
There are difficulties with the wording of this target.

- The target specifies that the threshold is met in 90% of years, but it is difficult to demonstrate a long term frequency based on only 10 years of data. Instead it is recommended that the target refers specifically to the number of years the target is met in a 10 year period.
- The wording includes the purpose of the target, which is to connect and contribute flows to the River Murray. This target will be assessed hydrologically, not by hydraulic connection, so it is recommended that the reference to connectivity is removed.

An alternative wording is proposed.
The baseflow and fresh flow requirements as specified in each asset are met in eight years of a ten year period.
Connectivity Target 2
Connectivity Target 2 addresses the LTWP objective to "improve connectivity between floodplains, anabranches and wetlands" in the Victorian Murray WRPA. The target is:
Meet required watering regime at 80% of wetland and floodplain assets that have water delivered through anabranch connections by 2025.
There are difficulties with the wording of this target.

- Under the Basin Plan, LTWP reporting must be conducted on an asset scale, so it is not possible to have a target for multiple assets. Several of the assets for this target have multiple sites within them where compliance could be assessed, so it is suggested that 'assets' is replaced with 'sites'. However, some assets consist of only one site (e.g. Pig Swamp), so it will be impossible to meet the 80% target. It is suggested that the target is reworded to recognise that some assets have multiple wetlands. The sites to be assessed within the complexes is yet to be determined.
- The recommended water regimes for wetlands are complex. They comprise a range of water level thresholds with a range of frequencies, timings and durations. These requirements can vary according to seasonal conditions (e.g. a wet year or a dry year) and according to ecological responses (e.g. to sustain waterbird breeding if it occurs). Consequently it can be difficult to determine what the water requirement is in a given year and difficult to assess if it is met. It is recommended that a simpler and more specific indicator of water regime compliance is used.
- A water regime represents a pattern of flooding over a long period of time. It may include events that happen only once every ten years. To confidently assess the frequencies of events, particularly rare events, several decades of data will be required. It is not possible to assess long term frequencies in a ten year time frame.
- A more specific and measurable target could be to assess if the minimum inundation frequency and maximum inundation intervals have been met.

An alternative wording is proposed:
At least 50% of environmental watering events in these assets over a ten year period are delivered via channels that provide hydraulic connectivity to the source waterway.
Other Target 1
Other Target 1 addresses the LTWP objective to "maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation " in the Wimmera Mallee WRPA. The target is:

Salinity targets for the Wimmera River at Horsham Weir (end of valley target) met 100% of the time.
The Murray-Darling Basin Salinity Management Strategy sets end-of-valley salinity targets for major anabranches. The salinity targets are presented in Schedule B of BSMS2030 (Murray-Darling Basin Ministerial Council, 2015). The salinity target for the Wimmera River is:

- Median 1,380 EC
- Peak (eightieth percentile) 1,720 EC

The AWRC Site Number is 415200.
End of valley salinity targets are assessed over a benchmark period. The valley report cards calculate compliance over a financial year.
There are difficulties with the wording of this target.

- The target does not specify a compliance period over which the median and eightieth percentile will be calculated. Because the end of valley targets are based on percentiles, salinity values can temporarily exceed the EC threshold as long as the median or eightieth percentile is lower over the compliance period.

It is recommended that this target is clarified to read:
End-of-valley salinity targets for the Wimmera River at Horsham Weir of median 1,380 EC and eightieth percentile 1,720 EC are met in every year in the ten years to 2025.

Other Targets 2, 3

Other Targets 2 and 3 addresses the LTWP objective to "maintain species richness of frog communities" in the Northern Victorian WRPA and Victorian Murray LTWP, respectively. Both targets are:
Maintain the number of native frog species recorded in 80% of years to 2025.
There are difficulties with the wording of this target.

- The target does not specify how the baseline frog diversity is defined. This could be the number of species observed in 2015 using a specified method. A difficulty here is that 2015 may not be a representative year to observe frogs. Alternatively the baseline could be the number of species observed over several years preceding 2015 from a range of sources. A difficulty with this approach is it could include more frog species than a single standardised method can detect.
- It would be less ambiguous to say that the number of species must not be less than the threshold in eight of the ten years to 2025.
- The number of observed species can increase with survey effort. It is important that a consistent method is used.

An alternative wording is proposed:
The number of frog species observed in eight in a ten year period must be more than 75% of the highest diversity recorded in any one year.

Appendix E. Priority environmental asset goals and objectives

The information in Table 27 presents some of the key planning information collated from the EWMPs for the relevant priority environmental assets in the Victorian Murray water resource plan area. This information can also be extracted from the MDBA Environmental Assets and Functions Database (MDBA, 2021) which collates data from relevant Victorian Murray EWMPs. Note that this information is only intended to provide an indication of the level of planning undertaken by catchment management authorities for these sites. Please refer to the individual EWMP for full information on the relevant site. All Victorian Basin Plan EWMPs are available at https://www.water.vic.gov.au/waterways-and-catchments/rivers-estuaries-and-waterways/environmental-water/environmental-water-management-plans.

Table 27: Environmental objectives for priority environmental assets in the Victorian Murray water resource plan area

Asset Name	Basin Plan Theme	Objectives
Barmah Forest, including Tullah Creek	Fish	Fa: Promote successful recruitment of native fish species by improving flow variability in spring and early summer to replicate natural cues, and by inundation of floodplain and wetland areas to provide breeding and nursery habitat.
	Other Fauna	OFN: Provide high quality feeding, breeding and nursery habitat for native frogs, turtles and crayfish by: Facilitate successful breeding and feeding opportunities for native frog species by seasonal inundation of selected floodplain and wetland areas for
	Vegetation	Va. Promote healthy and diverse vegetation communities, with an emphasis on restoring natural extent and distribution of giant rush in at least 55% of the Barmah–Millewa icon site.
	Vegetation	Vb. Promote healthy and diverse vegetation communities, with an emphasis on restoring natural extent and distribution of moira grass in at least 55% of the Barmah–Millewa icon site.
	Vegetation	Vc. Promote healthy and diverse vegetation communities, with an emphasis on restoring natural extent and distribution of river red gum forest in at
		least 55% of the Barmah–Millewa icon site.
	Vegetation	Vd. Promote healthy and diverse vegetation communities, with an emphasis on restoring natural extent and distribution of river red gum woodland in at least 55% of the Barmah–Millewa icon site.
	Vegetation	Ve. Promote healthy and diverse vegetation communities, with an emphasis on restoring natural extent and distribution of blackbox woodland in at least 55% of the Barmah–Millewa icon site.
	Waterbirds	Wba. Promote and/or sustain successful breeding events for thousands of colonial and migratory waterbirds in at least 3 years in 10 by inundating selected floodplain and wetland areas to provide suitable nesting and feeding habitat.
Belsar and Yungera Islands	Vegetation	Improve River Red Gum health
	Vegetation	Improve tree recruitment on floodplain
	Vegetation	Increase understorey productivity

	Fish	Improve fish passage in Narcooyia Creek
	Waterbirds	Improve nesting habitat in flooded trees bordering creeks and Lakes
Black Swamp	Vegetation	Reduce the cover and diversity of exotic flora species.
	Vegetation	Improve the diversity of native wetland flora species consistent with red gum wwamp EVC benchmarks
	Waterbirds	Provide opportunities for waterbird breeding and feeding at least five in every ten years
	Other Fauna	Provide opportunities for native frog breeding at least five in every ten years.
Bottle Bend	Waterbirds	Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment.
	Vegetation	Promote a diverse aquatic macrophyte zone
	Other Fauna	Provide seasonal aquatic habitat that supports a diverse frog population
	Vegetation	Support the health of the fringing riverine chenopod woodland
Bridge creek (Piambie WMU)	Vegetation	Maintain vegetation health and structure in the fringing river red gum communities (EVCs 106, 809, 813, 818, 823)
	Vegetation	Improve vegetation health and structure in the river red gum communities (EVCs 106, 295, 809, 813, 818, 823)
	Vegetation	Improve vegetation health and structure in the black box communities (EVCs 103, 813, 818, 823)
	Vegetation	Improve vegetation health and structure in the lignum communities (EVCs 104, 813, 818, 823)
	Vegetation	Increase aquatic macrophyte diversity and area in the freshwater marsh habitats (EVCs 200, 810, 811)
	Vegetation	Maintain vegetation health and structure in the fringing river red gum communities (EVCs 106, 809, 813, 818, 823)
	Ecosystem Processes	Increase dissolved organic matter, particulate matter and macroinvertebrate productivity (Ecological objective met by other hydrological objectives)
	Ecosystem Processes	Increase aquatic macrophyte diversity and area in the freshwater marsh habitats (EVCs 200, 810, 811)
Broken Creek	Other	G1-1: Entrain and transport fine sediment that has accumulated in pools
	Vegetation	V1-1: Dry riparian zone and provide suitable conditions for flood tolerant rather than flood dependent riparian species
	Vegetation	V1-2: Variable water levels result in wet-dry zone at channel edge
	Vegetation	V1-3: Growing opportunity for Water Ribbons.
	Vegetation	V1-4: Transport seed, prepare soil, reduce competition for river red gum seedlings. Irrigate juveniles and sapling away from river channel.
	Fish	F1-1: Promote spawning by low flow specialist; Provide conditions that are unfavorable for exotic species
	Fish	F1-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events.

Fish	F1-3: Provide opportunities for dispersal
Water Quality	W1-1: Maintain aquatic habitats during periods of cease to flow – consistent with patterns from storm events
Water Quality	W1-2: Flush and replenish residual pools
Macroinvertebrate	M1-1: Promote successional change in community composition through disturbance
Macroinvertebrate	M1-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from natural storm events
Macroinvertebrate	M1-3: Movement of bed material to restore habitat diversity; Provide flow variability to generate a diversity of edge habitats
Macroinvertebrate	M1-4: Inundate accumulated organic matter in areas exposed during low flow/cease-to-flow
Other	G2-1: Entrain and transport fine sediment that has accumulated in pools
Vegetation	V2-1: Variable water levels result in wet-dry zone at channel edge
Vegetation	V2-2: Variable water levels result in wet-dry zone at channel edge
Vegetation	V2-3: Inundate wetlands (e.g. Moodies Swamp) connected at bankfull flow
Fish	F2-1: Promote spawning by low flow specialist; Provide conditions that are unfavorable for exotic species
Fish	F2-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
Fish	F2-3: Provide opportunities for dispersal
Water Quality	W2-1: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
Water Quality	W2-2: Flush and replenish residual pools
Macroinvertebrate	M2-1: Promote successional change in community composition through disturbance
Macroinvertebrate	M2-2: Maintain aquatic habitats during periods cease-to-flow – consistent with patterns from natural storm events
Macroinvertebrate	M2-3: Movement of bed material to restore habitat diversity; Provide flow variability to generate a diversity of edge habitats
Macroinvertebrate	M2-4: Inundate accumulated organic matter in areas exposed during low flow/cease-to-flow
Other	G3-1: Entrain and transport fine sediment that has accumulated in pools
Vegetation	V3-1: Variable water levels result in wet-dry zone at channel edge
Vegetation	V3-2: Variable water levels result in development of wet-dry zone at channel edge
Fish	F3-1: Promote spawning by low flow specialist; Provide conditions that are unfavorable for exotic species
Fish	F3-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
Fish	F3-3: Provide opportunities for dispersal
Water Quality	W3-1: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events

	Water Quality	W3-2: Flush and replenish residual pools
	Macroinvertebrate	M3-1: Promote successional change in community composition through disturbance
	Macroinvertebrate	M3-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from natural storm events
	Macroinvertebrate	M3-3: Movement of bed material to restore habitat diversity; Provide flow variability to generate a diversity of edge habitats
	Macroinvertebrate	M3-4: Inundate accumulated organic matter in areas exposed during low flow/cease-to-flow
	Other	G4-1: Entrain and transport fine sediment that has accumulated in pools
	Vegetation	V4-1: Prevents establishment of in-channel or nuisance terrestrial vegetation
	Vegetation	V4-2: Provides disturbance that prevents persistence of terrestrial and ephemeral plants
	Fish	F4-1: Promote spawning by low flow specialists; Provide conditions that are unfavorable for exotic species
	Fish	F4-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
	Fish	F4-3: Provide opportunities for dispersal
	Water Quality	W4-1: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
	Water Quality	W4-2: Flush and replenish residual pools
	Macroinvertebrate	M4-1: Promote successional change in community composition through disturbance
	Macroinvertebrate	M4-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from natural storm events
	Macroinvertebrate	M4-3: Movement of bed material to maintain habitat diversity; Provide flow variability to generate a diversity of edge habitats
	Macroinvertebrate	M4-4: Inundate accumulated organic matter in areas exposed during low/cease-to-flow
	Other	G5-1: Entrain and transport fine sediment that has accumulated in pools
	Vegetation	V5-1: Variable water levels result in development of wet-dry zone at channel edge
	Vegetation	V5-2: Variable water levels result in wet-dry zone at channel edge
	Vegetation	V5-3: Inundate wetlands connected at bankfull
	Fish	F5-1: Promote spawning by low flow specialists; Provide conditions that are unfavorable for exotic species
	Fish	F5-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
	Fish	F5-3: Provide opportunities for dispersal
	Water Quality	W5-1: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
	Water Quality	W5-2: Flush and replenish residual pools
	Macroinvertebrate	M5-1: Promote successional change in community composition through disturbance

	Macroinvertebrate	M5-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from natural storm events
	Macroinvertebrate	M5-3: Movement of bed material to maintain habitat diversity; Provide flow variability to generate a diversity of edge habitats
	Macroinvertebrate	M5-4: Inundate accumulated organic matter in areas exposed during low flow/cease-to-flow
	Other	G6-1: Entrain and transport fine sediment that has accumulated in pools
	Vegetation	V6-1: Variable water levels result in development of wet-dry zone at channel edge
	Vegetation	V6-2: Variable water levels result in wet-dry zone at channel edge
	Vegetation	V6-3: Inundate benches within the channel
	Water Quality	W6-1: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
	Water Quality	W6-2: Flush and replenish residual tool
	Macroinvertebrate	M6-1: Promote successional change in community composition through disturbance
	Macroinvertebrate	M6-2: Maintain aquatic habitats during periods of cease-to-flow – consistent with patterns from storm events
	Macroinvertebrate	M6-3: Movement of bed material to restore habitat diversity; Provide flow variability to generate a diversity of edge habitats
	Macroinvertebrate	M6-4: Inundate accumulated organic matter in areas exposed during low flow/cease-to-flow
	Fish	Ensure persistence of aquatic habitats during migration and breeding seasons particularly for Murray Cod.
	Fish	Supply sufficient flow to operate the fishways and provide fish access to appropriate habitat all year.
	Longitudinal Connectivity	Restore a more natural flood regime to Black and Purdies Swamps
	Water Quality	Dissolved oxygen levels maintained above 5 mg/L
	Other	Reduced azolla and algal blooms and dissolved oxygen levels maintained above 5 mg/L
Bumbang Island	Vegetation	Increased woodland and shrubland diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 106, 295, 811, 818
	Water Quality	Increased dissolved organic matter, particulate matter and macroinvertebrate productivity
	Other	Increased biofilm production and diversity
	Vegetation	Increased aquatic macrophyte diversity and area
	Fish	Increased small-bodied fish (e.g. Gudgeon spp., Murray-Darling Rainbowfish) diversity and abundance through improved conditions for recruitment, maintenance and movement
	Fish	Improved conditions for recruitment, maintenance and movement of Freshwater Catfish and other large-bodied native fish
	Waterbirds	Increase in waterfowl, shoreline foraging waterbirds and small wader diversity and abundance through improved conditions for foraging, nesting and recruitment

	Waterbirds	Maintenance of piscivorous waterbirds diversity and abundance
Burra Creek floodplain	Vegetation	Improve vegetation health and structure in the fringing Lignum, Black Box and Red Gum
	Vegetation	Promotion of seasonal emergent and semi-emergent macrophytes
	Longitudinal Connectivity	Reinstate seasonal connectivity along Burra Creek, wetlands and the floodplain in the target area
Cardross Lakes	Fish	Maintain Murray hardyhead populations: As a critically endangered (DEPI) species the downward trend in Murray hardyhead populations across Victoria must be stopped as a first priority.
	Fish	Improve Murray hardyhead populations: An improvement in the Murray Hardyhead numbers at these sites is the next required progression towards ensuring the persistence and recovery of this species. An increase in numbers will also allow harvesting of individuals
	Vegetation	Maintain Ruppia community: Maintaining and improving the health of Ruppia communities is of particular significance for Murray hardyhead but will also benefit other aquatic fauna, frogs and waterbirds through increased habitat and foraging opportunities.
	Vegetation	Improve Ruppia community: An improvement in Ruppia is the next required progression towards increasing habitat for Murray hardyhead and other aquatic fauna at these sites. Ruppia could also be harvested for translocation to other sites if these population
Carina Bend	Vegetation	Support the health of mature River Red Gum trees along the wetland perimeter.
	Fish	Provide seasonal aquatic habitat that supports a diverse population of native fish.
	Other Fauna	Provide seasonal aquatic habitat that supports a diverse population of native frog
	Waterbirds	Reliable nesting and feeding habitat for waterfowl in winter and spring.
	Vegetation	Diverse macrophyte and frog population supported by healthy Lignum Swampy Woodland vegetation.
	Other Fauna	Diverse macrophyte and frog population supported by healthy Lignum Swampy Woodland vegetation.
Chaffey and Johnstons	Vegetation	Preserve remnant old River Red Gum along the riverfront
	Vegetation	Improve health of River Red Gum communities
	Vegetation	Promote recruitment of River Red Gums
	Vegetation	Preserve extent of Black Box communities
	Vegetation	Improve health of Black Box communities
	Vegetation	Promote recruitment of Black Box
Gunbower Creek	Waterbirds	3c. Provide waterbird foraging, grazing and nesting habitat through provision of aquatic habitat in winter and spring with exposure of herblands and mud flats over summer and autumn
	Waterbirds	3d. Provide nesting habitat for colonial nesting waterbirds in spring
	Fish	4a. Provide minimum depth for fish habitat

Fish	4b. Maintain low nutrient and moderate DO
Fish	4c. Permanent deep water refuges in lagoons
Fish	4d. Provide conditions suitable for reproduction
Fish	4e. Provide conditions which initiate fish spawning
Fish	4f. Provide local fish passage
Fish	4g. Limit within-day water level fall rate
Longitudinal Connectivity	1a. Movement of sand bed material to maintain bed morphological and hydraulic diversity
Water Quality	1b. Scour sediments from base of pools to maintain quantity and quality of pool habitat
Longitudinal Connectivity	1c. Maintain stable channel bank form
Other	1d. Reduce rates of bank erosion
Longitudinal Connectivity	1e. Scour sediment accumulations from weir pools and maintain downstream sediment transport processes
Vegetation	2a. Promote colonisation of emergent macrophytes and semi-emergent macrophytes over a wide proportion of the shallow benches. Promote colonisation of mud flats by herbland species.
Vegetation	2b. Maintain a flushed zone in the soil at the perimeter of the creek to maintain the health of riparian trees
Vegetation	2c. Provide dry periods to control growth of willow, parrot feather, arrowhead and yellow water-lily
Other Fauna	3a. Maintain gently sloping shallow banks to provide passage for nesting turtles
Other Fauna	3b. Permanent deep water refuges (in-channel)
Fish	1.1 Increase the abundance and improve age class distribution of small and large-bodied native fish species
Fish	1.2 Increase connectivity to promote movement/migration of native fish species within the lagoons, floodplain and Murray River
Fish	1.3 Rehabilitate populations of native fish species that are poorly represented or absent in the system
Vegetation	2.1 Increase littoral and aquatic vegetation extent, diversity and productivity
Other Fauna	2.2 Increase the size of the resident breeding population of platypus
Other Fauna	2.3 Maintain feeding and breeding opportunities for turtles
Waterbirds	2.4 Maintain feeding and opportunistic breeding conditions for a diversity of waterbirds
Other Fauna	2.5 Maintain feeding and breeding opportunities for frogs

Gunbower Forest (TLM Icon site)	Vegetation	Va. 80% of permanent and semipermanent wetlands in healthy condition
	Vegetation	Vb. 30% of river red gum forest in healthy condition
	Waterbirds	Wba. Successful breeding of thousands of colonial waterbirds at least 3 years in 10
	Fish	Fa. Healthy populations of resident native fish in wetlands
Hattah Lakes (TLM Icon site)	Longitudinal Connectivity	OT. Restore a mosaic of hydrological regimes, which represent pre-regulation conditions (to maximise biodiversity)
	Vegetation	Va. Maintain and, where practical, restore the ecological character of the Ramsar site with respect to the Strategic Management Plan (2003)
	Vegetation	Vb. Restore the macrophyte zone around at least 50% of the lakes to increase fish and bird habitat
	Vegetation	Vc. Improve the quality and extent of deep freshwater meadow and permanent open freshwater wetlands so that species typical of these ecosystems are represented
	Fish	Fa. Increase distribution, number and recruitment of local wetland fish—including hardyhead, Australian smelt and gudgeon by providing appropriately managed habitat
	Fish	Fb. Maximise use of floodplain habitat for recruitment of all indigenous freshwater fish
	Waterbirds	Wba. Maintain habitat for the freckled duck, grey falcon and white-bellied sea-eagle in accordance with action statements
	Waterbirds	WBb. Increase successful breeding events for colonial waterbirds to at least two years in 10 (including spoonbills, egrets, night herons and bitterns)
	Waterbirds	WBc. Provide suitable habitat for a range of migratory bird species (including Latham's snipe, red-necked stint and sharp-tailed sandpiper)
Heywood's Lake	Vegetation	Maintain Black Box Woodland diversity and productivity - Heywood's Lake and Little Heywood's Lake
	Vegetation	Promote diverse aquatic macrophyte zones - Heywood's Lake
	Waterbirds	Provide open water habitat to encourage diversity and abundance of deep water foraging and piscivorous waterbirds - Heywood's Lake
	Waterbirds	Provide shallow water habitat that supports foraging, nesting and recruitment of dabbling ducks and large and small waders - Heywood's Lake and Little Heywood's Lake.
	Water Quality	Encourage a productive aquatic ecosystem through the release of nutrients and organic matter from the sediments and decomposition of inundated terrestrial vegetation through inundation of the wetlands following a dry phase - Heywood's Lake and Little Heywood
Hird Swamp	Vegetation	Restore wetland macrophyte plant community during watering events, and ensure successful reproduction through viable seeds and propagules for subsequent watering events - Hird Swamp west
	Waterbirds	Maintain open waterbird habitats at current extent through wetland - Hird Swamp west
	Vegetation	Reduce current extent and density of Phragmites australis and Typha sp., ensuring it does not encroach on other ecological values - Hird Swamp west

	Vegetation	Restore wetland macrophyte plant community during watering events, and ensure successful reproduction through viable seeds and propagules for subsequent watering events- Hird Swamp east
	Vegetation	Maintain biota typical of lignum and chenopod woodland - Hird Swamp east
Johnson Swamp	Vegetation	Reduce extent of cumbungi in tall marsh (EVC 821) by twenty percent at Johnson Swamp west by 2025: Corresponding increase in extent of Aquatic Herbland (EVC 653); Reduce density of common reed in Tall Marsh (EVC 821).
	Vegetation	Rehabilitate Intermittent Swampy Woodland (EVC 813) and Lignum Swampy Woodland (EVC 823) at Johnson Swamp West and East by 2025: 2.1 Improve condition of lignum fringing vegetation; 2.2 Improve condition of existing river red gum and facilitate recruitment
	Waterbirds	Maintain all waterbird feeding guilds, a waterbird species richness between 30 and 50 species and abundance levels in the thousands per month between October to January at Johnson Swamp, in three out of four targeted surveys over any 10 year period
	Waterbirds	Increase, or facilitate, breeding opportunities for waterbirds at Johnson Swamp through environmental water management by either: - Providing improved habitat conditions for breeding (achieved through vegetation objectives 1 and 2); or - Prolonging flood
	Longitudinal Connectivity	Create through flow conditions by rehabilitating lateral connectivity between wetland and Pyramid Creek
Karadoc Swamp	Vegetation	Support the health of mature black box along Inlet Creek
	Fish	Provide seasonal aquatic habitat that supports a diverse population of native fish and frogs
	Vegetation	Productive and healthy lignum swampy woodland vegetation community
	Waterbirds	Provide suitable feeding and breeding habitat for various waterbird guilds
	Ecosystem Processes	Maintain high levels of aquatic productivity
King's Billabong	Wetland-related	Increase diversity of macrophytes, especially emergent macrophytes
	Vegetation	Reduce the abundance or dominance of Vallisneria
	Ecosystem Processes	Increase abundance and diversity of zooplankton and macro- invertebrates
	Other Fauna	Increase breeding opportunities for frogs, including *Litoria raniformis* (growling grass frog)
	Fish	Increase abundance and diversity of small bodied native fish
	Fish	Maintain self-sustaining population structure of *Tandanus tandanus* (freshwater catfish) and increase abundance.
	Waterbirds	Increase foraging habitat for shore birds
	Waterbirds	Maintain aquatic refuge for water dependent birds
	Waterbirds	Maintain a variety of habitat types for waterbird species diversity

Kinnairds Swamp	Vegetation	Improve the diversity of native wetland flora species to be consistent with Red Gum Swamp and Plains Grassy Wetland EVC benchmarks (Refer to Appendix 9)
	Vegetation	Reduce the cover and diversity of exotic and/ or highly invasive native flora species.
	Vegetation	Maintain populations of rigid water-milfoil and slender water-milfoil (This objective is included although watering regimes and ecological information for both species is not known well enough to include specific requirements)
	Other Fauna	Maintain or increase the diversity and abundance of frog species supported by the wetland during flood events (Refer to appendix 10)
	Waterbirds	Provide opportunities for waterbird breeding especially royal spoonbills and Australasian shoveler during flood events.
	Waterbirds	Provide feeding habitat for significant waterbird species such as the eastern great egret, magpie goose, brolga, glossy ibis, Latham's snipe and whiskered tern.
Lake Cullen	Vegetation	Maintain submerged aquatic species typical of a saline wetland (e.g. Ruppia spp., Lepilaena spp. and Potamogeton spp.).
	Vegetation	Maintain Black box communities surrounding the wetland and promote regeneration of species typical of Black Box communities (see note)
Lake Elizabeth	Vegetation	Maintain/ reinstate submerged aquatics (i.e. Large-fruit Sea Tassel, Stonewort and Long-fruit Water-mat): Provision of habitat and food sources for waterbird species; Provision of vegetation seed source for on-going recruitment; Key primary producer
	Vegetation	Restore and maintain (expansion) of chenopod shrubland from the littoral zones to wetland margins: Habitat and food source (fruits) for waterbirds and waders; Improves soil condition and structure for micro-organisms and invertebrates
	Vegetation	Restore littoral zone of wetland
		:Open water and mudflat habitat for waterbirds; seed germination and recruitment
	Waterbirds	Restore breeding of waterbirds: Linked to habitat objectives; Records of Australian pelican, blue-billed duck and black swan breeding at Lake Elizabeth
	Waterbirds	Restore feeding opportunities (food source for waterbirds): Linked to habitat objectives; Vegetation supports high abundance of invertebrates as a food source for waterbirds
	Macroinvertebrate	Restore diversity and abundance of invertebrates: Linked to habitat objectives; Vegetation supports high abundance of invertebrates as a food source for waterbirds
	Fish	Maintain and support breeding of Murray Hardyhead
	Ecosystem Processes	Maintain salinity within 25,000 to 40,000 EC
		: Linked to water dependent habitat objectives; Promotes high productivity for waterbirds
Lake Murphy	Waterbirds	Rehabilitate feeding opportunities for a diversity of waterbirds
	Waterbirds	Maintain opportunistic breeding of waterbirds
	Macroinvertebrate	Rehabilitate habitat for frog and macroinvertebrate populations

	Ecosystem Processes	Maintain open water and associated mudflat habitat
	Vegetation	Rehabilitate the existing amphibious herb assemblage associated with brackish aquatic herbland, brackish lakebed herbland, freshwater Lake Aggregate, and dwarf floating aquatic herbland EVCs (see note)
	Vegetation	Maintain emergent vegetation at the outfall and littoral zone
	Vegetation	Rehabilitate the tangled lignum (*Duma florulenta*) habitat
	Vegetation	Maintain the existing black box (E*. largiflorens*) overstorey and provide conditions to promote recruitment, where possible.
Lakes Hawthorn and Ranfurly	Vegetation	Reintroduce saline marsh habitat, particularly benthic herblands including ruppia beds.
	Waterbirds	Provide suitable wading, feeding, foraging and loafing habitat for shorebirds
Lindsay, Wallpolla, Mulcra Islands (TLM Icon site)	Vegetation	V1. Provide a diversity of structural aquatic habitats
	Vegetation	V2. Increase diversity and abundance of wetland aquatic vegetation
	Vegetation	V3. Maintain and improve the populations of threatened flora and fauna that are flow-dependent
	Vegetation	V4. Restore productivity linkages between the river and floodplain habitats.
	Fish	F1. Increase abundance, diversity and extent of distribution of native fish
	Waterbirds	WB1. Provide occasional breeding and roosting habitat for colonial waterbirds
	Waterbirds	WB2. Provide habitat suitable for migratory birds, especially species listed under the JAMBA, CAMBA and RoKAMBA
Loddon River (lower)	Fish	Operate fishways, maintain connectivity and habitat for fish, platypus and turtles Maintain and promote fringing vegetation along lower banks
	Fish	Trigger and facilitate fish movement
	Vegetation	Maintain and promote
		fringing vegetation along lower banks
	Other Fauna	Habitat for platypus and turtles
Margooya Lagoon	Vegetation	Maintain and enhance the condition of river red gum with chenopod understorey.
	Vegetation	Maintain and enhance the condition of river red gum with flood tolerant understorey (littoral RRG).
	Fish	Provide nursery habitat for silver and golden perch
	Fish	Exclude large-bodied carp from the wetland and provide habitat for small-bodied fish
	Other Fauna	Provide periodic frog habitat
	Other Fauna	Provide periodic habitat for growling grass frog

	Waterbirds	Provide periodic habitat for waterbirds – piscivores, deep water foragers
	Waterbirds	Provide periodic habitat for waterbirds – dabbling ducks, grazing waterfowl, waders
	Vegetation	Provide conditions to enhance littoral vegetation zones – broad and diverse
	Ecosystem Processes	Introduce a periodic drying phase to promote nutrient cycling
McDonalds Swamp	Waterbirds	Maintain foraging and feeding areas for a diversity of waterbirds.
	Waterbirds	Support opportunistic breeding events for waterbirds.
	Other Fauna	Maintain a diverse frog community by providing access to suitable habitat and food sources.
	Ecosystem Processes	Maintain open water and mudflat habitat and associated herbaceous aquatic and amphibious species in sections of the wetland.
	Vegetation	Maintain marsh habitat and associated sedges, rushes and reeds, keeping the extent of Typha and Phragmites to no more than 40% of the wetland extent.
	Vegetation	Rehabilitate the extent of River Red Gum canopy and associated understorey (appropriate for Intermittent Swampy Woodland): Maintain canopy health of existing trees; Provide opportunities for recruitment of river red gum and understorey species
Merbein Common	Fish	Diverse large and small bodied native fish community: Cowanna and Catfish wetland areas
	Waterbirds	Provide productive feeding habitat for large wading birds: Cowanna and Catfish wetland areas
	Ecosystem Processes	Maintain high levels of aquatic productivity: Cowanna, Catfish and Brickworks Billabong wetland areas
	Vegetation	Extensive submerged aquatic macrophytes such as Potomegeton spp. And emergent macrophyte community: Cowanna and catfish wetland areas
	Vegetation	Diverse fringing emergent macrophyte community over a broad littoral zone: Cowanna and catfish wetlands
	Waterbirds	Inundate Intermittent Swampy Woodland vegetation to provide foraging and resting habitat for large waders: catfish wetland
	Fish	Self-sustaining Murray Hardyhead population: Brickworks Billabong wetland area
	Vegetation	Extensive beds of ruppia spp. In wetland: Brickworks Billabong wetland area
	Waterbirds	Provide shallow water habitat and exposure of mudflats to support foraging and resting of small waders: Brickworks Billabong wetland area
Murray floodplain between Lake Hume and Lake Mulwala	Wetland-related	Rehabilitate cut-off meanders and floodplain depressions inundated at flows <25,000 ML/d by introducing a more variable water level regime with inundation in winter/spring and a period of draw down, preferably in summer / autumn
	Wetland-related	Rehabilitate cut-off meanders and floodplain depressions inundated at flows >25,000 ML/d by implementing a seasonally variable regime that inundates cut-off meanders during winter and spring and allows summer and autumn draw down a
	Wetland-related	Rehabilitate flood runners inundated at flows <25,000 ML/d by introducing a more variable flow

		regime that provides a period of low flow, preferably in summer / autumn
	Wetland-related	Rehabilitate flood runners engaged at flows >25,000 ML/d by implementing a seasonally
		variable flow regime that engages flood runners during winter and spring
	Wetland-related	Rehabilitate shedding floodplains by introducing a seasonally variable inundation regime with a
		range of inundation recurrence intervals from annual through once every 3-5 years
Murray River – Lock 6-10	Ecosystem Processes	Maintain aquatic habitat and provide refuge for a range of aquatic fauna species
	Vegetation	Promote aquatic fauna associated with fast flowing habitat
	Other	Support migration and spawning of aquatic fauna dependent on spring freshes
	Other	Promote productivity of riparian habitat
	Vegetation	Maintain a vegetation structure with open water, emergent macrophytes and fringing woodland vegetation
	Fish	Provide habitat for wetland specialist species including small-bodied native fish and growling grass frog
	Waterbirds	Provide annual breeding opportunities for waterbirds
	Waterbirds	Frequently provide feeding and nesting habitat for waterbirds
	Ecosystem Processes	Contribute to the carbon requirements of the Murray River channel ecosystem
	Other Fauna	Protect and restore floodplain productivity to maintain resident populations of
		vertebrate fauna including carpet python, insectivorous bats and Giles' Planigale
	Waterbirds	Provide reliable breeding habitat for waterbirds, including colonial nesting species
Murray River – Lock15	Ecosystem Processes	Maintain aquatic habitat and provide refuge for a range of aquatic fauna species
	Ecosystem Processes	Improve the productivity of connected riparian zones and wetlands
	Fish	Maintain resident populations of frogs and small fish in wetlands
	Waterbirds	Provide reliable breeding habitat for waterbirds, including colonial nesting species
	Waterbirds	Frequently provide feeding habitat for thousands of waterbirds
	Wetland-related	Restore floodplain productivity to maintain resident populations of vertebrate fauna including carpet python and insectivorous bats
	Ecosystem Processes	Contribute to the carbon requirements of the Murray River channel ecosystem

Murrumbidgee Junction	Wetland-related	Maintain a healthy and productive wetland woodland mosaic (particularly EVCs 809, 810,818, 200) - Bidgee Lagoons (Narrung Wetlands).
	Vegetation	Maintain mature River Red Gum which provide nesting, roosting and structural habitat for Carpet Python, White-bellied Sea-eagle, Regent Parrot and Major Mitchell's Cockatoo- Bidgee Lagoons (Narrung Wetlands)
	Vegetation	Promote a healthy and productive Lignum Shrubland (EVC 808) providing habitat for waterbird nesting and roosting - Wakool Creek
	Fish	Sustain resident populations of small-bodied native fish and opportunistic use by large-bodied native fish through maintenance of permanent pool habitat - Bidgee Lagoons (Narrung Wetlands)
	Vegetation	Promote seasonal emergent and semi emergent macrophytes - Bidgee Lagoons (Narrung Wetlands)
Neds Corner (see note)	Vegetation	Improve vegetation recruitment, diversity and productivity to meet EVC benchmarks in the Floodway Pond Herbland EVC (810) - Neds East and Woolshed Creek
	Vegetation	Maintain the health and structure of Shrubby Riverine Woodland EVC (818) to enhance habitat for terrestrial fauna and waterbirds - Neds East and Woolshed Creek
	Vegetation	Improve condition of Lignum communities (EVCs 104, 808, 813, 823) to provide nesting habitat availability and quality for waterbirds. – Neds Central
	Vegetation	Enhance habitat values in the Alluvial Plains Semi-arid Grassland (806) EVC to support terrestrial fauna – Neds Central
Nyah and Vinifera FMU (Nyah and Vinifera Forests)	Wetland-related	Nyah Park: Restore resident populations of frogs and small fish Provide seasonal feeding and reproductive opportunities for riverine fish species Restore the structure of wetland plant communities Provide reliable breeding habitat for waterbirds, including
	Wetland-related	Nyah Park: Provide reliable breeding habitat for waterbirds, including colonial nesting species Restore floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler Contribute
	Ecosystem Processes	Nyah Park: Provide reliable breeding habitat for waterbirds, including colonial nesting species Restore floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler Contribute
	Wetland-related	Vinifera Park: Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Providing seasonal feeding and reproductive opportunities for riverine fish species Provide reliable breeding habitat for waterbirds, in
	Wetland-related	Vinifera Park: Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River
	Wetland-related	Vinifera Park: Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River
	Ecosystem Processes	Vinifera Park: Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River Murray channel ecosystem Restoring floodplain productivity to maintain resident populations of vertebrate
	Fish	Nyah Park: Provide seasonal feeding and reproductive opportunities for riverine fish species, Restore the structure of wetland plant communities
Pig Swamp	Vegetation	1.1 Rehabilitate the health and distribution of sedgy riverine forest/tall marsh/open water mosaic
	Vegetation	1.2 Rehabilitate the health and distribution of river red gums

	Vegetation	2.1 Establish a diverse native-dominated plant community and ensure species complete their lifecycle to maintain a viable seedbank
	Waterbirds	3.1 Rehabilitate feeding and roosting habitat for waterbirds, including threatened species.
	Other Fauna	3.2 Provide habitat for frog populations when the wetland holds water.
	Ecosystem Processes	3.3 Ensure adequate biomass of macroinvertebrate functional feeding groups and zooplankton to support ecological processes and wetland foodwebs.
	Longitudinal Connectivity	4.1 Restore connectivity between river, floodplain and wetland.
Pound Bend	Wetland-related	Protect and improve the diversity of native wetland flora species consistent with Shallow Freshwater Marsh, Floodway Pond Herbland, and Shrubby Riverine Woodland, by increasing the understorey species diversity in Un-named 1 and Tammit Wetlands.
	Vegetation	Protect and improve the diversity of native wetland flora species consistent with Lignum Swampy Woodland and Lignum Swamps, by increasing density of Lignum in Eastern Wetlands.
	Vegetation	Maintain the health of fringing River Red Gums and facilitate longevity of River Red Gum population, as evidenced by canopy health and germination and recruitment rates.
Psyche bend lagoon and Woorlong wetland	Fish	Self-sustaining population of Murray hardyhead following translocation - Psyche Bend Lagoon
	Vegetation	Extensive beds of ruppia spp. In wetland - Psyche Bend Lagoon
	Waterbirds	Provide shallow water habitat and exposure of mudflats to support foraging and resting of small waders - Psyche and Woorlong
	Vegetation	Healthy and productive Lignum and chenopod communities - Woorlong
	Fish	Provide seasonal aquatic that supports a diverse range of small fish and frogs - Woorlong
	Vegetation	Reduce the area of Woorlong wetland dominated by reed (Phragmites and Cumbungi) communities - Woorlong
	Ecosystem Processes	Maintain high levels of aquatic productivity
Richardson's Lagoon (Baillieu's Lagoon)	Wetland-related	Maintain deep water channels through the bed of the wetland with aquatic macrophytes and maintain healthy population of native aquatic reeds and rushes around the deep channels.
	Wetland-related	Maintain Spike-sedge Wetland (EVC 819) in floodplain areas. Promote dominance of the ground layer in these areas by sedge species.
	Vegetation	Maintain eucalypt floodplain woodland (Black Box) in the areas higher in the wetland reserve.
Sandilong Creek	Vegetation	Maintain the terrestrial vegetation structure
	Vegetation	Maintain the health of black box and lignum communities
	Vegetation	Improve health of black box and lignum communities
Spences Bend (Bullock Swamp)	Vegetation	Improve Swamp and woodland diversity and productivity to meet EVC benchmarks for lignum swamp (104) and lignum swampy woodland (823) communities in Bullock Swamp north

	Vegetation	Increase woodland and shrubland diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 810, 818, 811, 813
	Vegetation	Maintain and Improve woodland, shrubland and Swamp diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 104, 808, 810, 811, 813, 818, 823 (Focus of this hydrological objective is River Red Gum)
	Longitudinal Connectivity	Reinstate seasonal connectivity between all wetlands in the target area (Ecological objective met by other hydrological objectives)
	Vegetation	Increase aquatic macrophyte diversity and area in the Freshwater marsh habitats
	Water Quality	Increase dissolved organic matter, particulate matter and macroinvertebrate productivity (Ecological objective met by other hydrological objectives)
	Fish	Improve semi-permanent saline marsh habitat for Murray hardyhead reintroduction
	Water Quality	Improve or maintain water quality (particularly salinity) to meet standards for each wetland type and key species (Ecological objective met by other hydrological objectives)
Tata Creek	Vegetation	Maintain vegetation health and structure in the red gum communities (EVCs 106, 295, 809, 811, 813, 818, 823)
	Vegetation	Maintain vegetation health and structure in the black box communities (EVCs 103, 813, 818)
	Vegetation	Promote aquatic macrophyte diversity and area in the wetland habitats (EVCs 200, 810, 811, 819, 821)
	Vegetation	Maintain vegetation health and structure in the black box communities (EVCs 103, 813, 823)
	Vegetation	Maintain vegetation health and structure in the lignum communities (EVCs 104, 813, 823)
	Ecosystem Processes	Increase dissolved organic matter, particulate matter and macroinvertebrate productivity (Ecological objective met by other hydrological objectives)
Walshes Bend	Vegetation	Increased woodland diversity and productivity (including tree health) to meet EVC bencmarks for EVCs #810 (Floodway Pond Herbland), #811 (grassy riverine forest), #813 (Intermittent Swampy Woodland) and #823 (Lignum Swampy Woodland)
	Vegetation	Increased aquatic macrophyte diversity and area
	Ecosystem Processes	Increased dissolved organic matter, particulate matter and macroinvertebrate productivity
	Ecosystem Processes	Increased biofilm production and diversity
	Fish	Increased small-bodied fish (e.g. gudgeon spp., Murray-Darling rainbowfish) diversity and abundance through improved conditions for recruitment, maintenance and movement
Wemen-Liparoo	Fish	Support seasonal habitat for small native fish - Liparoo and Liparoo East Billabongs
	Waterbirds	Provide seasonal feeding habitat for large waders and waterfowl - Liparoo and Liparoo East Billabongs

	Vegetation	Maintain a community of drought-tolerant emergent aquatic macrophytes at the wetland edge - Liparoo and Liparoo East Billabongs
	Vegetation	Healthy and productive Lignum Swampy Woodland community that supports frogs and small native fish when flooded - Liparoo Billabong – Lignum Swampy Woodland area
	Vegetation	Maintain Lignum Shrubland and provide occasional breeding events by platform building waterbirds including Ibis and Spoonbill - Liparoo Billabong – Lignum Swampy Woodland area
Wirra-Lo Wetlands	Other Fauna	1.1 Wirra-Lo Wetlands: Restore the population of EPBC listed growling grass frog (*Litoria raniformis*) at the Wirra-Lo Wetland Complex through the provision of habitat for refuge and breeding
	Waterbirds	1.2 Wirra-Lo Wetlands: To provide feeding and breeding habitat for a high diversity of waterbirds.
	Wetland-related	2.1 Wirra-Lo Wetland: Maintain/ rehabilitate appropriate seasonality and duration of wetting and drying
	Vegetation	3.1 Duck Creek North and Duck Creek South and Lignum Swamp: To increase the extent of floating, submerged and emergent aquatic vegetation associated with Aquatic Herbland (e.g. Triglochin spp., Potamogeton spp.)
	Vegetation	3.2 Duck Creek North and Duck Creek South and Lignum Swamp: To increase the longitudinal extent of emergent aquatic vegetation along Duck Creek associated with tall marsh (including Typha spp., Juncus spp. And Eleocharis spp.)
	Vegetation	3.3 Duck Creek North and Duck Creek South and Lignum Swamp: To maintain/ rehabilitate the health of adult river red gum trees (Intermittent Swampy Woodland).
	Vegetation	3.4 Duck Creek North and Duck Creek South and Lignum Swamp: To facilitate recruitment of river red gum trees (Intermittent Swampy Woodland)
	Ecosystem Processes	3.5 Duck Creek North and Duck Creek South and Lignum Swamp: To maintain open water and associated mud-flat habitat
	Vegetation	4.1 Red Gum Swamp and Emu Creek: To maintain and rehabilitate the health of adult river red gum trees (Intermittent Swampy Woodland and Lignum Swampy Woodland).
	Vegetation	4.2 Red Gum Swamp and Emu Creek: To facilitate recruitment of river red gum trees (Intermittent Swampy Woodland and Lignum Swampy Woodland)
	Vegetation	4.3 Red Gum Swamp and Emu Creek: Where feasible maintain/rehabilitate the health of black box trees (Lignum Swampy Woodland)
	Vegetation	4.4 Red Gum Swamp and Emu Creek: To maintain an appropriate extent of Tangled Lignum vegetation

Appendix F. Priority environmental asset watering requirements

Information on watering requirements for priority environmental assets is taken from the MDBA Environmental Assets and Functions Database (MDBA, 2021) which contains data from relevant Victorian Murray EWMPs. Only wetlands are included in the below table, due to complexity and volume of information.

Table 28: Watering requirements for wetland priority environmental assets in the Victorian Murray water resource plan area

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Barmah–Millewa Forest	Va and Fa: Giant rush and Native Fish; Restore the extent and distribution of healthy wetland and floodplain vegetation communities	Y	Y				4500-12000 ML/d	7-10 years in 10	7-10 months	not critical	Y	Y	Y
Barmah–Millewa Forest	Vb and Fa: Moira grass plains and Native fish; Restore the extent and distribution of healthy wetland and floodplain vegetation communities	Y	Y				12000-25000 ML/d	6-10 years in 10	5-9 months (10m max)	min 0.5 m	Y	Y	Y
Barmah–Millewa Forest	Vc and Fa: River red gum forest and Native Fish; Restore the extent and distribution of healthy wetland and floodplain vegetation communities	Y	Y				15000-35000 ML/d	4-9 years in 10	3-5 months	not critical	Y	Y	Y
Barmah–Millewa Forest	Vd and Fa: River red gum woodland and Native fish; Restore the extent and distribution of healthy wetland and floodplain vegetation communities	Y	Y				35000-55000 ML/d	3-5 years in 10	1-4 months	not critical	Y	Y	Y
Barmah–Millewa Forest	Ve and Fa: Blackbox woodland and Native fish; Restore the extent and distribution of healthy wetland and floodplain vegetation communities	Y	Y				55000-60000 ML/d	1-2 years in 10	1-3 months	not critical	Y	Y	Y
Barmah–Millewa Forest	Wba and Fa: colonial waterbird nesting and Native fish; Restore the extent and distribution of healthy wetland and floodplain vegetation communities	Y		Y			18000-30000 ML/d	3 years in 10	4 months (30gl/ 3 months, 18gl/d for 1 month)	stable-no sudden drops	Y	Y	Y

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Belsar and Yungera Islands FMU	Improve river red gum health		Y			Preferred timing of inflows: Winter/Spring		Mean frequency of events (number per 10 years): Min-2; Opt-10; Max- 10	Median duration of ponding (months): Min- 3; Opt - 5, Max - 5				
Belsar and Yungera Islands FMU	Promote tree recruitment on floodplain		Y			Preferred timing of inflows: Winter/Spring		Mean frequency of events (number per 10 years): Min-2; Opt-10; Max- 10	Median duration of ponding (months): Min- 3; Opt - 5, Max - 5				
Belsar and Yungera Islands FMU	Increase understorey productivity		Y		Y	Preferred timing of inflows: Winter/Spring		Mean frequency of events (number per 10 years): Min-2; Opt-10; Max- 10	Median duration of ponding (months): Min- 3; Opt - 5, Max - 5				
Belsar and Yungera Islands FMU	Improve fish passage in Narcooyia Creek	Y				Preferred timing of inflows: Winter/Spring		Mean frequency of events (number per 10 years): Min-2; Opt-10; Max- 10	Median duration of ponding (months): Min- 3; Opt - 5, Max - 5				
Belsar and Yungera Islands FMU	Improve nesting habitat in flooded trees bordering creeks and Lakes			Y		Preferred timing of inflows: Winter/Spring		Mean frequency of events (number per 10 years): Min-2; Opt-10; Max- 10	Median duration of ponding (months): Min- 3; Opt - 5, Max - 5				
Black Swamp	Improve the diversity of native wetland flora species consistent with red gum Swamp EVC benchmarks		Y			Preferred timing of inflows: Late Autumn – Spring/spring summer for more growth (More growth achieved for Red Gums if flooded during spring-summer)	N/A	Recommended number of events in 10 years: Min-2, Opt-5-7, Max-10	Duration of ponding (months): Min-2, Opt-6,Max-18 (Red Gums have been used as the main indicator plant for this watering regime. Red Gums should not be wet for more than two consecutive summers	variable up to 500 mm			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Black Swamp	Provide opportunities for waterbird breeding			Y		Preferred timing of inflows: Spring	N/A	Recommended number of events in 10 years: Min-3, Opt-10, Max-10	Duration of ponding (months): Min-6, Opt-6,Max-N/A	variable up to 500 mm (Filling wetland from dry based on monitoring of past environmental water deliveries to Black Swamp)			
Black Swamp	Provide key opportunities for frog breeding				Y	Preferred timing of inflows: Spring-Autumn	N/A	Recommended number of events in 10 years: Min-N/A, Opt-N/A, Max-N/A	Duration of ponding (months): Min-1, Opt-2-6,Max-N/A	variable up to 500 mm			
Bottle Bend	Promote a diverse aquatic macrophyte zone		Y			Spring - Summer		Mean freq. of events in 10 years: Min- 2, Opt-5, Max-10	Duration of ponding (months): Min-1, Opt-6, Max-12	Inundation height: 35.9 mAHD			
Bottle Bend	Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment (Provided by other objectives)			Y		N/A				Inundation height: 35.9 mAHD			
Bottle Bend	Provide seasonal aquatic habitat that supports a diverse frog population (Provided by other objectives)				Y	Spring - Summer			Duration of ponding (months): Min-3, Opt-3, Max-3	Inundation height: 35.9 mAHD			
Bottle Bend	Support the health of the fringing riverine chenopod woodland.		Y			Winter - Spring		Mean freq. of events in 10 years: Min- 1, Opt-2, Max-3	Duration of ponding (months): Min-2, Opt-4, Max-6	Inundation height: 36.3 mAHD			
Bumbang Island	See note	Y	Y	Y	Y	See note	See note	See note	See note	See note			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Burra Creek	Promote seasonal emergent and semi-emergent macrophytes		Y			Spring - Summer	N/A	Mean freq. of events in 10 years: Min- 6, Opt-9, Max-10	Duration of ponding (months): Min-1, Opt-3, Max-3	Target supply level: ~1.5 m			
Burra Creek	Improve fringing terrestrial vegetation health and structure (river red gum)		Y			Spring - Summer	N/A	Mean freq. of events in 10 years: Min- 2, Opt-3, Max-5	Duration of ponding (months): Min-2, Opt-3, Max-4	Target supply level: ~1.5 m			
Burra Creek	Improve terrestrial vegetation health and structure (box/lignum)		Y			Spring - Summer	N/A	Mean freq. of events in 10 years: Min- 1, Opt-1, Max-3	Duration of ponding (months): Min-1, Opt-1, Max-3	Target supply level: ~0.5 m			
Burra Creek	Promote seasonal emergent and semi-emergent macrophytes		Y			Spring - Summer	N/A	Mean freq. of events in 10 years: Min- 6, Opt-9, Max-10	Duration of ponding (months): Min-1, Opt-1, Max-3	Target supply level: ~2 m			
Burra Creek	Improve fringing terrestrial vegetation health and structure (river red gum)		Y			Spring - Summer	N/A	Mean freq. of events in 10 years: Min- 2, Opt-3, Max-5	Duration of ponding (months): Min-2, Opt-3, Max-4	Target supply level: ~2.5 m (wetland)			
Burra Creek	Improve terrestrial vegetation health and structure (Box/Lignum)		Y			Spring - Summer	N/A	Mean freq. of events in 10 years: Min- 1, Opt-1, Max-3	Duration of ponding (months): Min-1, Opt-1, Max-3	Target supply level: ~0.5 m (floodplain)			
Burra Creek	Reinstate seasonal connectivity along Burra Creek, wetlands and the floodplain in the target area				Y		N/A	See note	See note	See note			
Cardross Basin 1 East	Improve Murray hardyhead populations; Maintain/improve ruppia community	Y	Y			Preferred timing of inflows: Aug-Oct	N/A		3 months between August and October	Optimal high water level (late Aug -mid Dec): >38.0 m AHD			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Cardross Basin 1 West	Improve Murray hardyhead populations; Maintain/improve ruppia community	Y	Y			Preferred timing of inflows: Aug-Oct	N/A		3 months between August and October	Optimal high water level (late Aug -mid Dec): >38.5 m AHD			
Carina Bend	Expose wetland bed; Ecological objectives: Support the health of mature River Red Gum trees along the wetland perimeter, Provide seasonal aquatic habitat that supports a diverse population of native fish, Reliable nesting and feeding habitat for waterfowl	Y	Y	Y	Y	Late summer/early autumn	N/A	1:1 (once in a year)	1 to 6 in late summer/early autumn	44.7 m AHD			
Carina Bend	Littoral zone; Ecological objectives: Support the health of mature river red gum trees along the wetland perimeter, Provide seasonal aquatic habitat that supports a diverse population of native fish, Reliable nesting and feeding habitat for waterfowl in w	Y	Y	Y	Y	Late winter/early summer	N/A	1:1 (once in a year)	4 - 6 months	45.5 m AHD			
Carina Bend	Fringing river red gum; Ecological objectives: Support the health of mature river red gum trees along the wetland perimeter, Provide seasonal aquatic habitat that supports a diverse population of native fish, Reliable nesting and feeding habitat for water	Y	Y	Y	Y	Late winter/early spring	N/A	1:2 (1 in 2 years)	2 - 4 months	46.0 m AHD			
Carina Bend	Lignum wetlands; Ecological objectives: Support the health of mature river red gum trees along the wetland perimeter, Provide seasonal aquatic habitat that supports a diverse population of native fish, Reliable nesting and feeding habitat for waterfowl in	Y	Y	Y	Y	Early spring/late summer	N/A	1:4 (1 in 4 years)	3 -7 months	46.7 m AHD			

Asset Name	Rationale/Objectives	Watering Period					Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
		FISH	VEG	WBIRD	OTHER								
Gunbower Forrest TLM	Va and Fa: For Wetland communities, Fringing river red gum and Floodplain creeks.	Y	Y			Aug-Sep	100-1000 ML/day	6-9 years in 10 years	Variable (depends upon inflow rate)		Y	Y	
Gunbower Forrest TLM	Vb and Fa: For river red gum forest	Y	Y				1600 ML/day	6-7 years in 10 years	90 days		Y	Y	
Gunbower Forrest TLM	Wba and Fa: Wrt wetlands, fringing river redgums and river red gum forest	Y		Y			300 – 1,000 ML/day (following river red gum watering)	3 years in 10 years	Variable depending upon species breeding.		Y	Y	
Gunbower Forrest TLM	Va and Fa: For Wetland communities, Fringing river red gum and Floodplain creeks.	Y	Y			Aug-Sep	100-1000 ML/day	6-9 years in 10 years	Variable (depends upon inflow rate)		Y	Y	
Gunbower Forrest TLM	Va and Fa: For Wetland communities, Fringing river red gum and Floodplain creeks.	Y	Y			Aug-Sep	100-1000 ML/day	6-9 years in 10 years	Variable (depends upon inflow rate)		Y	Y	
Gunbower Forrest TLM	Vb and Fa: For River Redgum forest	Y	Y				1600 ML/day	6-7 years in 10 years	90 days		Y	Y	
Gunbower Forrest TLM	Vb and Fa: For River Redgum forest	Y	Y				1600 ML/day	6-7 years in 10 years	90 days		Y	Y	
Gunbower Forrest TLM	Wba and Fa: Wrt wetlands, fringing river redgums and river red gum forest	Y		Y			300 – 1,000 ML/day (following river red gum watering)	3 years in 10 years	Variable depending upon species breeding.		Y	Y	
Hattah Lakes	Semipermanent wetlands: OT, Va, Vb Vc hydrological regimes		Y		Y		>37,000 ML/day	6 years in 10 years	90 days		Y	Y	
Hattah Lakes	Temporary wetlands: Vc, Wba, WBb		Y	Y			>50,000 ML/day	4 years in 10 years	30 days		Y	Y	
Hattah Lakes	Episodic wetlands: WBb, WBc, Fa, Fb	Y		Y			>150,000 ML/Day	1 year in 8 years	7 days		Y	Y	

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Hattah Lakes	Fringing river red gum: OT, Va, Wba, WBb, WBc, Fb	Y	Y	Y	Y		>45,000 ML/day	4-6 years in 10 years	60 days		Y	Y	
Hattah Lakes	River red gum woodland (flood-tolerant understorey): OT, Wba, WBb, WBc, Fb	Y	Y	Y	Y		>75,000 ML/day	2-4 years in 10 years	30 days		Y	Y	
Hattah Lakes	Black box woodland: OT, WBb, Fb	Y	Y	Y	Y		>120,000 ML/day	1:3 years in 10 years	14 days		Y	Y	
Heywood's Lake	Maintain black box woodland diversity and productivity		Y			Winter - Spring		Mean frequency of events (No. per 10 years): Min- 1, Opt-2, Max- 3	Duration of ponding (months): Min-2, Opt-4, Max-6	56.8 mAHD - Haywood; 57 mAHD - Little Heywood			
Heywood's Lake	Promote diverse aquatic macrophyte zones		Y			Spring - Summer		Mean frequency of events (No. per 10 years): Min- 2, Opt-5, Max- 10	Duration of ponding (months): Min-1, Opt-6, Max-12	53.5 mAHD			
Heywood's Lake	Provide open water habitat to encourage diversity and abundance of deep water foraging and piscivorous waterbirds			Y		N/A		Mean frequency of events (No. per 10 years): Min- 2, Opt-3, Max- 3	Duration of ponding (months): Min-24	54-56.8 mAHD			
Heywood's Lake	Provide shallow water habitat that supports foraging, nesting and recruitment of dabbling ducks and large and small waders (Ecological objective met through other hydrological objectives)			Y		N/A		N/A	N/A	54 mAHD			
Heywood's Lake	Encourage a productive aquatic ecosystem through the release of nutrients and organic matter from the sediments and decomposition of inundated terrestrial vegetation through inundation of the wetlands following a dry phase (Ecological objective met through other hydrological objectives)				Y	N/A		N/A	N/A	56.8 mAHD			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Hird Swamp East	Restore wetland macrophyte plant community during watering events and ensure successful reproduction through viable seeds and propagules for subsequent watering events.		Y			Preferred timing of inflows: Spring (note: top up from the western section may be required).		Recommended frequency of events (number per 10 years): A watering frequency of one to two events per ten year period is proposed to ensure optimal drying and wetting of the seed store.	Duration of flooding (months): Duration of flooding to target recruitment of this component is 12 to 24 months. This will ensure at least one annual cycle is completed prior to drying.	Target supply level (ML / mAHD): 350			
Hird Swamp East	Maintain biota typical of lignum and chenopod woodland.		Y		Y	Spring		Recommended frequency of events (number per 10 years): One to two events every ten year period is proposed to promote vigorous of lignum.	Duration of flooding (months): Between three and seven months to achieve best growth. Continuous flooding should be avoided.	Target supply level (ML / mAHD): 350			
Hird Swamp West	r Hird Swamp east: Restore wetland macrophyte plant community during watering events and ensure successful reproduction through viable seeds and propagules for subsequent watering events.		Y		Y	Spring (note: top up from the western section may be required)		Recommended frequency of events (number per 10 years): A watering frequency of one to two events per ten year period is proposed to ensure optimal drying and wetting of the seed store.	Duration of flooding (months): Duration of flooding to target recruitment of this component is 12 to 24 months. This will ensure at least one annual cycle is completed prior to drying.				
Hird Swamp West	r Hird Swamp east: Maintain biota typical of lignum and chenopod woodland.		Y			Spring		Recommended frequency of events (number per 10 years): One to two events every ten year period is proposed to promote vigorous of lignum.	Duration of flooding (months): Between three and seven months to achieve best growth. Continuous flooding should be avoided				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Hird Swamp West	Hird Swamp west: Restore wetland macrophyte plant community during watering events and ensure successful reproduction through viable seeds and propagules for subsequent watering events.		Y			Spring		Recommended frequency of events (number per 10 years): A watering frequency of two events per ten year period is proposed to ensure optimal drying and wetting of the seed store.	Duration of flooding (months): Duration of flooding to target recruitment of this component is 24 to 30 months. This will ensure two annual cycles are completed prior to drying.				
Hird Swamp West	Hird Swamp west: Maintain open waterbird habitats at current extent through wetland.			Y		Spring		Recommended frequency of events (number per 10 years): A watering frequency of two events to permanent inundation per ten year period is proposed to ensure open water habitat is provided.	Duration of flooding (months): Duration of flooding of between 12 months and permanent inundation is recommended.				
Hird Swamp West	Hird Swamp west: Reduce current extent and density of Phragmites australis and Typha sp., ensuring it does not encroach on other ecological values.		Y			Spring		Recommended frequency of events (number per 10 years): Annual inundation will provide ideal conditions for these species. Therefore, two events per ten years is recommended to limit their spread through the wetland, but allow for existing stands to flourish	Duration of flooding (months): Duration of greater than 12 months (with depth fluctuating) should limit the spread of these species through the wetland, while providing water to the existing stands.				
Johnson Swamp	Reduce extent of cumbungi in tall marsh (EVC 821) by 20 % at Johnson Swamp west) by 2025; Management phase: Long term		Y			Preferred timing of inflows: Most often autumn/ some years in spring		Recommended number of events in 10 years: Min-2, Opt-3-4, Max-5	Duration of ponding (months): Min-2, Opt-6-8, Max-12	West: <78.15 mAHD; East: N/A			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Johnson Swamp	Rehabilitate Intermittent Swampy Woodland (EVC 813) and lignum swampy woodland (EVC 823) at Johnson Swamp West and East by 2025; Management phase: Long term – targeted for black box outcomes		Y			Preferred timing of inflows: As per natural		Recommended number of events in 10 years: Min-1, Opt-2, Max-2	Duration of ponding (months): Min-1, Opt-3, Max-6	West: 77.85-78.2 m AHD; East: <77.95			
Johnson Swamp	Rehabilitate intermittent swampy woodland (EVC 813) and lignum swampy woodland (EVC 823) at Johnson Swamp West and East by 2025: Improve condition of lignum fringing vegetation; Management phase: Short term – improve condition		Y			Preferred timing of inflows: As per natural		Recommended number of events in 10 years: Min-1, Opt-2, Max-2	Duration of ponding (months): Min-3, Opt-5, Max-7	West: 77.85-78.2 m AHD; East: <77.95			
Johnson Swamp	Rehabilitate intermittent swampy woodland (EVC 813) and lignum swampy woodland (EVC 823) at Johnson Swamp West and East by 2025: improve condition of existing river red gum and facilitate recruitment; Management phase: Short term – improve condition		Y			Preferred timing of inflows: Winter to spring.		Recommended number of events in 10 years: Min-2, Opt-4, Max-5	Duration of ponding (months): Min-2, Opt-4, Max-18	West: 77.85-78.2 m AHD; East: <77.95			
Johnson Swamp	Rehabilitate intermittent swampy Woodland (EVC 813) and lignum swampy woodland (EVC 823) at Johnson Swamp West and East by 2025: improve condition of existing river red gum and facilitate recruitment: Management phase: Long term-facilitate recruitment		Y			Preferred timing of inflows: Late spring to early summer.		Recommended number of events in 10 years: Min-2, Opt-3, Max-5 (Following up flooding may be required)	Duration of ponding (months): Min-1, Opt-2, Max-	West: 77.85-78.2 m AHD; East: <77.95			
Johnson Swamp	Rehabilitate intermittent swampy woodland (EVC 813) and lignum swampy woodland (EVC 823) at Johnson Swamp West and East by 2025: Improve condition of existing black box woodland and facilitate recruitment; Management phase: Short term –improve condition		Y			Note: Preferred timing of inflows: As per natural.		Recommended number of events in 10 years: Min-1, Opt-2, Max-2	Duration of ponding (months): Min-1, Opt-3, Max-6	West: 77.85-78.2 m AHD; East: <77.95			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Johnson Swamp	Reduce extent of cumbungi in tall marsh (EVC 821) by 20 % at Johnson Swamp west) by 2025: Corresponding increase in extent of aquatic herbland (EVC 653); Management phase: Long term facilitate recruitment		Y			Preferred timing of inflows: Most often autumn/ some years in spring		Recommended number of events in 10 years: Min-2, Opt-3-4, Max-5	Duration of ponding (months): Min-2, Opt-6-8, Max-12	West: <78.15 mAHD; East: N/A			
Johnson Swamp	Reduce extent of cumbungi in tall marsh (EVC 821) by 20 % at Johnson Swamp west) by 2025: Reduce density of Phragmites in tall marsh (EVC 821); Management phase: Long term facilitate recruitment		Y			Preferred timing of inflows: Most often autumn/ some years in spring		Recommended number of events in 10 years: Min-2, Opt-3-4, Max-5	Duration of ponding (months): Min-2, Opt-6-8, Max-12	West: <78.15 mAHD; East: N/A			
Johnson Swamp	Maintain all waterbird feeding guilds, a waterbird species richness between 30 and 50 species and abundance levels in the thousands per month between October to January at Johnson Swamp, in three out of four targeted surveys over any 10 year period			Y		See note		See note	See note	See note			
Johnson Swamp	Increase, or facilitate, breeding opportunities for waterbirds at Johnson Swamp through environmental water management by either: Providing improved habitat conditions for breeding (achieved through objectives for vegetation – see above)			Y		Preferred timing of inflows: Autumn/ winter/ spring Following species utilised as a guide: Brolga: June- Aug to commence Bittern: Oct-Feb		Breeding needs variable dependent on the species. Most species can breed most years if sufficient resources are available.	Species dependent. Following species utilised as a guide: Brolga: minimum of 2-4, optimum of 6-9 and maximum until fledging; Australasian bittern: breeding requirements are not known however assumed to need 3-8	West: >77.3 m AHD; East: >77.65 m AHD			
Johnson Swamp	Create through flow conditions by rehabilitating lateral connectivity between wetland and Pyramid Creek; Management phase: long term				Y	See note		See note	See note	See note			
Johnstons and Chaffey Bend	Preserve remnant old red gums along the riverfront and promote recruitment of red gums (i.e. germination and retention of seedlings): Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions.		Y			Preferred timing spring to summer		3 in 10 years	3 months	not specified			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Johnstons and Chaffey Bend	Preserve remnant old red gums along the riverfront and promote recruitment of Red Gums (i.e. germination and retention of seedlings): Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions.		Y			Preferred timing spring to summer		4 in 10 years	5 months	not specified			
Johnstons and Chaffey Bend	Preserve remnant old red gums along the riverfront and promote recruitment of red gums (i.e. germination and retention of seedlings): Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions.		Y			Preferred timing spring to summer		5 in 10 years	6 months	not specified			
Johnstons and Chaffey Bend	Improve health of river red gum communities: Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions. Their health is essential to maintaining a functioning floodplain and river system.		Y			Preferred timing spring to summer		4 in 10 years	3 months	not specified			
Johnstons and Chaffey Bend	Improve health of river red gum communities: Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions. Their health is essential to maintaining a functioning floodplain and river system.		Y			Preferred timing spring to summer		8 in 10 years	5 months	not specified			
Johnstons and Chaffey Bend	Improve health of river red gum communities: Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions. Their health is essential to maintaining a functioning floodplain and river system.		Y			Preferred timing spring to summer		10 in 10 years	6 months	not specified			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Johnstons and Chaffey Bend	Promote recruitment of river red gums: Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions. Their health is essential to maintaining a functioning floodplain and river system.		Y			Preferred timing: flood recession during spring or later		not specified	not specified	not specified			
Johnstons and Chaffey Bend	Promote recruitment of river red Ggums: Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions. Their health is essential to maintaining a functioning floodplain and river system.		Y			Preferred timing: flood recession during spring or later		not specified	not specified	not specified			
Johnstons and Chaffey Bend	Promote recruitment of river red gums: Remnant old red gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions. Their health is essential to maintaining a functioning floodplain and river system.		Y			Preferred timing: flood recession during spring or later		not specified	not specified	not specified			
Johnstons and Chaffey Bend	Preserve extent of black box communities: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y			Preferred timing spring to summer		1 in 10 years	2 months	not specified			
Johnstons and Chaffey Bend	Preserve extent of black box communities: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y			Preferred timing spring to summer		2 in 10 years	4 months	not specified			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Johnstons and Chaffey Bend	Preserve extent of black box communities: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y			Preferred timing spring to summer		3 in 10 years	6 months	not specified			
Johnstons and Chaffey Bend	Improve health of black box communities: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y			Preferred timing spring to summer		2 in 10 years	2 months	not specified			
Johnstons and Chaffey Bend	Improve health of black box communities: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y			Preferred timing spring to summer		3 in 10 years	4 months	not specified			
Johnstons and Chaffey Bend	Improve health of black box communities: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y			Preferred timing spring to summer		5 in 10 years	6 months	not specified			
Johnstons and Chaffey Bend	Promote recruitment of black box: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y			Preferred timing: flood recession during spring or summer		not specified	not specified	not specified			
Johnstons and Chaffey Bend	Promote recruitment of black box: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y					not specified	not specified	not specified			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Johnstons and Chaffey Bend	Promote recruitment of black box: black box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.		Y					not specified	not specified	not specified			
Karadoc Inlet Creek	Support the health of mature black box along Inlet Creek		Y			Preferred timing of inflows: Late winter/early spring		Mean frequency of events (Number per 10 years): Min-2; Opt-3 ; Max-3	Duration of ponding: Min-2; Opt-4 ; Max-6				
Karadoc Inlet Creek	Provide seasonal aquatic habitat that supports a diverse population of native fish and frogs (see note)	Y			Y	See note		See note	See note				
Karadoc Inlet Creek	Productive and healthy Lignum Swampy Woodland vegetation community		Y			Preferred timing of inflows: Late winter/early spring		Mean frequency of events (Number per 10 years): Min-3; Opt-5 ; Max-10	Duration of ponding: Min-3; Opt-5 ; Max-7				
Karadoc Inlet Creek	Provide suitable feeding habitat for various waterbird guilds (See note)			Y		See note		See note	See note				
Karadoc Inlet Creek	Maintain high levels of aquatic productivity				Y	N/A		N/A	N/A				
King's Billabong FMU	Increase diversity of macrophytes, especially emergent macrophytes				Y	Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				
King's Billabong FMU	Reduce the abundance or dominance of Vallisneria		Y			Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				
King's Billabong FMU	Increase abundance and diversity of zooplankton and macro- invertebrates				Y	Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				
King's Billabong FMU	Increase breeding opportunities for frogs, including *Litoria raniformis* (growling grass frog)				Y	Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
King's Billabong FMU	Increase abundance and diversity of small bodied native fish	Y				Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				
King's Billabong FMU	Maintain self-sustaining population structure of *Tandanus tandanus* (freshwater catfish) and increase abundance.	Y				Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				
King's Billabong FMU	Increase foraging habitat for shore birds			Y		Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				
King's Billabong FMU	Maintain aquatic refuge for water dependent birds			Y		Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				
King's Billabong FMU	Maintain a variety of habitat types for waterbird species diversity			Y		Spring		Mean frequency of events (number per 10 years): Min- 8, Opt-10, Max-10	Median duration of ponding (months): Min- 3, Opt-6, Max-12				
Kinnairds Swamp	Improve the diversity of native wetland flora species to be consistent with Red Gum Swamp EVC benchmarks (This objective is included although watering regimes and ecological information for both species is not known well enough to include specific require		Y			Late autumn-spring OR spring-summer for more growth (More growth achieved for Red Gums if flooded during spring-summer (Roberts and Marston, 2011).		Recommended no. of events in 10 years: Min-2; Opt-5-7; Max-10	Duration of ponding (months): Min-2; Opt-6; Max-18 (Red Gums have been used as the main indicator plant for this watering regime. Red Gums should not be wet for more than two consecutive summers (Barlow, 2011)	Depth: variable to 500 mm			
Kinnairds Swamp	Improve the diversity of native wetland flora species to be consistent with Plains Grassy Wetland EVC benchmarks.		Y			Late autumn-spring		Recommended no. of events in 10 years: Min-3; Opt-5-7; Max-10	Duration of ponding (months): Min-3; Opt-6; Max-9	Depth: variable to 500 mm			
Kinnairds Swamp	Maintain populations of rigid water milfoil and slender water-milfoil.		Y			Late autumn		N/A	N/A	Depth: variable to 500 mm			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Kinnairds Swamp	Provide opportunities for waterbird breeding especially royal spoonbills and Australasian			Y		Spring (Rogers and Ralph, 2011; Young 2003)		Recommended no. of events in 10 years: Min-3; Opt-5-7; Max-10	Duration of ponding (months): Min-6; Opt-8; Max-N/A	Depth: Max of 500 mm (Water depth should be kept fairly constant if waterbirds are nesting/ breeding to avoid nests being abandoned (Young 2003).			
Kinnairds Swamp	Maintain or increase the diversity and abundance of frog species supported by the wetland during flood events.				Y	Spring-summer		N/A	Duration of ponding (months): Min-2; Opt-2-6 (ARC, 2010; Appendix 9); Max-N/A	Depth: variable to 500 mm			
Koorlong Lake	Maintain/improve Murray hardyhead populations; Maintain/improve ruppia community	Y	Y			Preferred timing of inflows: Aug-Oct	N/A		3 months between August and October	Optimal high water level (late Aug -mid Dec): >38.0 m AHD			
Lake Cullen	Maintain submerged aquatic species typical of a saline wetland (e.g. ruppia spp. and lepilaena spp.).		Y			Preferred timing of inflows: Winter / Spring		Recommended frequency of events (number per 10 years): To achieve vigorous growth of species, a watering frequency of between two and four events per ten years is proposed (ideal number is three events).	Duration of flooding (months): Duration of flooding should be 24 to 30 months to allow species to complete their lifecycle and ensure seed is available for following event/s (two full growing seasons).	Target supply level: 72 m AHD			
Lake Cullen	Maintain black box communities surrounding the wetland and promote regeneration of species typical of black box communities		Y			Preferred timing of inflows: Winter / Spring.		Recommended frequency of events (number per 10 years): To achieve vigorous growth, a watering frequency of between one and two events per ten years is recommended.	Duration of flooding (months): Duration of flooding should be between three and six months.	Target supply level: 73 m AHD			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Lake Elizabeth	Maintain/ reinstate submerged aquatics (i.e. Large-fruit Sea Tassel, Stonewort and Long-fruit Water-mat)		Y			Late winter/ early spring with top ups (slow or incremental delivery to assist with multiple germination events)		Recommended frequency of events (number per 10 years): Vigorous growth if watering frequency of between two and four events per ten years (ideal number is three events). However can persist in permanent conditions. Note: Flooding frequency and duration of	Duration of flooding: Between 24 and 48 months to ensure sufficient recruitment for current and future events	Target supply level (TSL): Based on salinity but likely to range between 73-74m AHD			
Lake Elizabeth	Restore and maintain (expansion) of chenopod shrubland from the littoral zones to wetland margins		Y			Late winter/ early spring		Variability in water level	variable	Target supply level (TSL): Based on salinity but likely to range between 73-74m AHD			
Lake Elizabeth	Restore littoral zone of wetland		Y	Y	Y	Late winter/ early spring		Variability in water level	Variable	Target supply level (TSL): Based on salinity but likely to range between 73-74m AHD			
Lake Elizabeth	Maintain and support breeding of Murray hardyhead	Y				Winter/ spring to freshen conditions during spawning		Permanent regime	Variable	Target supply level (TSL): Variable based on Figure 5 and salinity			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Lake Hawthorn	Reintroduce saline marsh habitat, particularly benthic herblands including Ruppia beds; Provide suitable wading, feeding, foraging and loafing habitat for shorebirds		Y	Y	Y	Note: Preferred timing of inflows: Spring/Summer to achieve permanent ponding (Timing of inflows is dependent on system demand and ability to deliver during low irrigation demand, which will coincide with lower irrigation drainage inflows. Environmental w		Mean frequency of events (number per 10 years): Min- 10, Opt-10, Max-10	Median duration of ponding (months): Min- 12, Opt-12, Max-12				
Lake Murphy	Rehabilitate feeding opportunities for waterbirds			Y		Preferred timing of inflows: Autumn to spring		Recommended number of events in 10 years: Min-2, Opt-3, Max-	Duration of ponding(months): Min- 4, Opt-6-8, Max-12				
Lake Murphy	Maintain opportunistic breeding of waterbirds			Y		Preferred timing of inflows: Winter/ Spring/ early summer, top up water if needed		Recommended number of events in 10 years: Min-3, Opt-4-5, Max-10	Duration of ponding(months): Min- 4, Opt-9, Max-12				
Lake Murphy	Rehabilitate frog and macro/micro invertebrate habitat				Y	Preferred timing of inflows: Winter to summer		Prefer ephemeral or semi-permanent water bodies but will retreat to permanent water bodies in drought conditions	Duration of ponding(months): Min- 3, Opt-3-6, Max-12				
Lake Murphy	Maintain open water and associated mudflat habitat				Y	Preferred timing of inflows: Late Winter/ Spring		Recommended number of events in 10 years: Min-2, Opt-4, Max-5	Duration of ponding(months): Min- 9, Opt-18, Max-24				
Lake Murphy	Rehabilitate the existing aquatic herb assemblage		Y			Preferred timing of inflows: Early Spring/ Late summer		Recommended number of events in 10 years: Min-5, Opt-6-8, Max-8	Duration of ponding(months): Min- 4, Opt-5, Max-6				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Lake Murphy	Maintain emergent vegetation at the outfall and littoral zone		Y			Preferred timing of inflows: Winter to summer		Recommended number of events in 10 years: Min-4, Opt-6-8, Max-8	Duration of ponding(months): Min- 4-6, Opt-5-9, Max-6-12				
Lake Murphy	Rehabilitate the Tangled Lignum (*Muehlenbeckia florulenta*) habitat		Y			Preferred timing of inflows: Autumn/winter (not critical)		Recommended number of events in 10 years: Min-1, Opt-2, Max-3	Duration of ponding(months): Min- up to 7, Opt-up to 7, Max-7				
Lake Murphy	Maintain the existing black box (E. largiflorens) overstorey and provide conditions to promote recruitment, where possible.		Y			Preferred timing of inflows: Late winter/ early spring		Recommended number of events in 10 years: Min-1, Opt-2, Max-3	Duration of ponding(months): Min- 2, Opt-6, Max-12				
Lindsay–Wallpolla Islands and Chowilla floodplain	Objectives V1, V2, F1; high value wetlands maintained; temporary and semi permanent wetlands	Y	Y				>30,000 ML/d	2–8 years in 10 years	2 months		Y	Y	
Lindsay–Wallpolla Islands and Chowilla floodplain	Objectives V1, V2, F1; High value wetlands maintained; Temporary wetlands semipermanent wetlands	Y	Y				>60,000 ML/d	2–8 years in 10 years	1 month		Y	Y	
Lindsay–Wallpolla Islands and Chowilla floodplain	Objectives WB1, V3; High value wetlands maintained; Lignum shrubland		Y	Y			>50,000 ML/d	5 years in 10 years	2 months		Y	Y	
Lindsay–Wallpolla Islands and Chowilla floodplain	Objective V4: High value wetlands maintained; Anabranches		Y			Aug-Dec	15,000 ML/d	8 years in 10 years	14 days (3–4 freshes/y)		Y	Y	
Lindsay–Wallpolla Islands and Chowilla floodplain	Objectives WB1, WB2; Current area of river red gum forest maintained			Y			>60,000 ML/d	7 years in 10 years	4 months		Y	Y	

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Lindsay–Wallpolla Islands and Chowilla floodplain	Objective V4; Current area of river red gum woodland maintained		Y				>80,000 ML/d	6 years in 10 years	2 months		Y	Y	
Lindsay–Wallpolla Islands and Chowilla floodplain	Objectives WB2, V4; At least 20% of the original area of black box vegetation maintained; black box woodland		Y	Y		Aug-Dec	n/a	1-2 years in 10 years	1 month		Y	Y	
Margooya Lagoon	Maintain and enhance the condition of river red gum with chenopod understorey.		Y			Preferred timing of inflows- Winter-spring		Mean frequency of events (Number per 10 years): Min-4 ; Opt-4-5 ; Max-5	Duration of Ponding (months): Min-2 ; Opt-2-8 ; Max-24	Target supply level: 48.7 m AHD			
Margooya Lagoon	Maintain and enhance the condition of river red gum with flood tolerant understorey (littoral RRG)		Y			Preferred timing of inflows- Winter-spring		Mean frequency of events (Number per 10 years): Min-4; Opt- 5-10 ; Max-10	Duration of Ponding (months): Min-2 ; Opt-2-8 ; Max-24	Target supply level (m) AHD: 47.64			
Margooya Lagoon	Provide nursery habitat for Silver and golden perch	Y				Preferred timing of inflows- Late spring – early summer		Mean frequency of events (Number per 10 years): Min-opportunistic ; Opt- ; Max-	Duration of Ponding (months): Min- <12; Opt-12 ; Max-24	Target supply level (m) AHD:≤47.64;			
Margooya Lagoon	Exclude carp from the wetland and provide habitat for small-bodied fish	Y				Preferred timing of inflows- All year		Mean frequency of events (Number per 10 years): Min-At all times – utilise carp screen; Opt- ; Max-					
Margooya Lagoon	Provide periodic frog habitat				Y	Preferred timing of inflows- Spring/summer		Mean frequency of events (Number per 10 years): Min-Opportunistic ; Opt- ; Max-	Duration of Ponding (months): Min- 3-4; Opt-7 ; Max-8	Target supply level (m) AHD: ≤47.64			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Margooya Lagoon	Provide periodic habitat for waterbirds – piscivores, deep water foragers			Y		Preferred timing of inflows- Any time of year – spring for breeding		Mean frequency of events (Number per 10 years): Min-Opportunistic ; Opt- ; Max-	Duration of Ponding (months): Min-6 (breeding) ; Opt-8 (breeding) ; Max-N/A	target supply level (m) AHD: 47.64;			
Margooya Lagoon	Provide periodic habitat for waterbirds – dabbling ducks, grazing waterfowl, waders			Y		Preferred timing of inflows- Any time of year – spring for breeding (summer for migratory waders).		Mean frequency of events (Number per 10 years): Min-Opportunistic ; Opt- ; Max-	Duration of Ponding (months): Min-6 (breeding) ; Opt-8 (breeding) ; Max-N/A	Target supply level (m) AHD: ≤47.64;			
Margooya Lagoon	Provide conditions to enhance littoral vegetation zones – broad and diverse		Y			Preferred timing of inflows- Spring/summer		Mean frequency of events (Number per 10 years): Min-7 ; Opt- 10 ; Max-10	Duration of Ponding (months): Min- 2; Opt- 2-12; Max-12	Target supply level (m) AHD: Water level variation.			
Margooya Lagoon	Introduce a periodic drying phase to promote nutrient cycling				Y	Preferred timing of inflows- late summer - winter		Mean frequency of events (Number per 10 years): Min-5 ; Opt- 10 ; Max-10					
McDonalds Swamp	Maintain foraging and feeding areas for a diversity of waterbird feeding guilds.			Y		Preferred timing of inflows: Winter to summer		Recommended number of events in 10 years: Min-3, Opt-5-10, Max-10	Duration of ponding(months): Min- 4, Opt-6, Max-12				
McDonalds Swamp	Maintain breeding habitat for waterbird species known to breed at McDonalds Swamp.			Y		Preferred timing of inflows: Early winter to summer		Recommended number of events in 10 years: Min-2, Opt-5-10, Max-10	Duration of ponding(months): Min- 3-5, Opt-3-6, Max-9-12				
McDonalds Swamp	Maintain a healthy frog community by providing access to suitable habitat and food sources.				Y	Preferred timing of inflows: Spring/summer		Prefer ephemeral or semi-permanent water bodies but will retreat to permanent water bodies in drought conditions	Duration of ponding(months): Min- 3, Opt-3-6, Max-12				
McDonalds Swamp	Maintain open water and mudflat habitat and associated herbaceous aquatic species in sections of the wetland.				Y	Preferred timing of inflows: Late winter/spring		Recommended number of events in 10 years: Min-5, Opt-6-8, Max-8	Duration of ponding(months): Min- 1, Opt-6-8, Max-11				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
McDonalds Swamp	Maintain marsh habitat and associated sedges, rushes and reeds, keeping the extent of typha and phragmites to no more than 40% of the wetland extent.		Y			Preferred timing of inflows: Autumn to spring		Recommended number of events in 10 years: Min-5, Opt-6-8, Max-8	Duration of ponding(months): Min-<1, Opt-6-8, Max-11				
McDonalds Swamp	Restore the distribution of river red gum and associated understorey: Maintain health of few existing trees; Provide opportunities for recruitment of trees and understorey species		Y			Preferred timing of inflows: Not critical, but more growth achieved if flooded during spring-summer		Recommended number of events in 10 years: Min-2, Opt-5, Max-8	Duration of ponding(months): Min- 2, Opt-4, Max-6				
Merbein Common	Cowanna Billabong: Maintain aquatic habitat		Y			Winter		10 in 10 years	1-8 months	31.0 mAHD			
Merbein Common	Cowanna Billabong: Inundate woodland perimeter		Y		Y	Spring		5 in 10 years	1-4 months	31.65 mAHD			
Merbein Common	Cowanna Billabong: Maintain aquatic habitat / Expose woodland perimeter		Y			Summer		10 in 10 years	1-4 months	30.8 mAHD			
Merbein Common	Cowanna Billabong: Expose edges of wetland bed		Y		Y	Autumn		10 in 10 years	1-4 months	29.5 mAHD			
Merbein Common	Brickworks Billabong: Maintain aquatic habitat		Y			Winter		10 in 10 years	1-4 months	33.5 mAHD			
Merbein Common	Brickworks Billabong: Inundate woodland perimeter		Y		Y	Spring		10 in 10 years	1-4 months	34 mAHD			
Merbein Common	Brickworks Billabong: Expose woodland perimeter		Y		Y	Summer		10 in 10 years	1-4 months	33.5 mAHD			
Merbein Common	Brickworks Billabong: Expose edges of wetland bed		Y		Y	Autumn		10 in 10 years	1-4 months	33 mAHD			
Merbein Common	Catfish Billabong: Maintain aquatic habitat		Y			Winter		10 in 10 years	1-8 months	32 mAHD			
Merbein Common	Catfish Billabong: Inundate woodland perimeter		Y		Y	Spring		5 in 10 years	1-4 months	33.5 mAHD			
Merbein Common	Catfish Billabong: Maintain aquatic habitat / Expose woodland perimeter		Y		Y	Timing: Summer/Autumn		10 in 10 years	1-4 months	30.8 mAHD			

Asset Name	Rationale/Objectives	Watering Period					Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
		FISH	VEG	WBIRD	OTHER								
Murray River between Lake Hume and Lake Mulwala	To retain permanent habitat for small bodied native fish : Cut-off meanders /floodplain depressions with a variable water level regime that is high in winter/spring and draws down over summer/autumn yet retains a permanently inundated zone for native fish	Y			Y	Aug-Oct	30,000 ML/d	Annual	Duration of river flow event : Sufficient to fill flood runners and wetlands (a few days to several weeks). Water will then pond in depressions and remain in wetlands and on the floodplain even after the river level falls.			Y	
Murray River between Lake Hume and Lake Mulwala	To maintain seed bank for flood dependent plant species: Cut-off meanders / floodplain depressions and shedding floodplain with a variable water level that is high in most winter/spring periods and dries out over summer/autumn.		Y		Y	Aug-Oct	35,000 ML/d	Twice in every 3 to 4 years	Duration of river flow event : Sufficient to fill flood runners and wetlands (a few days to several weeks). Water will then pond in depressions and remain in wetlands and on the floodplain even after the river level falls.			Y	
Murray River between Lake Hume and Lake Mulwala	To maintain seed bank for flood dependent plant species: Cut-off meanders / floodplain depressions and shedding floodplain with a variable water level that is high in most winter/spring periods and dries out over summer/autumn.		Y		Y	Aug-Oct	40,000 ML/d	One to two times every five years	Duration of river flow event : Sufficient to fill flood runners and wetlands (a few days to several weeks). Water will then pond in depressions and remain in wetlands and on the floodplain even after the river level falls.			Y	
Murrumbidgee Junction	Maintain a healthy and productive wetland woodland mosaic (particularly EVCs 809, 810,818, 200).		Y		Y	Spring - Summer	N/A	Mean freq. of events in 10 years: Min- 2, Opt-3, Max-5	Duration of ponding (months): Min-2, Opt-3, Max-4	Target supply level: 54.4 mAHD			
Murrumbidgee Junction	Maintain mature river red gum which provide nesting, roosting and structural habitat for carpet python, white-bellied sea-eagle, regent parrot and Major Mitchell's cockatoo (Objective met by another hydrological objective)		Y				N/A						

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Murrumbidgee Junction	Sustain resident populations of small-bodied native fish and opportunistic use by large-bodied native fish through maintenance of pool habitat	Y				N/A	N/A	Mean freq. of events in 10 years: Min- 8, Opt-10, Max-10	Duration of ponding (months): Min-12, Opt-12, Max-12	Target supply level: 54.4 mAHD			
Murrumbidgee Junction	Promote seasonal emergent and semi-emergent macrophytes		Y			Winter - Spring	N/A	Mean freq. of events in 10 years: Min- 2, Opt-5, Max-10	Duration of ponding (months): Min-1, Opt-6, Max-12	Target supply level: 52.5 mAHD			
Murrumbidgee Junction	Promote a healthy and productive lignum shrubland (EVC 808) providing habitat for waterbird nesting and roosting.		Y			Spring - Summer	N/A	Mean freq. of events in 10 years: Min- 1, Opt-3, Max-5	Duration of ponding (months): Min-3, Opt-5, Max-7	Target supply level: 55.4 mAHD			
Neds Corner	With current infrastructure: Improve recruitment, diversity and productivity to meet EVC benchmarks in the Floodway Pond Herbland EVC (810) Maintain structure of Shrubby Riverine Woodland EVC (818)		Y			Preferred timing of inflows: Spring		Mean frequency of events (Number per 10 years): Min-3; Opt-6 ; Max-7	Duration of ponding: Min-2; Opt-4 ; Max-6				
Neds Corner	With current infrastructure: Improve recruitment, diversity and productivity to meet EVC benchmarks in the Floodway Pond Herbland EVC (810) Maintain structure of Shrubby Riverine Woodland EVC (818)		Y			Preferred timing of inflows: Spring		Mean frequency of events (Number per 10 years): Min-3; Opt-6 ; Max-7	Duration of ponding: Min-2; Opt-4 ; Max-6				
Neds Corner	With current infrastructure: Improve productivity of lignum communities (EVCs 104, 808, 813, 823)		Y			Preferred timing of inflows: Spring		Mean frequency of events (Number per 10 years): Min-3; Opt-5 ; Max-10	Duration of ponding: Min-2; Opt-4 ; Max-5				
Neds Corner	With proposed infrastructure: Improve floristic diversity to meet EVC benchmark for alluvial plains semi-arid grassland (806)		Y			Preferred timing of inflows: Spring		Mean frequency of events (Number per 10 years): Min-1; Opt-3 ; Max-5	Duration of ponding: Min-1.5; Opt-3 ; Max-5				
Nyah	Restore the structure of wetland plant communities ; Providing seasonal feeding and reproductive opportunities for riverine fish species	Y	Y		Y	Preferred timing of inflows: Spring/early Summer		Mean freq. of events in 10 years: Min- 10, Opt-10, Max-10	N/A				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Nyah	Restore the structure of wetland plant communities; Restore resident populations of frogs and small fish; Providing seasonal feeding and reproductive opportunities for riverine fish species; Provide reliable breeding habitat for waterbirds, including colonial species	Y	Y	Y	Y	Preferred timing of inflows: Spring/Summer		Mean freq. of events in 10 years: Min- 8, Opt-9, Max-9	Duration of ponding (months): Min-9, Opt-10, Max-12				
Nyah	Provide reliable breeding habitat for waterbirds, including colonial nesting species; Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler;			Y	Y	Preferred timing of inflows: Spring/Summer		Mean freq. of events in 10 years: Min- 7, Opt-9, Max-10	Duration of ponding (months): Min-5, Opt-6, Max-7				
Nyah	Provide reliable breeding habitat for waterbirds, including colonial nesting species; Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler;			Y	Y	Preferred timing of inflows: Spring/Summer		Mean freq. of events in 10 years: Min- 7, Opt-8, Max-9	Duration of ponding (months): Min-1, Opt-1.5, Max-3				
Pig Swamp	1.1 Rehabilitate the health and distribution of sedgy riverine forest/tall marsh/open water mosaic		Y			Spring		Recommended number of events in 10 years: Min- 3; Opt- 6; Max-10	Duration of ponding (months): Min- 4; Opt-5-6 ; Max-11	Depth: 0.2-1m; alternate between FSL and 75% FSL.			
Pig Swamp	1.2 Rehabilitate the health and distribution of river red gums		Y			Spring/Summer		Recommended number of events in 10 years: Min- 2; Opt- 3-6; Max-7	Duration of ponding (months): Min- 2; Opt-4 ; Max-18	Depth: Not critical			
Pig Swamp	2.1 Establish a diverse native-dominated plant community and ensure species complete their lifecycle to maintain a viable seedbank		Y			Spring		Recommended number of events in 10 years: Min- 3; Opt- 6; Max-10	Duration of ponding (months): Min- 4; Opt-5-6 ; Max-11	Depth: 0.2-1m; alternate between FSL and 75% FSL.			
Pig Swamp	3.1 Rehabilitate feeding and roosting habitat for waterbirds, including threatened species.			Y		Spring		Recommended number of events in 10 years: Min- 3; Opt- 6; Max-10	Duration of ponding (months): Min- 4; Opt-5-6 ; Max-11	Depth: 0.2-1m; alternate between FSL and 75% FSL.			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Pig Swamp	3.2 Provide habitat for frog populations when the wetland holds water.				Y	Spring through to Autumn		Recommended number of events in 10 years: Min- 2; Opt- 4; Max-8	Duration of ponding (months): Min- 3; Opt-3-6 ; Max-12	Depth: variable			
Pig Swamp	3.3 Ensure adequate biomass of macroinvertebrate functional feeding groups and zooplankton to support ecological processes and wetland foodwebs.				Y	Spring through to Autumn		Recommended number of events in 10 years: Min- 3; Opt- 4; Max-8	Duration of ponding (months): Min- 3; Opt-3-6 ; Max -	Depth: variable			
Pig Swamp	4.1 Restore connectivity between river, floodplain and wetland.				Y	See note		See note	See note	See note			
Pound Bend	Protect and improve the diversity of native wetland flora species consistent with shallow freshwater marsh, floodway pond herbland, and shrubby riverine woodland		Y		Y	Preferred timing of inflows: Spring – early Summer		Mean freq. of events in 10 years: Min- 5, Opt- 8, Max-10	Duration of ponding (months): Min-4, Opt- 8, Max- 10	Depth: 600-1000 mm			
Pound Bend	Protect and improve the diversity of native wetland flora species consistent with lignum swampy woodland and lignum swamps		Y		Y	Preferred timing of inflows: Spring – early Summer		Mean freq. of events in 10 years: Min- 2, Opt- 4-5, Max-5	Duration of ponding (months): Min-12, Opt- 6*, Max- 18 (*Duration is set to allow breeding cycle of waterbirds to complete; meeting an inundation duration of this length would be desirable in at least some years, as shorter periods can result in abandonment	Depth: 1000 mm			
Pound Bend	Maintain the health of fringing river red gums and facilitate longevity of river red gum population.		Y			Preferred timing of inflows: Spring – early Summer		Mean freq. of events in 10 years: Min- 2, Opt- 4, Max-7	Duration of ponding (months): Min-0, Opt- 2, Max- 3	Depth: 50-500 mm			
Psyche Bend Lagoon & Woorlong Wetland	Provide shallow water habitat and exposure of mudflats to support foraging and resting of small waders.			Y		Preferred timing of inflows: Late winter/early spring		Variability in water level	Permanent ponding with variable water level to alternately inundate/expose fringing vegetation and mud flats				
Psyche Bend Lagoon & Woorlong Wetland	Provide seasonal aquatic that supports a diverse range of small fish and frogs.	Y			Y	Achieved through other objectives		Achieved through other objectives	Achieved through other objectives				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Psyche Bend Lagoon & Woorlong Wetland	Maintain high levels of aquatic productivity				Y	Variability in water level		Variability in water level	Variability in water level				
Psyche Bend Lagoon & Woorlong Wetland	Self-sustaining population of Murray hardyhead following translocation	Y				Preferred timing of inflows: Late Winter (Aug) to early Spring (Oct)		Mean freq. of events in 10 years: Min- 10, Opt- 10, Max-10	Duration of ponding (months): Min-12, Opt-12, Max- 12				
Psyche Bend Lagoon & Woorlong Wetland	Extensive beds of Ruppia spp. in wetland		Y			Preferred timing of inflows: N/A		Permanent ponding with variation in water levels	Permanent ponding with variation in water levels				
Psyche Bend Lagoon & Woorlong Wetland	Healthy and productive Lignum and chenopod communities		Y			Preferred timing of inflows: Winter/ Spring		Mean freq. of events in 10 years: Min- 3, Opt- 5, Max-10	Duration of ponding (months): Min-3, Opt- 5, Max- 7				
Psyche Bend Lagoon & Woorlong Wetland	Improve aquatic macrophyte (submerged and emergent) diversity and area		Y			Preferred timing of inflows: N/A		Permanent ponding with variation in water levels	Permanent ponding with variation in water levels				
Psyche Bend Lagoon & Woorlong Wetland	Improve and maintain salinity levels to meet standards required for Murray hardyhead and other key species (between 5,000 and 30,000 EC)	Y			Y	Preferred timing of inflows: N/A		Mean freq. of events in 10 years: Min- 3, Opt- 5, Max-20	N/A				
Psyche Bend Lagoon & Woorlong Wetland	Reduce the area of Woorlong wetland dominated by reed (Phragmites and Cumbungi) communities.		Y			Preferred timing of inflows: Summer		Mean freq. of events in 10 years: Min- 3, Opt- 5, Max-10	Drying event				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Richardson's Lagoon	Maintain deep water channels through the bed of the wetland with aquatic macrophytes and maintain healthy population of native aquatic reeds and rushes around the deep channels.		Y		Y	Preferred timing of inflows: Late winter with top up in next two springs.		Recommended frequency of events (number per 10 years): Between annual inundation and three events per ten years will promote growth (The frequency of watering events only relates to wetland watering from dry, and does not show top-up events)	Duration of flooding (months): Between 24 and 48 months to ensure sufficient recruitment for current and future events.				
Richardson's Lagoon	Maintain spike-sedge wetland (EVC 819) in floodplain areas. Promote dominance of the ground layer in these areas by sedge and rush species.		Y		Y	Preferred timing of inflows: Spring, allowing drawdown over summer and top up following spring.		Recommended frequency of events (number per 10 years): Between annual to four events per ten years is recommended at this site (The frequency of watering events only relates to wetland watering from dry, and does not show top-up events)	Duration of flooding (months): Between eight and ten months.				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Richardson's Lagoon	Maintain eucalypt floodplain woodland (black box) in the areas higher in the wetland reserve.		Y			Preferred timing of inflows: Spring		Recommended frequency of events (number per 10 years): One to two events per ten years is recommended (The frequency of watering events only relates to wetland watering from dry, and does not show top-up events)	Duration of flooding (months): Between three and six months.				
Round Lake	Maintain and support breeding of Murray hardyhead	Y				Winter – early spring (September) to freshen conditions during peak spawning.		Permanent inundation is required. See additional requirements		Water levels should be maintained above 66.8 m AHD (2.58 m) and below 67.2 m AHD (2.98 m)			
Round Lake	Maintain populations of large-fruit tassel (*Ruppia megacarpa*) associated with brackish herbland (EVC 538)		Y			Winter – early spring (September)		Frequency of 3 inundation events per 10 years is ideal, however can persist in permanent conditions					
Round Lake	Maintain charophytes (macroscopic algae) persisting in the lake		Y		Y	Winter – early spring (September)		Frequency of 3 inundation events per 10 years is ideal, however can persist in permanent conditions					
Spence's Bend	Improve Swamp and woodland diversity and productivity		Y			Winter - Spring		Mean freq. of events in 10 years: Min- 3, Opt-5, Max-10	Duration of ponding (months): Min-3, Opt-5, Max-7				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Spence's Bend	Increase woodland and shrubland diversity and productivity		Y			Spring - Summer		Mean freq. of events in 10 years: Min- 2, Opt-3, Max-7	Duration of ponding (months): Min-2, Opt-3, Max-8				
Spence's Bend	Maintain and Improve woodland, shrubland and Swamp diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 104, 808, 810, 811, 813, 818, 823 (Focus of this hydrological objective is river red gum)		Y			Spring - Summer		Mean freq. of events in 10 years: Min- 2, Opt-3, Max-7	Duration of ponding (months): Min-2, Opt-3, Max-8				
Spence's Bend	Increase woodland and shrubland diversity and productivity		Y			Winter - Spring		Mean freq. of events in 10 years: Min- 2, Opt-3, Max-3	Duration of ponding (months): Min-2, Opt-4, Max-6				
Spence's Bend	Maintain and Improve woodland, shrubland and Swamp diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 104, 808, 810, 811, 813, 818, 823 (Focus of this hydrological objective is Black Box)		Y			Winter - Spring		Mean freq. of events in 10 years: Min- 2, Opt-3, Max-3	Duration of ponding (months): Min-2, Opt-4, Max-6				
Spence's Bend	Reinstate seasonal connectivity between all wetlands in the target area (Ecological objective met by other hydrological objectives)				Y								
Spence's Bend	Increase aquatic macrophyte diversity and area in the freshwater marsh habitats		Y			Winter - Spring		Mean freq. of events in 10 years: Min- 2, Opt-5, Max-10	Duration of ponding (months): Min-1, Opt-6, Max-12				
Spence's Bend	Increase dissolved organic matter, particulate matter and macroinvertebrate productivity (Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year w				Y								

Asset Name	Rationale/Objectives	Watering Period					Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
		FISH	VEG	WBIRD	OTHER								
Spence's Bend	Improve semi-permanent saline marsh habitat for Murray hardyhead reintroduction	Y				Winter - Spring		Mean freq. of events in 10 years: Min- 5, Opt-10, Max-10	Duration of ponding (months): Min-1, Opt-6, Max-8				
Spence's Bend	Improve or maintain water quality (particularly salinity) to meet standards for each wetland type and key species (Ecological objective met by other hydrological objectives)				Y								
Vinifera	Restore the structure of wetland plant communities; Restore resident populations of frogs and small fish; Providing seasonal feeding and reproductive opportunities for riverine fish species; Provide reliable breeding habitat for waterbirds, including colonial species	Y	Y	Y	Y	Preferred timing of inflows: Spring/Summer		Mean freq. of events in 10 years: Min- 8, Opt-9, Max-9	Duration of ponding (months): Min-6, Opt-7-8, Max-9				
Vinifera	Restore the structure of wetland plant communities; Restore resident populations of frogs and small fish; Provide reliable breeding habitat for waterbirds, including colonial nesting species; Contribute to the carbon requirements of the River Murray channel	Y	Y	Y	Y	Preferred timing of inflows: Spring/Summer		Mean freq. of events in 10 years: Min- 7, Opt-9, Max-10	Duration of ponding (months): Min-5, Opt-6, Max-7				
Vinifera	Restore the structure of wetland plant communities; Restore resident populations of frogs and small fish; Provide reliable breeding habitat for waterbirds, including colonial nesting species; Contribute to the carbon requirements of the River Murray Channel	Y	Y	Y	Y	Preferred timing of inflows: Spring/Summer		Mean freq. of events in 10 years: Min- 7, Opt-9, Max-10	Duration of ponding (months): Min-2, Opt-4, Max-6				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Vinifera	Provide reliable breeding habitat for waterbirds, including colonial nesting species; Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler; Contribute to the carbon requirements of the River Murray Channel		Y	Y	Y	Preferred timing of inflows: Spring/Summer		Mean freq. of events in 10 years: Min- 6, Opt-8, Max-9	Duration of ponding (months): Min-1, Opt-1.5, Max-2				
Walshes Bend	Increased diversity and productivity (including tree health and shrub health) to meet EVC bencmarks for EVCs #810, #811, #813 and #823: grassy riverine forest/floodway pond Herbland Complex EVC & Floodway Pond Herbland EVC.		Y			See note		See note	See note				
Walshes Bend	Increased aquatic macrophyte diversity and area		Y			Preferred timing of inflows: Spring, gradual exposure late Spring/ Summer		Recommended no of events in 10 years: Min- 2; Opt-5; Max-10	Duration of ponding: Min-1 ; Opt- 6; Max-12				
Walshes Bend	Increased dissolved organic matter, particulate matter and macroinvertebrate productivity				Y	Preferred timing of inflows: Spring/ Summer		Recommended no of events in 10 years: Min- 3; Opt-5; Max- 10	Duration of ponding: Min-2 ; Max-6	N/A			
Walshes Bend	Increased small-bodied native fish (e.g. gudgeon spp., Murray-Darling rainbowfish) diversity and abundance through	Y				See note		See note	See note				
Walshes Bend	Increased biofilm production and diversity				Y	N/A		Recommended no of events in 10 years: Min- 10; Opt- 10; Max-30	Duration of ponding: Min-1.5	N/A			
Walshes Bend	Increased diversity and productivity (including tree health and shrub health) to meet EVC bencmarks for EVCs #810, #811, #813 and #823: wetland #7428653680 intermittent swampy woodland EVC (Water regime recommended based on needs of river red gum.		Y			Preferred timing of inflows: Spring-Summer		Recommended no of events in 10 years: Min- 3; Opt-4; Max-5	Duration of ponding: Min-2 ; Opt- 3; Max-4	Depth: not critical			

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Walshes Bend	Increased diversity and productivity (including tree health and shrub health) to meet EVC bencmarks for EVCs #810, #811, #813 and #823: Wetland #7428653680 lignum swampy woodland (Water regime recommended based on needs of lignum. lignum generally does no		Y			Preferred timing of inflows: Not critical		Recommended no of events in 10 years: Min- 3; Opt- 5; Max-10	Duration of ponding: Min- 3 ; Opt- 5; Max-7	Depth: < 1m, but not critical			
Wemen-Liparoo	Support seasonal habitat for small native fish; Provide seasonal feeding habitat for large waders and waterfowl: Liparoo and Liparoo East Billabongs	Y		Y		Timing: Winter/Spring		1:2	Up to 12 months	44.5 m			
Wemen-Liparoo	Maintain a community of drought-tolerant emergent aquatic macrophytes at the wetland edge - Liparoo and Liparoo East Billabongs		Y			Timing: Late winter/early summer		1:2	4-6 months	45.3 m			
Wemen-Liparoo	Healthy and productive Lignum Swampy Woodland community that supports frogs and small native fish when flooded; Maintain Lignum Shrubland and provide occasional breeding events by platform building waterbirds including Ibis and Spoonbill; Liparoo Billabong		Y			Timing: Early Spring/ summer		1:4	3-7 months	45.7 m			
Wirra-Lo Wetlands complex	Restore the population of EPBC-listed Growling Grass Frog (*Litoria raniformis*) at the Wirra-Lo Wetland Complex through the provision of habitat for refuge and breeding				Y	Preferred timing of inflows: Spring/ Summer		Recommended number of events in 10 years: Min-7, Opt-8, Max-10	Duration of ponding(months): Min- 5, Opt-7, Max-				
Wirra-Lo Wetlands complex	To provide feeding and breeding habitat for a high diversity of waterbirds.			Y		Preferred timing of inflows: Late Winter/early spring		Recommended number of events in 10 years: Variable feeding and breeding needs dependent on the species.	Duration of ponding(months): Min- 4, Opt-5-12, Max-Until fledged				
Wirra-Lo Wetlands complex	Maintain/ rehabilitate appropriate seasonality and duration of wetting and drying				Y	See note		See note	See note				

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Flow	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH	BWS_VEG
Wirra-Lo Wetlands complex	To increase the extent of floating, submerged and emergent aquatic vegetation associated with Aquatic Herbland (e.g. *Triglochin* spp., *Potamogeton* spp.)		Y			Preferred timing of inflows: Autumn/Spring		Recommended number of events in 10 years: Min-5, Opt-6-7, Max-8	Duration of ponding(months): Min- 4, Opt-3-6(Shallow floodplain); 8-10(within historic channel creek), Max-12				
Wirra-Lo Wetlands complex	To increase the longitudinal extent of emergent aquatic vegetation along Duck Creek associated with Tall Marsh (including *Typha* spp., *Juncus* spp. and *Eleocharis* spp.)		Y			Spring		Recommended number of events in 10 years: Min-5, Opt-6-7, Max-8	Duration of ponding(months): Min- 4, Opt-8, Max-12				
Wirra-Lo Wetlands complex	To maintain/ rehabilitate the health of adult River Red Gum trees (Intermittent Swampy Woodland).		Y			Preferred timing of inflows: Spring/Summer		Recommended number of events in 10 years: Min-2, Opt-3-6, Max-7	Duration of ponding(months): Min- 2, Opt-4, Max-18				
Wirra-Lo Wetlands complex	To facilitate recruitment of River Red Gum trees (Intermittent Swampy Woodland)		Y			Preferred timing of inflows: Late Spring/Summer		Recommended number of events in 10 years: Min-2, Opt-3, Max-5 (number of desired recruitment events, follow up flooding required)	Duration of ponding(months): Min- 1, Opt-2, Max-				
Wirra-Lo Wetlands complex	To maintain open water and associated mud-flat habitat				Y	Note: Preferred timing of inflows: Not critical		Recommended number of events in 10 years: Min-3, Opt-5, Max-7	Duration of ponding(months): Min- 2, Opt-3, Max-6				
Wirra-Lo Wetlands complex	To increase the extent of floating, submerged and emergent aquatic vegetation associated with Aquatic Herbland (e.g. *Triglochin* spp., *Potamogeton* spp.)		Y			Note: Preferred timing of inflows: Not critical		Recommended number of events in 10 years: Min-2, Opt-5, Max-10	Duration of ponding(months): Min- 1, Opt-3, Max-7				
Wirra-Lo Wetlands complex	To increase the longitudinal extent of emergent aquatic vegetation along Duck Creek associated with Tall Marsh (including *Typha* spp., *Juncus* spp. and *Eleocharis* spp.)		Y			See note		See note	See note				

Appendix G. Roles and responsibilities

Table 29 outlines the range of agencies and authorities that are involved in managing and delivering environmental flows.

Table 29: Responsible minister and agencies

Minister / Agency	Responsibilities
Minister for Water	Oversee Victoria's environmental water management policy framework Oversee the VEWH, including appointment and removal of commissioners and creation of rules ensuring VEWH manages the water holdings in line with environmental water management policy. Administer the broader water allocation and entitlements framework and the *Water Act 1989* (Vic)
Department of Environment, Land, Water and Planning (DELWP)	Manage the water allocation and entitlements framework Develop state policy on water resource management and waterway management approved by the Minister for Water Develop state policy for the management of environmental water in regulated and unregulated systems Act on behalf of the Minister for Water to maintain oversight of the VEWH and waterway managers (in their role as environmental water managers)
Victorian Environmental Water Holder (VEWH)	Make decisions about the most effective use of the water holdings, including use, trade and carryover Authorise waterway managers to implement watering decisions Liaise with other water holders to ensure co-ordinated use of all sources of environmental water Publicly communicate environmental watering decisions and outcomes Commission targeted projects to demonstrate ecological outcomes of environmental watering at key sites Report on management of the water holdings
Catchment management authorities (Mallee, North Central, Goulburn Broken and North East CMAs for this water resource plan area)	Waterway management authorities under Part 10 of the *Water Act 1989* (Vic) Identify regional priorities for environmental waterway management in regional waterway strategies, in consultation with the community Assess water regime requirements of priority rivers, estuaries and wetlands to identify environmental watering needs to meet agreed objectives Identify opportunities for, and implement, environmental works to use environmental water more efficiently Propose annual environmental watering actions to the VEWH and implement the VEWH environmental watering decisions Provide critical input to management of other types of environmental water (passing flows management, above cap water) Report on environmental water management activities undertaken
Commonwealth Environmental Water Holder (CEWH)	Make decisions about the use of commonwealth water holdings, including delegating water to the VEWH for use in Victoria Liaise with the VEWH to ensure co-ordinated use of environmental water in Victoria Report on management of commonwealth water holdings

Minister / Agency	Responsibilities
Water corporations (Goulburn-Murray Water [in relation to its own assets and systems and also as Constructing Authority for MDBA], MDBA, South Australian Water [as Constructing Authority for MDBA], and Lower Murray Water)	Work with the VEWH and waterway managers in planning for the delivery of environmental water to maximise environmental outcomes Operate water supply infrastructure such as dams and irrigation distribution systems to deliver environmental water Ensure the provision of passing flows and compliance with management of diversion limits in unregulated and groundwater systems
Formally recognised Traditional Owner groups in the Victorian Murray water resource plan area (First Peoples of the Millewa-Mallee Aboriginal Corporation and Yorta Yorta Nations Aboriginal Corporation)	There are currently three different processes[10] for groups to become formally recognised as Traditional Owners of Country in Victoria. This includes holding Registered Aboriginal Party (RAP) status (under the *Aboriginal Heritage Act 2006*), Native Title Determination (under the Commonwealth *Native Title Act 1993*) and entering into a Recognition and Settlement Agreement (under the Victorian *Traditional Owner Settlement Agreement Act 2010*). Chapter 8 of the Victoria Northern and Murray Water Resource Plan (DELWP, 2020) and Aboriginal Victoria provides further information on formal recognition in Victoria.
Murray and Lower Darling Rivers Indigenous Nations (MLDRIN) Federation of Victorian Traditional Owner Corporations (FVTOC)	MLDRIN has a formal role under Basin Plan to advise on development and accreditation of water resource plans. FVTOC has a formal role in advising the State on diverse matters related to water management. Individual Traditional Owner groups may participate in the state's management of natural resources, in recognition of the special relationship of Aboriginal peoples with their land and waters.
Local Government	Specifically with regard to waterways, local government have the following roles and responsibilities: • incorporate waterway and catchment management objectives, priorities and actions into strategic and statutory planning processes; • undertake elements of floodplain management in accordance with the renewed Victorian Floodplain Management Strategy; • develop and implement urban stormwater plans; • manage on-site domestic wastewater systems; • manage sections of waterways where formal agreements are in place; and • manage rural drainage and infrastructure (e.g. town weirs) where appropriate.
Parks Victoria	Manages parks and conservation reserves in which many waterways are located, including national, State, wilderness, metropolitan and regional parks, sanctuaries and natural features reserves.

[10] A Recognition and Settlement Agreement is negotiated by Traditional Owners with the Victorian Government. Native title is determined by the Federal Court of Australia or, on appeal by the High Court. Determinations and Agreements may differ for each group.

Appendix H. Qualitative risk analysis

This appendix documents a qualitative analysis of long-term risks identified for this LTWP. The analysis includes a review of the process that generates the risk, the implications of that process and the options for management of the risk.

Table 30 relates to risks that result in failure to achieve objectives.

Table 31 relates to risks that arise from the provision of environmental water.

Table 30: Risks that result in failure to achieve objectives

Risk category	Threat	Implication	Themes and related objectives at risk	Management options
Failure to provide recommended watering regime	Operational failure in delivery e.g. Water released from dam at incorrect time	Failure to provide appropriate duration, timing, frequency, depth, extent, and velocity of watering	Has potential to impact on all environmental objectives for the water resource plan area	The identified risks can be addressed through the provision of an appropriate flow regime that addresses the objective The provision of water can be complemented with: • Monitoring watering regime and ecological response • Liaison with water authorities, land holders, other stakeholders and the broader community • Prioritisation of watering requirements (in SWP) • Determine environmental water requirements based on seasonal conditions and within constraints • Develop and implement programs to alleviate physical constraints
	Loss of water during delivery	Failure to provide appropriate duration, timing, frequency, depth, extent, and velocity of watering	Has potential to impact on all environmental objectives for the water resource plan area	
	Constraints that prevent delivery of water e.g. isolation of wetlands from floodplain or river	Failure to provide appropriate duration, timing, frequency, depth, extent, and velocity of watering Reduced lateral connectivity	Has potential to impact on all environmental objectives for the water resource plan area	
	Inadequate conceptual and detailed modelling of water requirements	Failure to provide appropriate duration, timing, frequency, depth, extent, and velocity of watering	Has potential to impact on all environmental objectives for the water resource plan area	Monitoring watering regime and ecological response Update conceptual model with latest research Undertake research to fill knowledge gaps
Failure to undertake complementary works necessary to achieve objective	Poor quality or lack of in-channel habitat associated with past practice e.g. de-snagging and channel modifications	Limited habitat and refuge for target species	Native fish, macroinvertebrates, platypus	Provision of in-channel habitat through large woody debris installation. Management of accelerated rates of erosion and sedimentation within and in adjoining reaches of waterway
	Presence of fish barriers	Reduced longitudinal connectivity	Native fish, aquatic vegetation, platypus	Provision of fish passage over / around structures and or removal of obsolete structures
	Inadequate riparian habitat (includes grazing pressures)	Prevent and regeneration of establishment of appropriate vegetation	Macroinvertebrates, native fish, aquatic and riparian vegetation	Fencing and stock management
	Introduced species	Limits establishment of native vegetation Predation of fauna Competition – reduced habitat and resource availability	Vegetation, platypus, native fish	Monitor introduced species Provide watering regimes that provide competitive advantage for native species Development and implementation of pest management plans Installation of carp screens

Risk category	Threat	Implication	Themes and related objectives at risk	Management options
	Inappropriate fish stocking or excessive recreational fishing	Limits native fish populations through fishing pressure, predation and competition for resources	Native fish	Review fish stocking programs Education programs for recreational fishing
	Poor water quality	Low dissolved oxygen High turbidity High water temperature Increased salinity levels	Fish, Waterbirds, vegetation, amphibians, invertebrates, wetland habitats and types	Monitor groundwater and assets Manage water regime
	Saline groundwater intrusion	Poor vegetation health Limited regeneration and dominance of salt tolerant species Unsuitable habitat for waterbirds and food sources	Vegetation, waterbirds, wetland habitats and types	Monitoring, adaptive management of watering regime Investigate regional groundwater influences
External factors	Climate variability	Extreme low flows	May apply to all objectives	Use seasonally adaptive approach in setting EWRs
	Fire	Altered hydrology, sediment	May apply to all objectives	Monitoring and adaptive management of watering regime
	Land use change	Salinisation, altered hydrology	May apply to all objectives	Monitoring and adaptive management of watering regime
	Climate change	Changes in species composition and hence watering requirements at sites Changes in the variability of flow regimes		Monitoring and adaptive management of watering regime Undertake ongoing research into climate change adaption
Failure to demonstrate achievement of environmental objectives	Delayed ecosystem response	Objective may be achieved, but may not be demonstrated	May apply to all objectives	Monitoring and adaptive management of watering regime Ongoing research into ecosystem response to environmental water
	Monitoring not provided			
	Inadequate research to support conceptual models or monitoring design			

Table 31: Risk that arise from the provision of environmental water

Category	Threat	Implication	Comment and management options
Environmental	Winter high fresh inundate platypus burrows	Limits platypus populations	Deliver winter high fresh in August to trigger female to select or construct nursery burrows at high elevation in the river bank
	Summer fresh mobilises build-up of leaf litter and nutrients	Blackwater event or other water quality issues	Time water events to coincide with cooler water temperatures to reduce microorganism activity Management option is to deliver a summer fresh at the same magnitude as the previous winter low flow therefore the summer fresh will entrain only litter that has built up since the winter low flow was ceased Monitor nutrient and Blue Green Algae levels, and the ecological response of the wetland to flooding
	Other native species (non-target) disadvantaged	Decrease in abundance of non-target species	Identify potential non-target species and monitor the effect of intervention Adapt management intervention to reduce the effects on non-target species
	Watering regime favours non-native species	May competitively inhibit native species	Monitor the abundance of native and invasive aquatic species. Pest management plans and complementary works
	Watering regime initiates erosion	Scour of banks, loss of habitat, sediment mobilisation in large events	Manage rise and fall rates of freshes. Provision of complementary works including revegetation
Social	Inundation of cultural heritage sites	Damage to cultural heritage sites	Monitor condition of sites, communicate with community
	Reduction in recreation opportunity	Use of water for environmental outcome, reduces water available for recreation outcomes	Work closely and engage with local communities Monitor water levels
Economic	Inundation and or erosion of private land and or watering infrastructure (pump equipment)	Community angst and liability	Work closely with land managers, water agencies to provide advanced warning of water delivery Monitor water levels Communicate with landholders and establish watering agreements
	Inundation and or erosion of roads and other transport and communications infrastructure		Work closely with infrastructure managers to provide advanced warning of water delivery Monitor water levels

Appendix I. Groundwater

An assessment was made (Groundwater Logic, 2019) of the level of groundwater dependency of priority environmental assets in the Wimmera-Mallee water resource plan area, existing level of management protection for them and hence their level of risk.

Groundwater dependency

The Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE Atlas) (Sinclair Knight Merz, 2012) was used to assess groundwater dependence of priority environmental assets in the Wimmera-Mallee water resource plan area. The GDE Atlas includes attributes which indicate the relative potential for groundwater dependence of each feature, based on supporting field and desktop studies (hence being of high potential), and based on remote sensing data analysis, which can range from high to low potential.

For wetland priority environmental asset features the GDA Atlas processing of CDM Smith (2017), who combined two components of the Atlas for assessing the likelihood of wetland features' groundwater dependence:

GDEs reliant on the surface expression of groundwater (i.e. surface GDEs); and

GDEs reliant on the sub surface expression (vegetation) and located in riverine (floodplain or riparian) environments (i.e. subsurface GDEs).

For river priority environmental asset GDEs: only the GDE Atlas' "*GDEs reliant on the surface expression of groundwater*" layer was utilised as input to the GDE confidence level assignments of this study. Only reaches with "desktop study" evidence were classified as "high confidence" for the mapping deliverable of this report (although so too were reaches identified through supplementary desktop studies). Remote sensing-based confidence levels for river reaches were re-classified as follows:

High → moderate; and

Moderate → low.

In this way, river GDEs that have been identified through site-specific desktop studies, which would typically rely on field data analysis (flow and water quality gauging, groundwater potentiometry, tracers, numerical modelling, etc), are classified as being of high confidence in this project's spatial layer deliverable. In contrast, those river GDEs inferred solely through spatially and temporally coarse remote sensing data are classified as being of moderate confidence at best in this project's deliverable.

Management protection

An assessment was then made of the relative level of management protections that are in place for groundwater dependent river priority environmental assets under Victoria's existing water management framework.

Classification of the level of management protection was undertaken as follows:

- High level of management protection:
    - Areas in which specific management triggers are in place to protect GDEs; and/or
    - Areas in which there are existing environmental watering targets specifically aimed at protecting baseflows, as outlined in the LTWPs; and/or
    - Areas in which GDE protections were considered during the licensing process and through sub-catchment specific limits on Permissible Consumptive Volumes, which were derived through assessment of potential pumping impacts (by volume) on stream flows.
- Moderate level of management protection:
    - All other Groundwater Management Units in which there are no specific GDE protections in place, but in which risks to GDEs are identified and assessed for each licence application, in accordance with the relevant policies and Ministerial Guidelines.

Level of Risk

Relative levels of risk posed to each groundwater-dependent priority environmental asset feature were determined as follows:

- Relative Level of Risk = Likelihood x Consequence, where:
    - Likelihood = [1.0 - Level of management protections] x Maximum of ([Scaled shallow groundwater entitlement density] and [Scaled deeper groundwater entitlement density]).
        - The “level of management protections” risk component values were set to: 0.66 (high protection), 0.33 (moderate protection) and 0.0 (low protection).
        - Groundwater use between the shallow and deep aquifers was conservatively treated as being of equal risk – so whichever aquifer class had the greatest groundwater usage density was used in the risk calculation.
    - Consequence = 1.0 for High/Medium/Low confidence GDEs, and 0.0 for non-GDEs (losing reaches). In this case, consequence only considers the sensitivity of a GDE to stressors and does not consider GDE value (all are of equal value in this case). This is considered a conservative approach.
- Risk levels are limited to a maximum of 1.0, and a minimum of 0.0.

All priority environmental assets in the Victorian Murray water resource plan area were generally found to be at low risk (Groundwater Logic, 2019). Four river reaches across northern Victoria were classified as moderate risk GDEs (including parts of Broken and Nine Mile Creek in the Victorian Murray water resource plan area), but all are in areas with existing water management protections in place (e.g. ongoing groundwater usage restriction triggers in place under the Local Management Plan, or where there are baseflow-related targets for environmental watering). Wetland assets (Table 32) were all considered to be at low risk.

Table 32: Groundwater dependencies - wetlands in the Victorian Murray water resource plan area (DELWP 2020)

PEA Name	Index of Wetland Condition ID	Surface water SDL resource unit source	Groundwater dependent features (confidence)
Barmah Forest	60702	SS2 (Victorian Murray)	M
	60706	SS2 (Victorian Murray)	M
	63903	SS2 (Victorian Murray)	M
	63971	SS2 (Victorian Murray)	M
Belsar and Yungera Islands	12218	SS2 (Victorian Murray)	H
	12220	SS2 (Victorian Murray)	M
	12221	SS2 (Victorian Murray)	H
Cardross Lakes	11461	SS2 (Victorian Murray)	H
Gunbower Forest	45248	SS2 (Victorian Murray)	M
	45249	SS2 (Victorian Murray)	M
	45239	SS2 (Victorian Murray)	H
	45250	SS2 (Victorian Murray)	M
	45251	SS2 (Victorian Murray)	M
	45252	SS2 (Victorian Murray)	M
	45270	SS2 (Victorian Murray)	M
Hattah Lakes	11155	SS2 (Victorian Murray)	M

PEA Name	Index of Wetland Condition ID	Surface water SDL resource unit source	Groundwater dependent features (confidence)
	11186	SS2 (Victorian Murray)	M
Hird Swamp	45231	SS2 (Victorian Murray)	H
Johnson Swamp	45222	SS2 (Victorian Murray)	H
Kings Billabong	11355	SS2 (Victorian Murray)	M
	11367	SS2 (Victorian Murray)	H
	11371	SS2 (Victorian Murray)	M
	11373	SS2 (Victorian Murray)	H
	11374	SS2 (Victorian Murray)	H
	11374	SS2 (Victorian Murray)	H
Lindsay, Wallpolla, Mulcra Islands	10001	SS2 (Victorian Murray)	M
	10626	SS2 (Victorian Murray)	M
	10156	SS2 (Victorian Murray)	H
	10159	SS2 (Victorian Murray)	M
	10164	SS2 (Victorian Murray)	H
	10176	SS2 (Victorian Murray)	M
	10179	SS2 (Victorian Murray)	M
	10180	SS2 (Victorian Murray)	H
	10181	SS2 (Victorian Murray)	M
	10183	SS2 (Victorian Murray)	M
	10186	SS2 (Victorian Murray)	M
	10187	SS2 (Victorian Murray)	H
	10188	SS2 (Victorian Murray)	H
	10189	SS2 (Victorian Murray)	M
	10191	SS2 (Victorian Murray)	H
	10195	SS2 (Victorian Murray)	M
	10197	SS2 (Victorian Murray)	H
	10199	SS2 (Victorian Murray)	M
	10207	SS2 (Victorian Murray)	M
	10208	SS2 (Victorian Murray)	M
	10209	SS2 (Victorian Murray)	M
	10212	SS2 (Victorian Murray)	M
	10213	SS2 (Victorian Murray)	H
	10219	SS2 (Victorian Murray)	H
	10220	SS2 (Victorian Murray)	H
	10228	SS2 (Victorian Murray)	H
	10234	SS2 (Victorian Murray)	H
	10235	SS2 (Victorian Murray)	H
	10242	SS2 (Victorian Murray)	H

	10245	SS2 (Victorian Murray)	H
	10555	SS2 (Victorian Murray)	H
	10561	SS2 (Victorian Murray)	H
	10562	SS2 (Victorian Murray)	M
	10563	SS2 (Victorian Murray)	M
	10565	SS2 (Victorian Murray)	H
	10594	SS2 (Victorian Murray)	M
	10613	SS2 (Victorian Murray)	M
	10619	SS2 (Victorian Murray)	H
	10620	SS2 (Victorian Murray)	H
	10622	SS2 (Victorian Murray)	H
	10625	SS2 (Victorian Murray)	H
Murray floodplain between Lake Hume and Lake Mulwala	75156	SS2 (Victorian Murray)	M
	75373	SS4 (Ovens)	M
	75373	SS4 (Ovens)	M
	75373	SS4 (Ovens)	M
	75373	SS4 (Ovens)	M
	75373	SS4 (Ovens)	M
	75373	SS4 (Ovens)	M
	75195	SS2 (Victorian Murray)	M
	75363	SS2 (Victorian Murray)	M
	75363	SS2 (Victorian Murray)	M
	75157	SS4 (Ovens)	M
	75157	SS4 (Ovens)	M
	75157	SS4 (Ovens)	M
	75157	SS4 (Ovens)	M
	75157	SS4 (Ovens)	M
	75158	SS4 (Ovens)	M
	75158	SS4 (Ovens)	M
	75174	SS4 (Ovens)	H
	75174	SS4 (Ovens)	H
	75174	SS4 (Ovens)	H
	75174	SS4 (Ovens)	H
	75174	SS4 (Ovens)	H
	75191	SS4 (Ovens)	H
	75197	SS4 (Ovens)	H
	75159	SS4 (Ovens)	M
	75159	SS4 (Ovens)	M
	75164	SS4 (Ovens)	H
	75165	SS4 (Ovens)	H
	75173	SS4 (Ovens)	M

	75176	SS4 (Ovens)	H
	75178	SS4 (Ovens)	H
	75178	SS4 (Ovens)	H
	75180	SS4 (Ovens)	M
	75181	SS4 (Ovens)	M
	75183	SS4 (Ovens)	M
	75184	SS4 (Ovens)	M
	75188	SS4 (Ovens)	M
	75192	SS4 (Ovens)	M
	75192	SS4 (Ovens)	M
	75193	SS4 (Ovens)	M
	75193	SS4 (Ovens)	M
	75196	SS4 (Ovens)	M
	75196	SS4 (Ovens)	M
	75198	SS4 (Ovens)	M
	75198	SS4 (Ovens)	M
	75200	SS4 (Ovens)	M
	75200	SS4 (Ovens)	M
	75205	SS4 (Ovens)	M
	75205	SS4 (Ovens)	M
	75208	SS4 (Ovens)	M
	75174	SS4 (Ovens)	H
Nyah	12502	SS2 (Victorian Murray)	H
Vinifera	12508	SS2 (Victorian Murray)	M
Psyche Bend Lagoon	11354	SS2 (Victorian Murray)	M
Tata Creek	12789	SS2 (Victorian Murray)	M
	12790	SS2 (Victorian Murray)	M
Wirra-Lo Wetlands Complex	43210	SS2 (Victorian Murray)	M
	43214	SS2 (Victorian Murray)	M

Appendix J. Waterway types

The table below shows example Australian National Aquatic Ecosystems (ANAE) waterway type(s) (Brooks, 2017) of each priority environmental asset in the Victorian Murray water resource plan area. The full list of ANAE aquatic ecosystem types should be available on Data.gov.au in second half of 2021.

Table 33: Example ANAE waterway types of priority environmental assets in the Victorian Murray water resource plan area

Asset Name	CMA	WPRA	System Type	ANAE Type
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Floodplain	F1.12: Woodland riparian zone or floodplain
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Floodplain	F1.2: River red gum forest riparian zone or floodplain
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Floodplain	F1.4: River red gum woodland riparian zone or floodplain
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Floodplain	F1.8: Black box woodland riparian zone or floodplain
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Lacustrine	Lt1.1: Temporary lake
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pp2.1.2: Permanent tall emergent marsh
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pp2.2.2: Permanent sedge/grass/forb marsh
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pp2.4.2: Permanent forb marsh
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pp4.2: Permanent wetland
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt1.1.2: Temporary river red gum swamp
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt1.2.2: Temporary black box swamp
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt1.6.2: Temporary woodland swamp
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt2.1.2: Temporary tall emergent marsh
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt2.2.2: Temporary sedge/grass/forb marsh
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt2.3.2: Freshwater meadow
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt3.1.2: Clay pan
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt4.1: Floodplain or riparian wetland
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Palustrine	Pt4.2: Temporary wetland
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Riverine	Rp1.2: Permanent transitional zone stream
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Riverine	Rp1.3: Permanent low energy upland stream
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Riverine	Rp1.4: Permanent lowland stream
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Riverine	Rp1: Permanent stream
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Riverine	Rt1.3: Temporary low energy upland stream
Barmah Forest	Goulburn Broken CMA	Victorian Murray	Riverine	Rt1.4: Temporary lowland stream
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Floodplain	F1.12: Woodland riparian zone or floodplain
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Floodplain	F1.2: River red gum forest riparian zone or floodplain
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Floodplain	F1.4: River red gum woodland riparian zone or floodplain

Asset Name	CMA	WPRA	System Type	ANAE Type
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Floodplain	F1.8: Black box woodland riparian zone or floodplain
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Floodplain	F2.2: Lignum shrubland riparian zone or floodplain
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Lacustrine	Lp1.1: Permanent lake
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Palustrine	Pp2.4.2: Permanent forb marsh
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Palustrine	Pp4.2: Permanent wetland
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Palustrine	Pt1.1.2: Temporary river red gum swamp
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Palustrine	Pt1.2.2: Temporary black box swamp
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Palustrine	Pt1.6.2: Temporary woodland swamp
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Palustrine	Pt1.7.2: Temporary lignum swamp
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Palustrine	Pt2.1.2: Temporary tall emergent marsh
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Palustrine	Pt2.3.2: Freshwater meadow
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Riverine	Rp1.4: Permanent lowland stream
Belsar and Yungera Islands	Mallee CMA	Victorian Murray	Riverine	Rt1.4: Temporary lowland stream
Benwell Forest	North Central CMA	Victorian Murray	Floodplain	F1.2: River red gum forest riparian zone or floodplain
Benwell Forest	North Central CMA	Victorian Murray	Palustrine	Pt1.1.2: Temporary river red gum swamp
Benwell Forest	North Central CMA	Victorian Murray	Riverine	Rp1.4: Permanent lowland stream
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Floodplain	F1.12: Woodland riparian zone or floodplain
Hird Swamp	North Central CMA	Victorian Murray	Palustrine	Pt1.2.2: Temporary black box swamp
Johnson Swamp	North Central CMA	Victorian Murray	Palustrine	Pt1.2.2: Temporary black box swamp
Lake Cullen	North Central CMA	Victorian Murray	Lacustrine	Lst1.1: Temporary saline lake
Lake Cullen	North Central CMA	Victorian Murray	Palustrine	Pt3.1.2: Clay pan
Lake Elizabeth	North Central CMA	Victorian Murray	Lacustrine	Lsp1.2: Permanent saline lake with aquatic bed
Lake Murphy	North Central CMA	Victorian Murray	Palustrine	Pt1.2.2: Temporary black box swamp
McDonalds Swamp	North Central CMA	Victorian Murray	Palustrine	Pt1.2.2: Temporary black box swamp
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Floodplain	F1.2: River red gum forest riparian zone or floodplain
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Floodplain	F1.4: River red gum woodland riparian zone or floodplain
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Lacustrine	Lp1.1: Permanent lake

Asset Name	CMA	WPRA	System Type	ANAE Type
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Lacustrine	Lt1.1: Temporary lake
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pp2.1.2: Permanent tall emergent marsh
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pp2.2.2: Permanent sedge/grass/forb marsh
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pp4.2: Permanent wetland
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pt1.1.2: Temporary river red gum swamp
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pt1.6.2: Temporary woodland swamp
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pt2.1.2: Temporary tall emergent marsh
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pt2.2.2: Temporary sedge/grass/forb marsh
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pt2.3.2: Freshwater meadow
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pt3.1.2: Clay pan
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pt4.1: Floodplain or riparian wetland
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Palustrine	Pt4.2: Temporary wetland
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Riverine	Rp1.2: Permanent transitional zone stream
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Riverine	Rp1.4: Permanent lowland stream
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Riverine	Rt1.1: Temporary high energy upland stream
Murray floodplain between Lake Hume and Lake Mulwala	North East CMA	Victorian Murray	Riverine	Rt1.4: Temporary lowland stream

Appendix K. Basin Plan objectives

Table 34. Basin Plan objectives – Chapter 8 environmental watering plan.

EWP objective code	EWP objective
Ecosystem type and biodiversity	
8.05,2(a)	An objective is to protect and restore **a subset** of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that: declared **Ramsar wetlands** that depend on Basin water resources **maintain their ecological character**; and (Note: see paragraph 21(3)(c) of the Act
8.05,2(b)	An objective is to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that: 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
8.05,2(c)	An objective is to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that: water-dependent ecosystems are able to **support episodically high ecological productivity** and its **ecological dispersal**.
8.05,3(a)	An objective is to protect and restore **biodiversity** that is dependent on Basin water resources by ensuring that: 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
8.05,3(b)	An objective is to protect and restore **biodiversity** that is dependent on Basin water resources by ensuring that: **representative populations** and **communities of native biota** are **protected** and, if necessary, **restored**.
Ecosystem function	
8.06,2	An objective is 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(a)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: the **diversity and dynamics** of **geomorphic structures**, **habitats, species and genes** are **protected and restored**; and
8.06,3(b)(i)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: **ecological processes** dependent on **hydrologic connectivity**: (i) **longitudinally along watercourses**;
8.06,3(b)(ii)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: **ecological processes** dependent on **hydrologic connectivity**: (ii) **laterally** between watercourses and their floodplains (and associated wetlands);
8.06,3(b)(iii)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: **ecological processes** dependent on **hydrologic connectivity**: (iii) **vertically between the surface and subsurface**; are protected and restored; and
8.06,3(c)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: 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
8.06,3(d)	An objective is to protect and restore connectivity within and between water-dependent ecosystems, including by ensuring that: 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 Note: This is to ensure that water quality is maintained at a level that does not compromise the ecosystem and that hydrologic connectivity is restored and maintained.

EWP objective code	EWP objective
8.06,3(e)(i)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: 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: (i) **maintaining levels above 0.4 metres Australian Height Datum for 95% of the time**, as far as practicable; and
8.06,3(e)(ii)	An objective is to **protect and restore connectivity** within and between water-dependent ecosystems, including by ensuring that: 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: (ii) **maintaining levels above 0.0 metres Australian Height Datum** all of the time; and
8.06,3(f)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: **barriers to the passage of biological resources (including biota, carbon and nutrients)** through the Murray-Darling Basin are **overcome** or **mitigated**.
8.06,4	An objective is that **natural in-stream and floodplain processes** that **shape landforms** (for example, the formation and maintenance of soils) are protected and restored.
8.06,5	An objective is to support habitat diversity for biota at a range of scales (including, for example, the Murray-Darling Basin, riverine landscape, river reach and asset class).
8.06,6(a)	An objective is to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (for example recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that: flow sequences, and inundation and recession events, meet ecological requirements (for example, cues for migration, germination and breeding); and
8.06,6(b)	An objective is to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (for example recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that: habitat diversity, extent, condition and connectivity that supports the life cycles of biota of water-dependent ecosystems (for example, habitats that protect juveniles from predation) is maintained.
8.06,7	An objective is 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.
Ecosystem resilience	
8.07,2	An objective is that water-dependent ecosystems are resilient to climate change, climate variability and disturbances (for example, drought and fire).
8.07,3	An objective is 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	An objective is 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	An objective is to **mitigate human-induced threats** (for example, the impact of alien species, water management activities and degraded water quality).
8.07,6	An objective is to minimise habitat fragmentation.

Note: Coding system is from (Butcher & Fenton, 2020)

Table 35: Basin-wide environmental watering strategy (2019) Expected Environmental Outcomes relevant to Victorian Murray water resource plan area

Theme	Code.	Sub-theme		BWS Expected Environmental Outcome	Relevant to Victorian Murray	Page of BWS
River flows and connectivity	B1.1	Longitudinal connectivity		To keep base flows at least 60% of the natural level	X	30
	B1.2			A 30% overall increase in flows in the River Murray: from increased tributary contributions from the Murrumbidgee, Goulburn, Campaspe, Loddon and Lower Darling catchments collectively	X	30
	B1.3	Lateral connectivity		A 30 to 60% increase in the frequency of freshes, bank-full and lowland floodplain flows in the Murray, Murrumbidgee, Goulburn–Broken and Condamine–Balonne catchments	X	30
	B1.4			A 10 to 20% increase of freshes and bank-full events in the Campaspe, Loddon and Wimmera catchments		30
	B1.5			Current levels of connectivity maintained in the Ovens catchments		30
	All river flow and connectivity outcomes are to be achieved by 2024					
Native Vegetation	B2.1	Forests and Woodlands		Maintain current extent of forest and woodland including approximately: 360,000 ha of river red gum 409,000 ha of black box	X	36
	B2.2			No decline in the condition of river red gum and black box across the Basin	X	36
	B2.3		Ovens	Maintain extent and condition** of water-dependent vegetation (10,200ha RRG, <100ha BB) near river channels and on the floodplain		108
	B2.4		Goulburn–Broken	Maintain extent of water-dependent vegetation near river channels and on low lying areas of the floodplain. Improve condition of black box and river red gum (19,800ha RRG, 500ha BB)		108

	B2.5		Campaspe	Maintain extent and condition** of water-dependent vegetation near river channels (1,900ha RRG, <100ha BB)		108
	B2.6		Loddon	Maintain extent and condition** of water- dependent vegetation near river channels (2,200ha RRG, 700ha BB)		109
	B2.7		Murray	Maintain extent of water-dependent vegetation near river channels and on low-lying areas of the floodplain. Improve condition of black box and river red gum (90,600ha RRG, 41,700ha BB NSW & Vic).	X	109
	B2.8			By 2024 improve condition of black box and river red gum	X	36
	B2.9			By 2024 improve recruitment of trees within river red gum and black box communities	X	37
	B2.10	Shrublands		Maintain extent of Lignum along the River Murray from the junction with the Wakool River to downstream of Lock 3, including Chowilla and Hattah Lakes	X	37
	B2.11	Non-woody vegetation		To maintain the current extent of non-woody vegetation	X	37
	B2.12			By 2024, increased periods of growth for communities that closely fringe or occur within the main river corridors (includes Avoca, Avon, Richardson and Wimmera rivers)	X	37
	B2.13			By 2024, increased periods of growth for communities that form extensive stands within wetlands and low-lying floodplains including Moira grasslands in Barmah–Millewa Forest	X	37
Waterbirds	B3.1			That the number and type of water bird species present in the Basin will not fall below current observations	X	45
	B3.2			A significant improvement in waterbird populations in the order of 20 to 25% over the baseline scenario, with increases in all waterbird functional groups	X	45
	B3.3			Breeding events (the opportunities to breed rather than the magnitude of breeding per se) of colonial nesting waterbirds to increase by up to 50% compared to the baseline scenario	X	45
	B3.4			Breeding abundance (nests and broods) for all of the other functional groups to increase by 30-40% compared to the baseline scenario, especially in locations where the Basin Plan improves over bank flows	X	45
Native Fish	B4.1	Broad outcomes		No loss of native fish spp currently present within the basin	X	49
	B4.2			Improved population structure of key fish species through regular recruitment	X	49
	B4.3			Increased movement of key fish species	X	49

	B4.4			Expanded distribution of key fish species and populations	X	49
	B4.5			Improved community structure of key native fish species	X	49
	B4.6	Short-lived species		Restored distribution and abundance to levels recorded pre-2007	X	49
	B4.7	Moderate to long-lived species		Improved population structure (i.e. a range of size/age classes for all species and stable sex ratios where relevant) in key sites. This will require annual recruitment events in at least eight out of 10 years at 80% of key sites, with at least four of these being 'strong' recruitment events.	X	49
	B4.8			A 10-15% increase of mature fish (of legal take size) for recreational target species (Murray cod and golden perch) in key populations	X	49
	B4.9			Annual detection of species and life stages representative of the whole fish community through key fish passages; with an increase in passage of Murray cod, trout cod, golden perch, silver perch, Hyrtl's tandan, congolli, short-headed lamprey and pouched lamprey through key fish passages to be detected in 2019–2024; compared to passage rates detected in 2014–2019	X	49
	B4.10			Significant increases in the distributions of key species (see key fish spp table) in the southern Basin.	X	116