Wimmera-Mallee Long-term Watering Plan

Minor Update

September 2020

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VICTORIA State Government | Environment, Land, Water and Planning

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Wimmera River (source Wimmera 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.

ISBN 978-1-76105-281-1 (pdf)

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Abbreviations

ARI	Arthur-Rylah Institute
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
MDBFS	Murray-Darling Basin Fish Survey
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

SCBEW	Southern Connected Basin Environmental Watering Committee
TLM	The Living Murray
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 Piambe WMU Hattah Lakes Kiewa River Broken Creek
Basin Plan	The Basin Plan (MDBA, 2012a) was developed in accordance with the Commonwealth *Water Act 2007*. 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 Environment, Climate Change and 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 Wimmera-Mallee water resource plan area, which extends from the Grampians through to the broad floodplains of the Wimmera, Avon-Richardson and Avoca river systems and up to the Murray River floodplain in north western Victoria. The landscape of this water resource plan area is dominated by the terminal lakes and wetlands of these waterways.

This is a minor update to the 2015 LTWP for the Wimmera-Mallee, as required under the Basin Plan (s. 8.22) following the accreditation in 2019 by the Murray-Darling Basin Authority (MDBA) of the Wimmera-Mallee Water Resource Plan (DELWP, 2019) 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 the Wimmera-Mallee Water Resource Plan (DELWP, 2019), 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 what environmental watering will occur
- updated monitoring section
- updated list of priority environmental assets and functions
- inclusion of revised information from the updated Wimmera River EWMP (Wimmera CMA, 2020) and Wimmera Catchment Management Authority Wimmera-Mallee Pipeline wetlands Objectives (Fenton, 2020).

The next LTWP update is planned for 2022-3, following the next planned update by the MDBA of the Basin-wide environmental watering strategy in 2022.

This LTWP focuses on the use of environmental water to achieve ecological outcomes in the Wimmera-Mallee 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 ecological 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 Wimmera-Mallee 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 Wimmera-Mallee 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 Northern Victoria water resource plan areas.

Key elements of this plan can be summarised as follows:

Priority environmental assets

There is one main river system and associated wetlands in the Wimmera-Mallee water resource plan area that meet criteria for priority environmental assets, in that they are able to receive environmental water, and meet criteria set out in Schedule 8 of the Basin Plan. This is the Wimmera River system, which receives held environmental water.

Priority ecosystem functions

Four main ecosystem functions have been identified for this LTWP in the Wimmera-Mallee water resource plan area concerning hydrological connectivity between river reaches, surface water salinity, refuges for native fish species, and geomorphic habitat. 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 Wimmera-Mallee water resource plan area supports important water-dependent ecological values including: native fish (e.g. freshwater catfish, flat-headed gudgeon and Australian smelt); vegetation (e.g. spiny lignum, ridged water milfoil and cane grass); waterbirds (e.g. brolga, blue-billed duck, Australian painted snipe); frogs, turtles and platypus. Ecosystem functions that support these ecological values include geomorphological condition and hydrological connectivity.

Objectives

The LTWP includes thirteen objectives for identified ecological assets and ecosystem functions to support waterway health in the Wimmera-Mallee 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. For the unregulated rivers in the water resource plan area, information was also obtained from the CMA-authored Regional Waterway Strategies and supporting data.

Ecological objectives were extracted from individual EWMPs and standardised so that each included a trajectory (e.g. improve), aspect (e.g. abundance) and value (e.g. large-bodied native fish). Objectives were then grouped into themes across values and functions, producing a set of objectives relevant across the water resource plan area.

Theme	Objectives
Fish	Improve the abundance of large-bodied fish
	Improve habitat and movement and maintain species richness of native fish
Waterbirds	Improve breeding opportunities and habitat for waterbirds
Vegetation	Improve the abundance and maintain the species richness and extent of aquatic vegetation
	Improve the condition of riparian EVCs
	Improve the condition of wetland EVCs
	Maintain the condition of black box dominated EVCs
Connectivity and Functions	Improve longitudinal 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 (maintain channel form, clean substrates, prevent stream bed colonisation)
Other	Improve habitat for Platypus and Rakali communities
	Maintain habitat for crayfish, turtle and frog communities

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 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[1].

CMAs work with Traditional Owner groups with formal land use agreements in the management of waterways. In the Wimmera-Mallee water resource plan area these groups are the Dja Dja Wurrung, Latji Latji, Ngarket, Ngintait, Tati Tati, Wamba Wamba, Wotjobaluk, Jaadwa, Jadawadjali, Jupagulk and Wergaia.

Constraints

The Wimmera-Mallee water resource plan area falls outside the areas where the MDBA considered that a relaxation of constraints would give the greatest return for the environment from a Basin-scale perspective of environmental outcomes. As such, the environmental water delivery constraints in this water resource plan area have received comparatively less attention from the MDBA than the other water resource plan areas in Victoria, which have been considered through the MDBA's *Constraints Management Strategy 2013 to 2024*.

The EWMP for the Wimmera River system identifies a number of physical constraints arising from limited watercourse capacity and outlet release capacity. A number of studies have been undertaken in recent years to identify ways to overcome some of these constraints (recognising that some are unfeasible to address) and the Wimmera CMA continues to lead the implementation of the recommendations from such studies.

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 ecological objective
- risk of adverse impacts in the provision of environmental water.

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

The risks associated with adverse impacts arising from the provision of environmental water are grouped by their impact on environmental, social and economic values.

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

1. In other Victorian water resource plan areas the Southern Connected Basin Environmental Water Committee (SCBEWC) is also involved in the process.

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.

Consultation with Traditional Owner groups across northern Victoria on LTWPs has been carried out in 2020, together with consultation on improving the guidance for EWMPs on Traditional Owner partnership. Feedback from this consultation will be integrated into the next release of the EWMP guidelines. Due to the heavy reliance of the LTWPs on EWMP information this was agreed with the MDBA to be the most important area of 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 2022. 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.

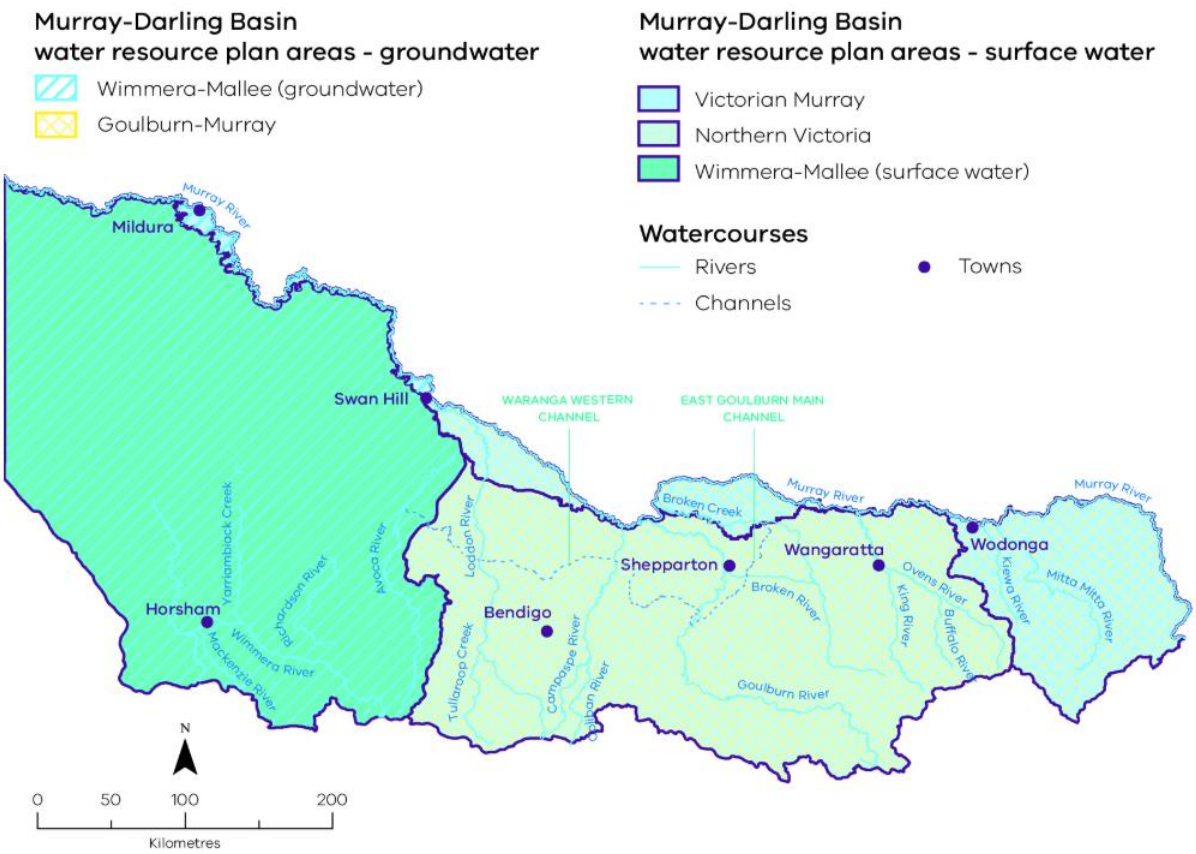


Figure 1: Victoria's three surface water resource plan areas – Victorian Murray, Northern Victoria, and Wimmera-Mallee.

This LTWP for the Wimmera-Mallee 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

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. These environments now operate in a way that is significantly modified from natural conditions. Without continuation of environmental watering in Victoria, the future trajectory of river and wetland biota and condition would continue to decline. While some improvements may be produced by complementary catchment activities (see Section 7), the provision of a suitable watering regime is essential to achieve the objectives and targets outlined in this plan.

Using environmental water to improve environmental conditions does not require the provision of a completely natural water regime. Specific components of a watering regime can have specific impacts on biota, or 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 specifically linked to the proposed outcomes from the environmental flows.

Environmental watering will not return rivers and wetlands to their pre-European condition. Many rivers and wetlands are so modified that this is not feasible. However, environmental watering can help to minimise some of the impacts of these modifications on rivers and wetlands, whilst still being a shared resource that meets economic, cultural and recreational needs.

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 provides for the attainment of 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.

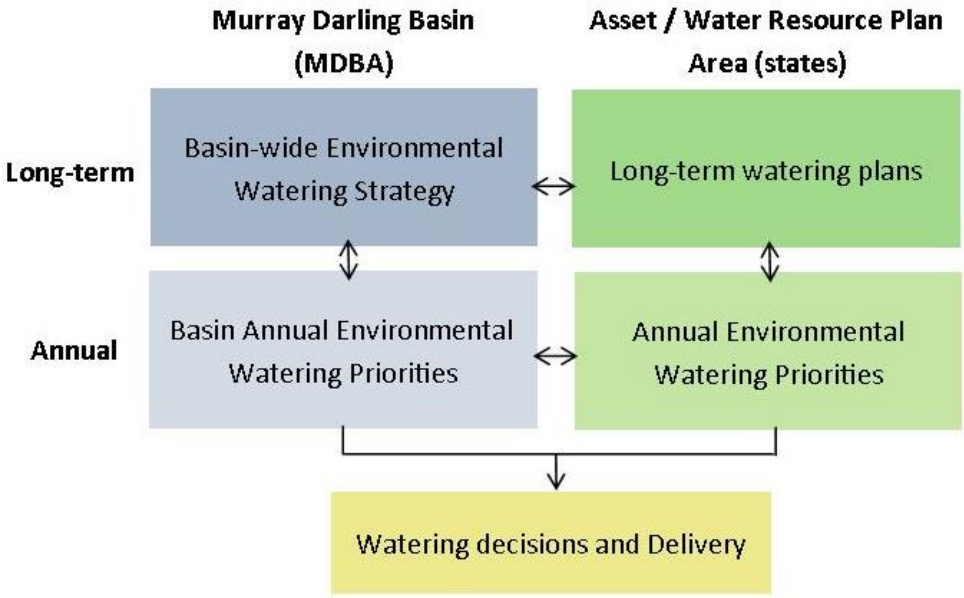


Figure 2: The long-term and annual planning documents required under Basin Plan Chapter 8 'Environmental Watering Plan'.

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).

1.1 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 Wimmera-Mallee water resource plan area. It identifies the priority environmental assets and ecosystem functions for the water resource plan area, long-term ecological 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 outlines potential ways to monitor and evaluate the targets in this plan.

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.

1.2 Purpose of the long-term watering plan

LTWPs assist planning for environmental water outcomes, in order 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 demands 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 Wimmera-Mallee Water Resource Plan (DELWP, 2019) was accredited by the MDBA in September 2019. 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 Wimmera-Mallee LTWP is required under Basin Plan due to the accreditation of the Wimmera-Mallee Water Resource Plan. The aim of this update is to ensure alignment with the Wimmera-Mallee Water Resource Plan and does not make substantive change to the document. A further update is planned in 2022/3, following the next planned update by the MDBA of the Basin-wide environmental watering strategy (Figure 3).

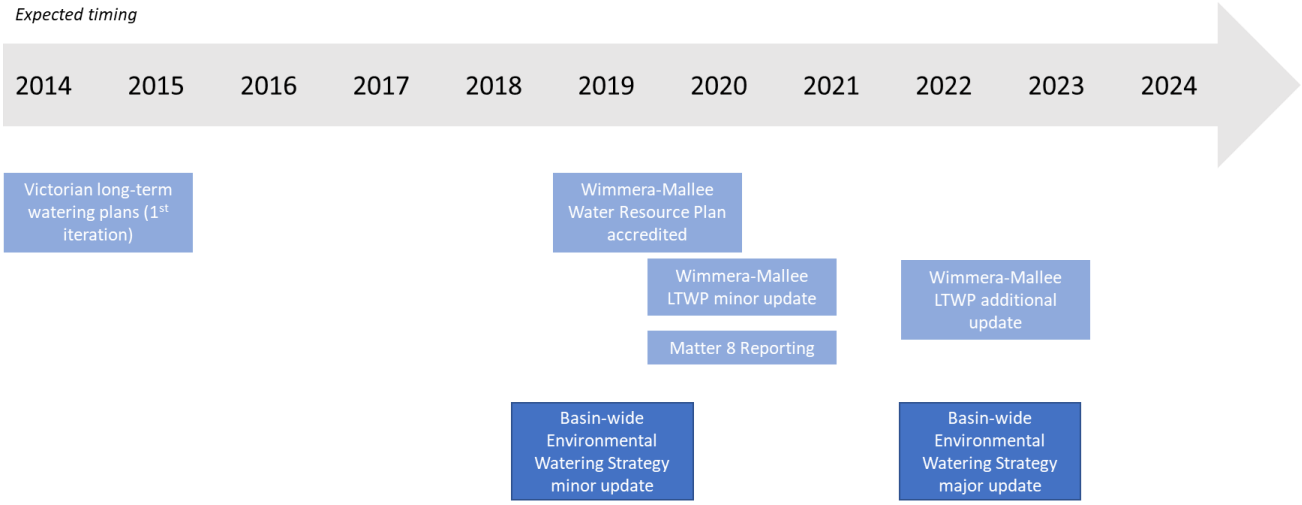


Figure 3: Victoria's long-term environmental water planning process in the context of other planning and strategic documents.

1.2 Basin-wide environmental watering strategy

The Basin-wide environmental watering strategy (BWS) 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. LTWP objective alignment 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. In the Wimmera-Mallee several sites are listed in the BWS as important for waterbirds, and are discussed in Section 2.2.

1.3 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 Appendix Ab).

1.4 Victorian frameworks

1.4.1 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 Wimmera-Mallee Water Resource Plan (DELWP, 2019)

1.4.2 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.

The VWMS acknowledges that co-dependencies exist between all management areas in maintaining or improving outcomes for waterway health.

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; and
- 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[2] are nominated as regional waterway managers under Part 10 of the Victorian *Water Act*.

CMAs have established Regional Catchment Strategies that are the primary integrated planning framework for land, water and biodiversity management in each region in northern 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 Wimmera-Mallee water resource plan area, the relevant CMAs and their Regional Waterway Strategies are:

- Wimmera; Wimmera Waterway Strategy 2014-22 (Wimmera CMA, 2014))
- Mallee; Mallee Waterway Strategy 2014-22 (Mallee CMA, 2014)
- North Central; North Central CMA Waterway Strategy 2014-22 (North Central CMA, 2014)

1.4.3 Environmental water framework

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

In order to provide more appropriate regimes for the environment, the adaptive management cycle is applied and includes:

- ensuring environmental water needs are understood and met
- 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 of environmental water management in order to demonstrate and adaptively manage outcomes; and
- reviewing the process in order to adapt and improve as required.

Necessary to support these are:

2. 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.

- clear roles and responsibilities
- management of risks relating to environmental water
- adequate research to support environmental watering knowledge
- appropriate investment at each stage.

1.4.4 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, taking into consideration the Basin, State and Regional scales, as well as long-term and annual. This includes development of EWMPs and Seasonal Watering Proposals by CMAs, and the state-wide Seasonal Watering Plan by VEWH.

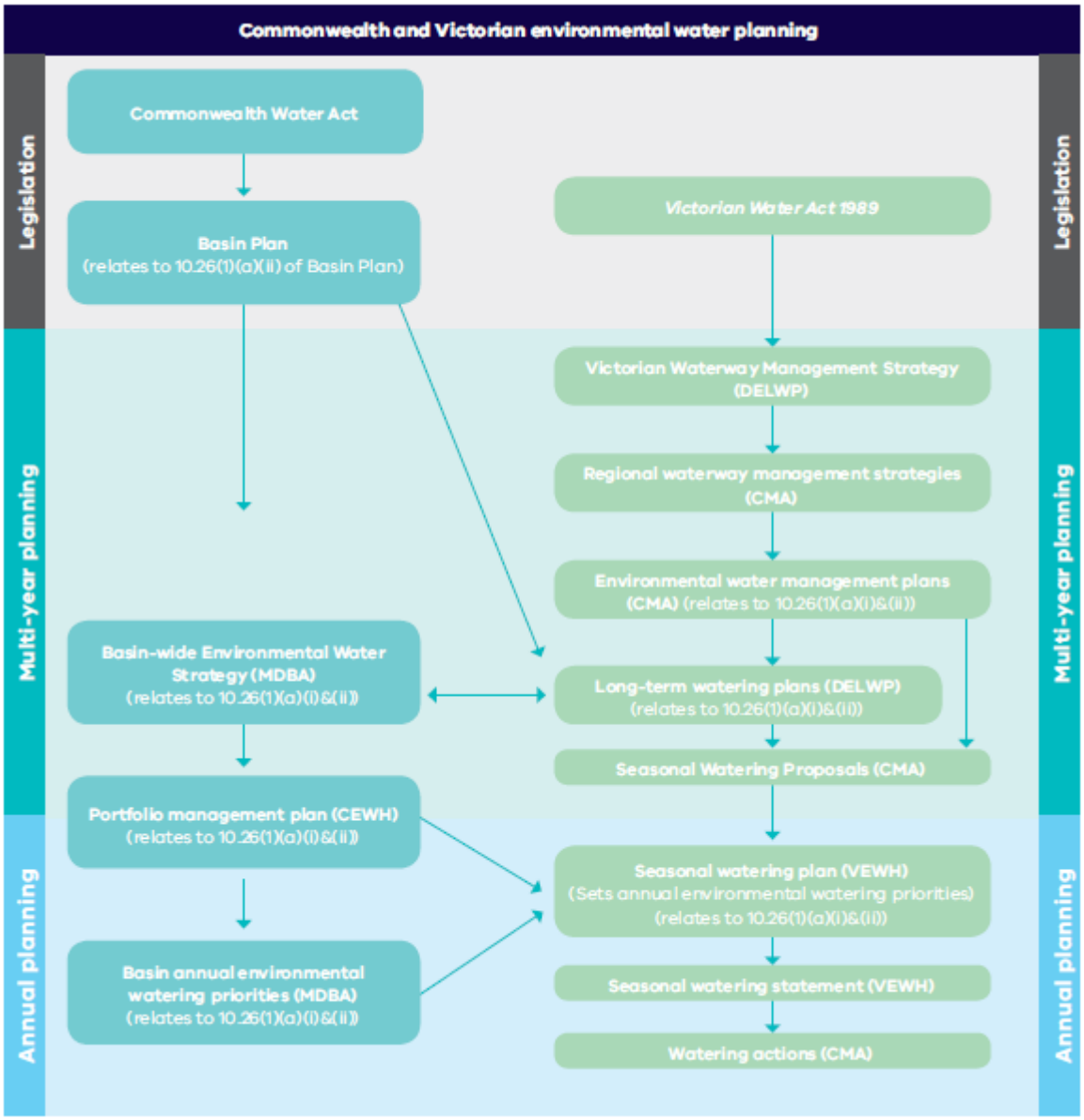


Figure 4: Environmental water planning and delivery framework in Victoria – Basin, State and Regional scales

In use of its environmental water holdings, the VEWH then employs criteria to prioritise watering actions 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).

Figure 5: VEWH Criteria for prioritising environmental watering actions

1.4.5 Seasonally adaptive approach

Victoria has adopted a 'seasonally adaptive' approach to achieving priorities for environmental watering, along with works and complementary measures (i.e. achieving objectives may rely on more than just delivering water), depending on the amount of water available in a given year (Table 1). It is a

flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts. This approach recognises that realizing the ecological outcomes associated with the BWS and the objectives outlined in the Basin Plan can require a medium to long-term outlook. For example, recruitment of native fish to increase abundance and diversity might require an outlook of one to 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 regional waterway management strategies and sustainable water strategies and reviewed through the 15-year resource review			
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	• Protect refuges • Protect high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management,	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal

	risk areas and contingency plans in place • Investigate feasibility of translocations • Environmental emergency 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	water quality improvement and in-stream habitat works • Environmental emergency management plans in place • Improve connectivity • Implement post-bushfire river recovery plans	and in-stream habitat works. • Monitor and survey river and wetland condition • Improve connectivity between rivers and floodplain wetlands.	management, water quality improvement and in-stream habitat works. • Monitor and survey river and wetland condition • Emergency flood management plans in place • Implementation of post flood river restoration programs

1.4.6 Delivery partners

A number of key delivery partners are involved in environmental water outcomes in Victoria. These organisations and their roles are identified in the Cooperative Arrangements section of this plan (Section 5).

1.4.7 Shared benefits

When planning for environmental watering and making decisions about the use of environmental water, the primary purpose is to maximise environmental benefit. Where consistent with this objective, environmental water managers also consider whether shared benefits can be achieved. Shared benefits are secondary opportunistic benefits that can be achieved from environmental watering, including social, cultural, recreational and economic benefits. In many situations environmental water provides these benefits. However, the use of environmental water to provide for specific social, cultural, recreational or economic benefits cannot be prioritised at the expense of achieving environmental objectives.

Waterway managers work with communities to identify the environmental, social, Indigenous, 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 Wimmera-Mallee Water Resource Plan.

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

The Wimmera-Mallee water resource plan area extends from the Grampians in the south, through the broad floodplains of the Wimmera, Avon-Richardson and Avoca river systems and up to the Murray River floodplain in north-western Victoria. It contains sections of the Mallee, Wimmera and North Central CMA regions.

2.1 Features of the Wimmera-Mallee water resource plan area

The Wimmera-Mallee water resource plan area (Figure 6Figure 7) is located in north-west Victoria and extends from the Grampians and the Pyrenees Ranges in the south, to Ouyen and Kerang in the north. The western extent of the water resource plan area is bounded by Victoria's border with South Australia, the Millicent Coast basin and the northern Victoria water resource plan area to the east.

The Wimmera-Mallee water resource plan area is dominated by the Wimmera, Avon-Richardson and Avoca River systems. The three waterway systems flow north and terminate before reaching the River Murray. The wetlands of the Wimmera-Mallee water resource plan area include the terminal lakes, Lake Albacutya and Lake Hindmarsh, and the Wimmera-Mallee Pipeline wetlands, a large collection of wetlands located east of the terminal lakes.

The surface water component of the Wimmera-Mallee water resource plan area includes parts of three basins[3] as shown in Figure 6:

- Basin 15 – Wimmera-Avon
- Basin 8 – Avoca
- Basin 14 – Mallee.

The Wimmera-Avon rivers' surface water basin is not connected to the River Murray. The Avoca basin is infrequently connected to the River Murray via the Avoca floodway that connects with the Kerang Lakes during floods. The Mallee basin is a semi-arid zone that has no perennial streams, with localised runoff during exceptionally wet conditions and no surface water diversions. The Wimmera-Mallee (surface water) water resource plan area includes inter-basin water transfers from the Glenelg basin in the south, the River Murray in the north and the Goulburn system in the east. It also transfers water south to the Hopkins basin to supply towns such as Ararat.

The Wimmera-Mallee headworks system is a complex network of storages, channels and pipes that regulates flow in many of the waterways of the Wimmera-Mallee water resource plan area. This headworks system enables water to be shifted between storages and interconnects the three major river basins of the Wimmera, Avoca and Glenelg. Two notable changes to the regulated systems within this water resource plan area were the completion of the Wimmera-Mallee Pipeline in 2010 and the cessation of the Wimmera Irrigation Area. These two factors have greatly reduced the consumptive water demand requirements and system operating losses.

3. In Division IV, Murray-Darling Basin, of the Australian Water Resources Council (AWRC) Drainage Basins (Auslig 2001).

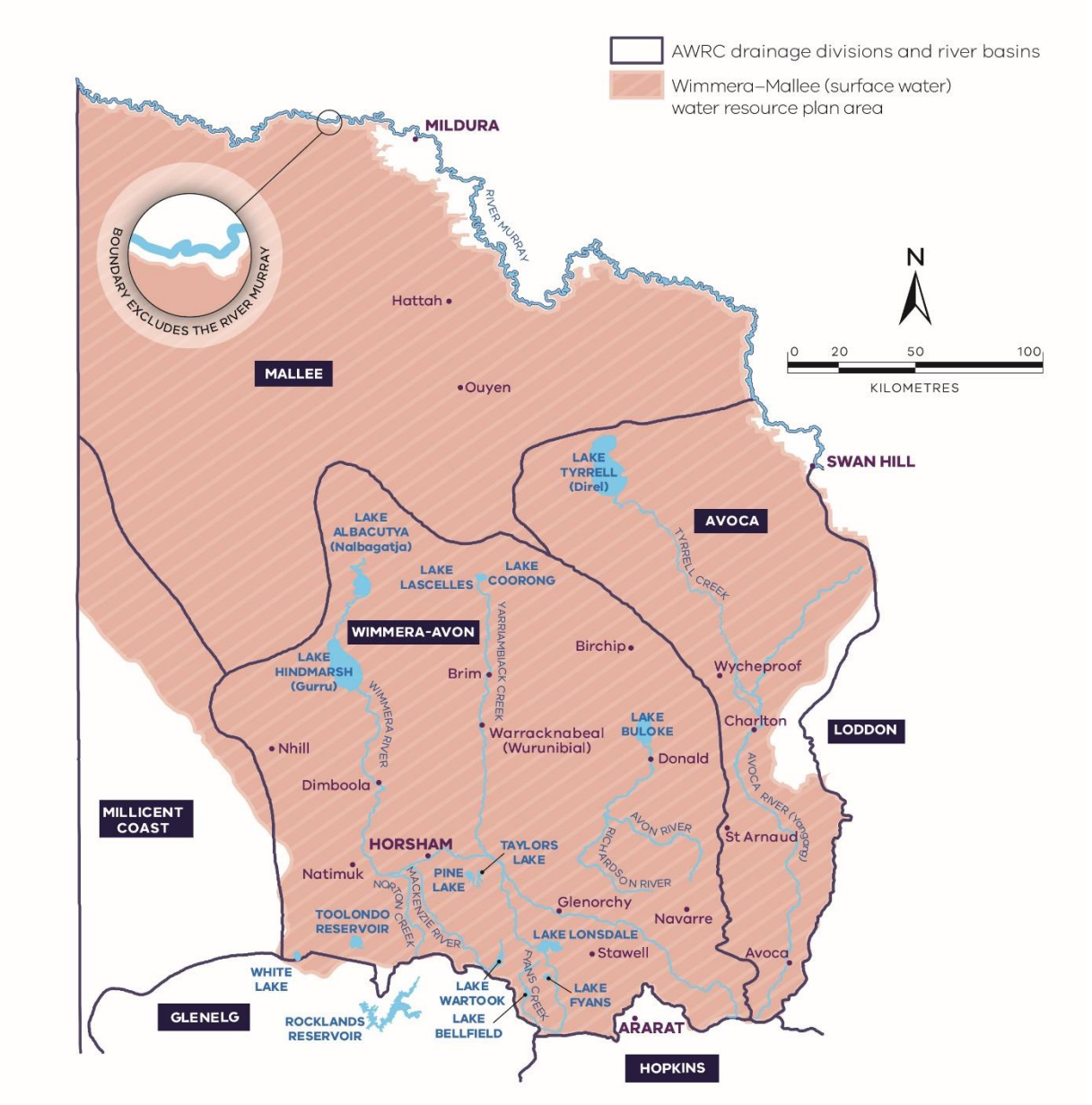


Figure 6: Wimmera-Mallee (surface water) water resource plan area

2.1.1 Topography

The landscape in this region is dominated by the Grampians and Pyrenees Ranges to the south, the broad floodplains of the Wimmera and Avon-Richardson and Avoca River systems that flow through the landscape, the Aeolian (wind-blown/dune) areas of the Little Desert, Wyperfield and Murray Sunset National Parks and the large terminal lakes including Lake Albacutya (which is a Ramsar listed asset), Lake Hindmarsh, Lake Tyrrell and the Kerang Lakes. The Wimmera-Mallee region is part of Victoria's *North West Plains*.

The highest point in the Grampians is Mount William at 1167 m AHD, with the surrounding south-eastern area sitting at around 500 m AHD which quickly drops down into the low land areas of the terminal lakes and Mallee area located under 100 m AHD (ABS, 2012). Figure 7 presents the (relative) topography in the Wimmera-Mallee water resource plan area.

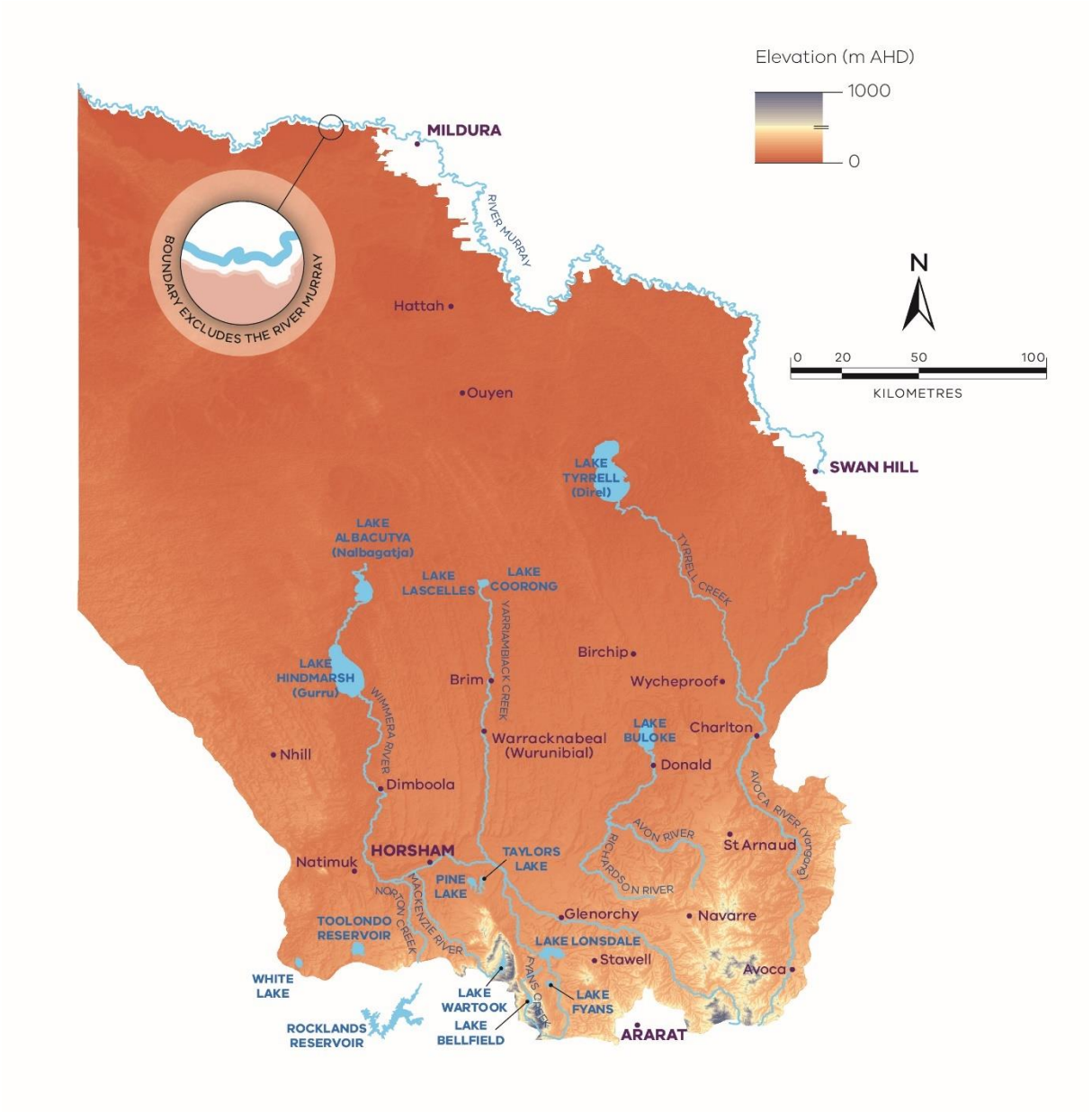


Figure 7: Topography in the Wimmera-Mallee water resource plan area

2.1.2 Geology, soils and land use

The region is relatively flat and sits on the geologically stable western plains of Victoria. The geology of the Wimmera-Mallee includes alluvium and dune deposits in the vast floodplain areas signifying wind-blown Aeolian landscapes over the Woorinen Formation to the north of the water resource plan area, and Cambrian rock of the Grampians and St Arnaud groups in the south-east.

The dominant land-use in the Wimmera-Mallee region is dryland grazing/cropping in the south and irrigated cropping in the Murray floodplains (CSIRO, 2007). There is also some plantation forestry and viticulture in the higher rainfall areas in the south.

The remarkable nature of the landscape is its flatness that, along with the soil and geological nature of the landscape, supports the numerous lakes in the region. The flat topography increases the area's susceptibility to prolonged and extensive flooding (see Figure 8 below).

2.1.3 Rainfall distribution

The average annual rainfall for the region ranges from up to 700 mm in the Grampians to less than 300mm near Mildura. The rainfall distribution for the Wimmera-Mallee is driest in early autumn, and wettest in winter (BoM, 2015).

Figure 8: Aerial view of flooding at Birchip township in 2018 (Source: Buloke Shire Council).

2.1.4 Working rivers

The rivers of this water resource plan area provide for environmental, economic, cultural and social outcomes. As such the rivers have been modified to varying extents 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-European state, but that they be managed as 'working rivers' with agreed sustainable levels of modification and use, which may include improvements in ecological values and functions.

2.2 Priority environmental assets within the Wimmera-Mallee water resource plan area

Priority environmental assets listed in this LTWP (Table 2) 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. An asset may be a single wetland or waterbody (e.g. Lake Hindmarsh), a wetland complex (e.g. Wimmera-Mallee Pipeline wetlands), or a river/creek (e.g. Mount William Creek). Asset locations are provided in Figure 9.

The Wimmera River is the main river system in the Wimmera-Mallee water resource plan area. This river, together with its tributaries and associated terminal wetlands, are listed as priority environmental assets. Other priority environmental assets include Yarriambiack Creek and a suite of 52 wetlands in the centre of the water resource plan area that are watered by the Wimmera-Mallee pipeline.

It should be noted that there are some assets on the northern boundary of the Wimmera-Mallee water resource plan area (e.g. Hattah Lakes, Kerang Lakes) that are included in the LTWP for the Victorian Murray water resource plan area, as these receive water from the Murray River and upstream catchments, rather than from the Wimmera-Mallee catchments.

Wetlands that are listed in the BWS as important environmental assets at the Basin scale for waterbirds in the Wimmera-Mallee water resource plan area are Lake Hindmarsh, Lake Albacutya, Lake Buloke, Hattah Lakes and Kerang Lakes. As noted above, Hattah Lakes and Kerang Lakes are included in the Victorian Murray LTWP. Lake Buloke, a terminal lake of the Richardson River cannot receive environmental water and hence is not included as a priority environmental asset in this LTWP.

Changes to priority environmental assets since the previous LTWP

The Avon-Richardson and Avoca Rivers were provisionally included in the 2015 LTWP whilst the definition of planned environmental water was being clarified. As discussed in section 4.2, a review of Victoria's bulk entitlements and statutory management plans in the Wimmera-Mallee water resource plan area undertaken during the water resource plan process has determined that there is no planned environmental water in the Wimmera-Mallee water resource plan area. Hence the Avon-Richardson and Avoca Rivers are no longer considered to be priority environmental assets. The aim for unregulated rivers is to maintain existing arrangements (e.g. conditions regulating the take of water through Bulk Entitlements and licences) rather than deliver held environmental water.

Beulah Weir Pool is no longer watered and is not considered a priority environmental asset. It had previously received water largely to meet temporary recreational rather than environmental objectives.

Three new wetlands are being considered for full inclusion as priority environmental assets in the 2022/3 LTWP update. These include two wetlands in the Wimmera system and one new Wimmera-Mallee Pipeline Wetland that have recently been watered:

- Dock Lake, one of the Wimmera's large terminal lakes near Horsham, would have naturally filled when the nearby Green Lake filled and overflowed. In the 1930s, Dock Lake was modified to allow it to be used as a water storage for irrigation supply in the Wimmera-Mallee system. Dock Lake was removed from the supply system after the completion of the Wimmera-Mallee Pipeline in 2010. In late 2016, large-scale flooding in the catchment partially filled Dock Lake when Green Lake filled and overflowed. Managed water deliveries can now only be delivered through a small channel from Green Lake, when there is enough water in Green Lake to gravity-feed Dock Lake.
- Ranch Billabong, near Dimboola, is located on land managed by Barengi Gadjin Land Council Aboriginal Corporation (BGLC). The billabong system was disconnected from the Wimmera River by a road embankment. The embankment and river regulation in the Wimmera River have significantly altered the natural water regime of Ranch Billabong. Restoring habitat for native animals, fish and plant communities at Ranch Billabong is an important outcome for the environment, Traditional Owners and their Nations.
- Uttiwillock Wetland is a newly connected Wimmera-Mallee Pipeline wetland with diverse flora and fauna including numerous listed species. Environmental water delivery will contribute to outcomes for aquatic and woodland vegetation, along with providing refuge habitat for frogs and turtles and an important watering point for birds and other animals.

Some information for these additional wetlands is included in this minor LTWP update, but they have not yet been fully incorporated, for example their objectives are not collated into the LTWP objectives. Their further inclusion will be assessed for the next LTWP update planned in 2022/3.

Table 2: Priority environmental assets in the Wimmera-Mallee water resource plan area

Asset Name	Basin	Asset Manager	Terminal lakes	Schedule 8 Criteria	Asset characteristics
Wimmera River	Wimmera-Avon	Wimmera CMA	Lakes Hindmarsh, Lake Albacutya	2 3 4 5	Heritage listed; Wetland of national importance Deep pools – drought refuge Connectivity and pathways for dispersal Breeding and nursery habitat for Freshwater Catfish Instream macrophytes provide food and habitat High load of large woody debris EPBC Act, FFG Act, DSE list High biodiversity Number of EVCs in the region – 22 Riverine Chenopod Woodland – Endangered, EVC 103 Floodplain Riparian Woodland – Endangered, EVC 56 Sand Ridge Woodland – Endangered, EVC 264
Mount William Creek	Wimmera-Avon	Wimmera CMA	Lakes Hindmarsh, Lake Albacutya	3 4 5	Chain-of-ponds sequence Riffles Breeding and nursery habitat for Southern Pygmy Perch and Obscure Galaxias Inputs organic and inorganic sediment into terminal lakes EPBC Act, FFG Act, DSE list Number of EVCs in the region – Plains Woodland/Plains Sedgy Woodland – Endangered, EVC 871

Asset Name	Basin	Asset Manager	Terminal lakes	Schedule 8 Criteria	Asset characteristics
MacKenzie River	Wimmera-Avon	Wimmera CMA	Lakes Hindmarsh, Lake Albacutya	2 3 4 5	Intact discontinuous anastomosing channel form noted as unique in Victoria Rocky stretches, transitioning to pools and runs Dense riparian vegetation in upper reaches Instream macrophytes provide food and habitat Complex instream woody habitat Breeding and nursery habitat for platypus, Southern pygmy perch and obscure galaxias Glenelg spiny crayfish and Western swamp crayfish Inputs organic and inorganic sediment into terminal lakes Connectivity and pathways for dispersal EPBC Act, FFG Act, DSE list Number of EVCs in the region – Riverine Chenopod Woodland – endangered, EVC 103
Bungalally Creek	Wimmera-Avon	Wimmera CMA	Lakes Hindmarsh, Lake Albacutya	3 4 5	Productive floodplain areas EPBC Act, FFG Act, DSE list
Burnt Creek	Wimmera-Avon	Wimmera CMA	Lakes Hindmarsh, Lake Albacutya	3 4 5	Intact chain-of-ponds Productive floodplain areas Breeding and nursery habitat for Southern pygmy perch and obscure galaxias Western swamp crayfish Inputs organic and inorganic sediment into terminal lakes EPBC Act, FFG Act, DSE list Number of EVCs in the region – Riverine Chenopod Woodland – Endangered, EVC 103
Outlet Creek	Wimmera-Avon	Wimmera CMA	Lake Albacutya	4 5	EPBC Act, DSE list

Asset Name	Basin	Asset Manager	Terminal lakes	Schedule 8 Criteria	Asset characteristics
Yarriambiack Creek	Wimmera-Avon	Wimmera and Mallee CMAs	Lake Coorong	3 4 5	Productive floodplain areas FFG Act, DSE list Number of EVCs in the region – 2
Lake Albacutya	Wimmera-Avon	Wimmera CMA	-	1 3 4 5	Ramsar, JAMBA, CAMBA, ROKAMBA, Bonn Convention Exposed mudflats provide habitat for waders and shorebirds EPBC Act, FFG Act, DSE list High biodiversity Number of EVCs in the region – Lunette Woodland – Endangered, EVC 652
Lake Hindmarsh	Wimmera-Avon	Wimmera CMA	-	1 2 3	JAMBA, CAMBA, ROKAMBA, Bonn Convention Victoria's largest freshwater lake Exposed mudflats provide habitat for waders and shorebirds Important habitat for nursery sites Drought refuge EPBC Act, FFG Act, DSE list High biodiversity Number of EVCs in the region – Lunette Woodland – Endangered, EVC 652
Barbers Swamp Broom Tank Reserve Bull Swamp Chiprick Reserve Clinton Shire Dam Cokum Bushland Reserve Considine Coundon Wetland	Wimmera-Avon/Avoca (pipeline)	Mallee CMA	-	2 3 4 5	Shallow freshwater marsh DIRWA listed (e.g. Creswick Swamp) Important drought refuge Breeding and nursery habitat Pathways for dispersal EPBC Act, FFG Act, DSE list High biodiversity Number of EVCs in the region – Lunette Woodland – Endangered, EVC 652 Black-Box Wetland – Endangered, EVC 369

Asset Name	Basin	Asset Manager	Terminal lakes	Schedule 8 Criteria	Asset characteristics
Cronomby Tanks Reserve					2c) A number of rare water dependent ecosystems are present in the WMP Wetlands including the rare Cane Grass field at Cherrup Swamp (see Section 6) and FFG listed Marbled Marshwort at Jesse and Creswick swamps. 3 a) With over 22,000 dams and 17,500 kilometers of open channel being decommissioned in the region through the Wimmera-Mallee Pipeline Project (Draper et al., 2006), the WMP Wetlands provides some of the only remaining refuges for water dependent fauna. The impacts of the dramatic loss of open water are not yet quantified however the provision of environmental water to connected sites will ensure that reliable open water remains in the landscape to support some of the regions environmental values. 3 a iii) The lack of open water in the landscape limits the opportunity for waterbird feeding and breeding in the region. The WMP Wetlands will therefore provide some opportunities for breeding (primarily opportunistic generalist species) and feeding (i.e. dabbling duck, grazing waterfowl). 3 b) The WMP Wetlands will ensure that pockets of aquatic habitat remain in the landscape for the benefit of biodiversity. 4 a) The WMP Wetlands support two water dependent EPBC listed species and three terrestrial EPBC listed species that have been recorded and require watering points in the landscape. 4 b) The WMP Wetlands support seven water dependent EVCs, two of which are considered endangered and three
D Smith					
Goulds Reserve					
Greens Wetland					
Homelea					
J Ferrier Wetland					
John Ampt					
Kath Smith					
Lake Danaher Bushland Reserve					
Mahoods Corner					
Morton Plains Reserve					
Pam Juergens					
Part of Gap Reserve					
Paul Barclay					
Poyner					
R Ferrier					
Rickard Glenys					
Roselyn Wetland /Reids Dam					
Round Swamp Bushland Reserve (Newer Tank)					

Asset Name	Basin	Asset Manager	Terminal lakes	Schedule 8 Criteria	Asset characteristics
Shannon's Wayside					vulnerable in the Wimmera Bioregion. A further two EVCs are not listed for the Wimmera bioregion but are considered endangered/ vulnerable in neighbouring bioregions (refer to Section 3.2.3). 4 c) The WMP Wetland supports two water dependent and three terrestrial FFG listed species; and 16 water dependent and 15 terrestrial DELWP Advisory listed species (not including those non-indigenous to the area or planted).
Tchum Lakes Reserve (Wetland)					
Tchum Lakes Reserve (Dam)					
Towma FFR (Lake Marlbed)					
Uttiwillock Wetland					
Chirrup Swamp	Wimmera-Avon/Avoca (pipeline)	North Central CMA	-		
Corack Lake					
Creswick Swamp					
Davis Dam					
Jeffcott Wildlife Reservoir					
Jesse Swamp					
Carapugna	Wimmera-Avon/Avoca (pipeline)	Wimmera CMA	-		
Challambra Swamp					
Crow Swamp					
Fieldings Dam					
Harcoans Swamp					
Krong Swamp					
Mutton Swamp					
Opies Dam					
Pinedale					

Asset Name	Basin	Asset Manager	Terminal lakes	Schedule 8 Criteria	Asset characteristics
Sawpit Swamp					
Schultz/Koschitzke					
Tarkedia					
Wal Wal Swamp					
*Dock Lake	Wimmera-Avon	Wimmera CMA	-		Breeding and nursery habitat for waterbirds (e.g. whiskered tern)
*Ranch Billabong	Wimmera-Avon	Wimmera CMA	-		Significant cultural values

*These assets now receive held environmental water and will be assessed for inclusion as priority environmental assets. Numbers in the asset characteristics refer to Schedule 8 Criteria.

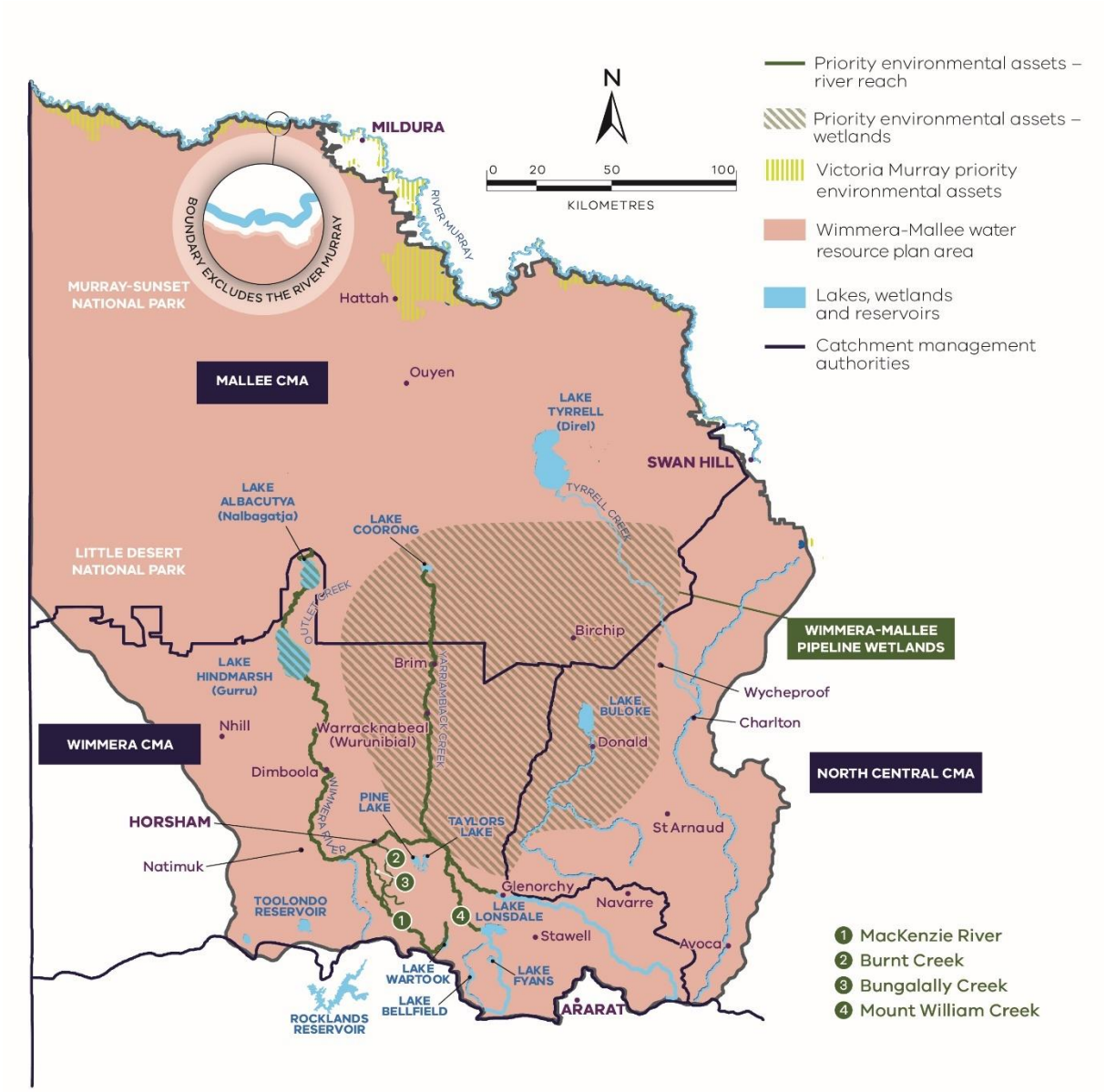


Figure 9: Priority environmental assets within the Wimmera-Mallee water resource plan area.

2.3 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, for example, 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 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 freshwater.

By contrast with northern Victoria as a whole, the priority environmental assets within the Wimmera-Mallee water resource plan area represent a relatively small proportion of the wetland types present within the water resource plan area. Based on area, most of the wetland priority environmental assets within the Wimmera-Mallee water resource plan area (Appendix J) are temporary lakes (Table 47). This ANAE waterway type is relatively over-represented, whilst five ANAE waterway types are under-represented (e.g. black box woodland riparian zone or floodplain, river red gum woodland riparian zone or floodplain and others). The over-representation of temporary lakes is mainly due to the presence of a few large temporary lakes such as Lake Hindmarsh and Lake Albacutya. While clay pans are not significantly represented, they are rarely a priority for environmental water given their lack of vegetation and ephemeral water regime. The inclusion of additional black box or river red gum woodland riparian zones in existing or new EWMPs is constrained by their position on floodplain and constraints on delivering water to these waterway types with existing infrastructure. The very flat landscape also makes watering difficult except in times of large flood.

Based on length, riverine priority environmental assets within the Wimmera-Mallee water resource plan area are dominated by three types: Temporary lowland stream, temporary transitional zone stream and temporary high energy upland stream (Table 47). The latter two types are less represented due to the distance of most from infrastructure that can deliver water.

Table 3: Representativeness of Wimmera-Mallee water resource plan area wetland priority environmental assets compared with ANAE waterway type.

ANAE Type	Wimmera-Mallee WRPA		Wimmera-Mallee priority environmental assets		Difference	Representation in WRPA
	Area (ha)	%Area	Area (ha)	% area		
Lt1.1: Temporary lake	37,552.4	15.9%	19714.1	98.6%	82.7%	Over
F1.8: Black box woodland riparian zone or floodplain	32,369.2	13.7%	0.0	0.0%	-13.7%	Under
Pt3.1.2: Clay pan	23,739.8	10.1%	34.6	0.2%	-9.9%	Under
F1.4: River red gum woodland riparian zone or floodplain	23,080.4	9.8%	0.0	0.0%	-9.8%	Under
Lst1.1: Temporary saline lake	22,459.6	9.5%	0.0	0.0%	-9.5%	Under
F1.12: Woodland riparian zone or floodplain	17,689.7	7.5%	0.0	0.0%	-7.5%	Under
Pt2.3.2: Freshwater meadow	10,178.2	4.3%	80.8	0.4%	-3.9%	Similar
F2.2: Lignum shrubland riparian zone or floodplain	9,774.7	4.1%	0.0	0.0%	-4.1%	Similar
Lt1.2: Temporary lake with aquatic bed	8,300.1	3.5%	0.0	0.0%	-3.5%	Similar
Pt1.2.2: Temporary black box swamp	6,755.2	2.9%	49.3	0.2%	-2.6%	Similar
Pt1.8.2: Temporary shrub swamp	5,977.7	2.5%	48.7	0.2%	-2.3%	Similar
Pt1.1.2: Temporary river red gum swamp	5,172.3	2.2%	14.5	0.1%	-2.1%	Similar
Pt1.6.2: Temporary woodland swamp	4,753.9	2.0%	43.4	0.2%	-1.8%	Similar
Pst4: Temporary saline wetland	4,123.3	1.7%	0.0	0.0%	-1.7%	Similar
Pst1.1: Temporary saline swamp	3,773.7	1.6%	0.0	0.0%	-1.6%	Similar
Pt1.7.2: Temporary lignum swamp	3,636.4	1.5%	12.5	0.1%	-1.5%	Similar
Pst2.2: Temporary salt marsh	3,564.3	1.5%	0.0	0.0%	-1.5%	Similar
Pst3.2: Salt pan or salt flat	2,669.9	1.1%	0.0	0.0%	-1.1%	Similar
F1.6: Black box forest riparian zone or floodplain	2,500.9	1.1%	0.0	0.0%	-1.1%	Similar
Lp1.1: Permanent lake	2,122.9	<1%	0.0	0.0%	-1.0 to 0%	Similar

ANAE Type	Wimmera-Mallee WRPA		Wimmera-Mallee priority environmental assets		Difference	Representation in WRPA
	Area (ha)	%Area	Area (ha)	% area		
Lst1.2: Temporary saline lake with aquatic bed	1,999.9	<1%	0.0	0.0%	-1.0 to 0%	Similar
F2.4: Shrubland riparian zone or floodplain	836.6	<1%	0.0	0.0%	-1.0 to 0%	Similar
Pt4.2: Temporary wetland	766.9	<1%	0.0	0.0%	-1.0 to 0%	Similar
Pp4.2: Permanent wetland	594.5	<1%	0.0	0.0%	-1.0 to 0%	Similar
Lsp1.1: Permanent saline lake	198.0	<1%	0.0	0.0%	-1.0 to 0%	Similar
Lp1.2: Permanent lake with aquatic bed	191.7	<1%	0.0	0.0%	-1.0 to 0%	Similar
Pt1.5.2: Temporary paperbark swamp	184.9	<1%	0.0	0.0%	-1.0 to 0%	Similar
F1.2: River red gum forest riparian zone or floodplain	155.1	<1%	0.0	0.0%	-1.0 to 0%	Similar
Psp2.1: Permanent salt marsh	146.2	<1%	0.0	0.0%	-1.0 to 0%	Similar
Pt2.1.2: Temporary tall emergent marsh	132.9	<1%	0.0	0.0%	-1.0 to 0%	Similar
Pt4.1: Floodplain or riparian wetland	113.9	<1%	0.0	0.0%	-1.0 to 0%	Similar
Psp4: Permanent saline wetland	111.3	<1%	0.0	0.0%	-1.0 to 0%	Similar
Pp2.3.2: Permanent grass marsh	94.7	<1%	0.0	0.0%	-1.0 to 0%	Similar
Pu1: Unspecified wetland	33.5	<1%	0.0	0.0%	-1.0 to 0%	Similar
Psp1.1: Saline paperbark swamp	31.0	<1%	0.0	0.0%	-1.0 to 0%	Similar
Pp2.4.2: Permanent forb marsh	1.3	<1%	0.0	0.0%	-1.0 to 0%	Similar
F1.13: Paperbark riparian zone or floodplain	0.7	<1%	0.0	0.0%	-1.0 to 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 4: Representativeness of Wimmera-Mallee riverine priority environmental assets compared with ANAE waterway type.

ANAE Type	Wimmera-Mallee WRPA		Wimmera-Mallee priority environmental assets		Difference	Representation in WRPA
	Length (km)	%Length	Length (km)	%Length		
Rt1.4: Temporary lowland stream	5664.3	51.8%	596.6	96.1%	44.3%	Over
Rt1.2: Temporary transitional zone stream	3072.2	28.1%	10.6	1.7%	-26.4%	Under
Rt1.1: Temporary high energy upland stream	1875.9	17.1%	12.1	2.0%	-15.2%	Under
Rp1.4: Permanent lowland stream	163.0	1.5%	0.0	0.0%	-1.5%	Similar
Rt1.3: Temporary low energy upland stream	89.3	0.8%	1.7	0.3%	-0.5%	Similar
Rp1.2: Permanent transitional zone stream	66.4	0.6%	0.0	0.0%	-0.6%	Similar
Ru1: Unspecified river (landform unknown)	13.2	0.1%	0.0	0.0%	-0.1%	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 Wimmera-Mallee (adapted from (Brooks, 2019)

2.4 Significant ecological values of the Wimmera-Mallee water resource plan area[4]

The priority environmental assets of the Wimmera-Mallee water resource plan area support ecological values that are significant at the national and state level. The information below focuses on the priority environmental assets where held environmental water can be managed to deliver specific environmental outcomes.

2.4.1 Wimmera River

The Wimmera River priority environmental assets include the regulated section of the Wimmera River itself and associated tributaries (the MacKenzie River and the Mount William, Burnt and Bungalally creeks). These assets are home to many significant native fish populations (Table 5), including one of Victoria's few self-sustaining populations of freshwater catfish, although the larger species are not regarded as indigenous to the region (Earth Tech, 2005).

The MacKenzie River contains the only known confirmed population of platypus in the Wimmera and also supports good populations of native fish, macroinvertebrates and turtles. Given the diverse habitat and fish species found in the MacKenzie River, in dry times in particular, it acts as a refuge for fish populations.

The lower Wimmera River from Polkemmet Bridge to Outlet Creek at the northern end of Lake Albacutya was declared a Heritage River due to its significant environmental (particularly areas with river red gum open forests and woodlands with an intact understorey and waterbird habitat) and social values (LCC, 1991). The Wimmera River has also been declared a Wetland of National Importance.

The most recent Index of Stream Condition results indicate the majority of the Wimmera River is in moderate to poor environmental condition (DEPI, 2013c).

Table 5: Significant native fish in the Wimmera-Mallee water resource plan area.

Common name	Scientific name	Conservation significance (DSE, 2013)
Murray cod	*Maccullochello peeli peeli*	Vulnerable (EPBC Act) FFG list Vulnerable (Victoria)
Silver perch	*Bidyanus bidyanus*	FFG list Critically Endangered (EPBC) Vulnerable (Victoria)
Golden perch	*Macquaria ambigua*	Near Threatened (Victoria)
Freshwater catfish	*Tandanus tandanus*	FFG list Endangered (Victoria)
Yarra pygmy perch	*Nannoperca obscura*	Vulnerable (EPBC Act) FFG list Vulnerable (Victoria)
Flat-headed galaxias	*Galaxias rostratus*	Vulnerable (Victoria)

2.4.2 Terminal lakes

There is a series of terminal lakes at the end of the Wimmera River and given their size (especially Lake Hindmarsh and Lake Albacutya) they fill only rarely, during very high flows from upstream. This wet-dry cycle produces an environment where the beds of the lakes are often colonised by terrestrial vegetation. Filling leads to replacement with aquatic species (such as water milfoil and emergent reeds). When inundated, the central areas of the lakes provide open water habitat for large fish, including Murray cod, freshwater catfish

[4] Much of this information has been derived from the Seasonal Watering Plan 2015-2016 (Western Region) produced by the Victorian Environmental Water Holder.

and golden perch, and large numbers of birds such as the Australian pelican, pied cormorant and black swan (MDBA, 2010). Aquatic vegetation in the lakes provides habitat for smaller fish.

Surrounding the lakes, fringing woodlands are dominated by river red gum and black box.

Lake Albacutya was declared a Ramsar wetland site of international importance as a representative near-natural example of a 'seasonal intermittent freshwater lake' supporting vulnerable, endangered, or critically endangered species or threatened ecological communities and high numbers of waterbirds. (see section 2.5) Both Lake Hindmarsh and Lake Albacutya are Wetlands of National Importance. The true terminal lake of the Wimmera River system is the Wirrengren Plain which has not received inflows for well over a century. All of the terminal lakes comprise the Heritage River section of the Wimmera River.

2.4.3 Wimmera-Mallee Pipeline wetlands

The Wimmera–Mallee Pipeline wetlands include 52 dams and wetlands spread across the dry north-western area of Victoria on public and private land. They vary widely in wetland types (such as freshwater meadows, open freshwater lakes and freshwater marshes), size and vegetation communities (such as lignum and black box dominated EVCs). As a group, they are home to native waterbird populations including brolga, egrets, herons, blue-billed duck, freckled duck, Australian painted snipe and glossy ibis. Other biota present include the vulnerable growling grass frog, turtles and many other species. Watered from the Wimmera-Mallee Pipeline system, these wetlands act as important refuges and drinking holes throughout dry times in the region.

Significant water-dependent ecological values in the Wimmera-Mallee water resource plan area are presented in Figure 10, in alignment with themes set out in the Basin-wide environmental watering strategy (MDBA, 2019).

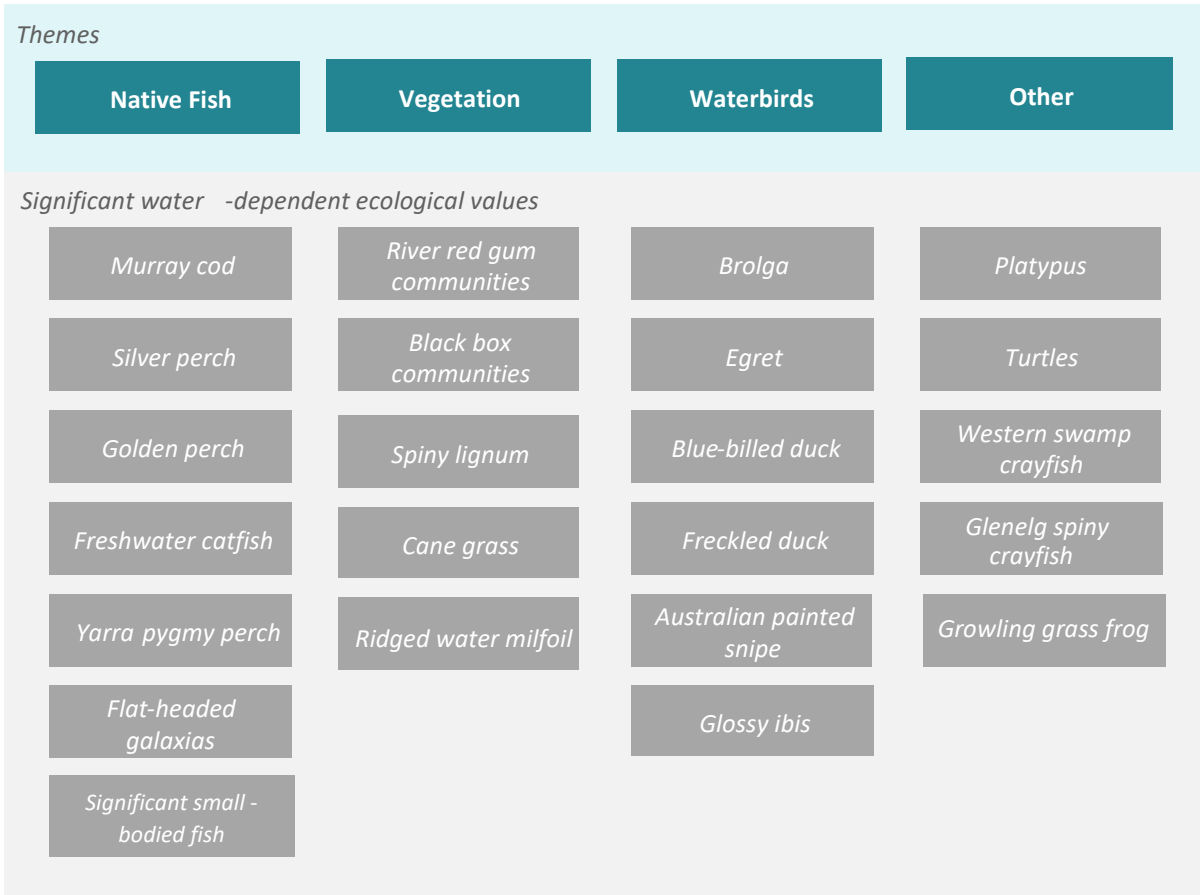


Figure 10: Significant water-dependent ecological values in the Wimmera-Mallee water resource plan area.

2.5 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 the Wimmera-Mallee Water Resource Plan (DELWP, 2019).

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.

The Wimmera-Mallee water resource plan area has one Ramsar site[5], Lake Albacutya. As discussed in Section 2.4.2 above, this is a terminal lake of the Wimmera system and receives water only in exceptionally wet years when Lake Hindmarsh spills and overflows into Outlet Creek which then carries water into Lake Albacutya. It is significant largely in relation to its important bird habitat and threatened bird species, as well as several significant ecological vegetation communities, including a genetically distinct river red gum sub-species.

The Lake Albacutya Ramsar Site Management Plan (Appendix 2 of https://wcma.vic.gov.au/docs/default-source/riversdocs/waterwaystrategy/wimmera-cma-waterway-strategy-2014-2022.pdf) was developed in accordance with the Australian Ramsar Management Principles and provides more information on its management.

The key threat to the ecological character of Lake Albacutya and its environmental values is its changed water regime, caused by a long history of river regulation and water extraction from the Wimmera River and, more recently, drying climate. It poses a threat to the health of the fringing eucalypt woodland as well as the waterbird and the regent parrot populations. The significant changes that were in place at the time of listing have since been exacerbated by drought and are predicted to continue with reduced rainfall due to climate change.

To maintain ecological character, it will be necessary to ensure that the hydrological regime is within the Ramsar guidelines for limits of acceptable change. However, this will be challenging, especially if reductions in rainfall persist. With the completion of the pipeline projects and the purchase of water to return to the environment, there are is now water available to provide flows to the lower Wimmera River which in turn will benefit the terminal lakes in extremely wet years. Based on the historical flow record, there could be

5. Kerang Wetlands are Ramsar listed and located within the Wimmera-Mallee water resource plan area but are watered from the River Murray and so are included in the Victorian Murray LTWP

occasions where high flows during a sequence of very wet years have led to substantial volumes entering Lake Hindmarsh and Lake Albacutya. However modelling results to date suggest that due to the long (20 year) wet-dry periods for Lake Albacutya, the current 121 year hydrological record is too short to make definitive conclusions around the lake's hydrological regime (both current and desired) (Jacobs, 2014). Therefore, there is some uncertainty around the potential for Lake Albacutya's hydrological regime to remain within the limits of acceptable change.

Complementary land management actions are ongoing at Lake Albacutya and led by Parks Victoria, DELWP and the Wimmera CMA, in particular control of invasive fauna such as rabbits and weeds (e.g. bridal creeper, African love grass, boneseed and boxthorn).

2.6 Priority ecosystem functions in the Wimmera-Mallee water resource plan area

Four ecosystem functions are prioritised for the Wimmera-Mallee water resource plan area, 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. Note that future iterations of LTWPs will 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 for the water resource plan area are listed in Table 6 below. They are considered priority under Basin Plan definitions in that they are able to be managed with environmental water and meet 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 Wimmera-Mallee water resource plan area.

Ecosystem Function	Schedule 9 criteria	Function characteristics
Longitudinal hydrological connectivity (between river reaches for fish movement)	2	Supports the transportation and dilution of nutrients, organic matter and sediment
	3	Provides connections along a watercourse (longitudinal connections)
Surface water salinity (for growth and reproduction of aquatic vegetation)	1	Supports the creation and maintenance of vital habitats
Refuges (for native fish species)	1	Supports the creation and maintenance of vital habitats and populations
Geomorphic habitat	1	Supports the creation and maintenance of vital habitats

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

This section outlines ecological objectives and targets, with watering requirements, for priority environmental assets and functions in the Wimmera-Mallee water resource plan area.

3.1 Approach to developing objectives, targets and watering requirements

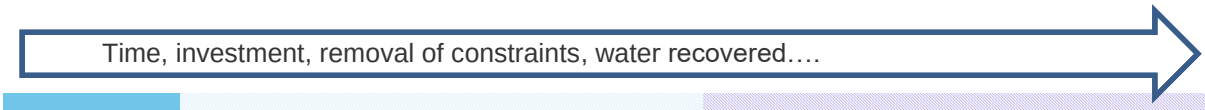
The objectives for this LTWP have been developed from the CMA's EWMPs, together with environmental flow studies and watering guides prepared for priority environmental assets and regions across the Wimmera-Mallee. LTWP objectives and their targets show the overall alignment of EWMPs with Basin Plan objectives and how they are planned to be met. They show the alignment with management goals developed for the Basin (see Section 1.1) and for the Wimmera-Mallee (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 ecological 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 11.



	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 – hope to meet one day / beyond BP implementation**
timeline	1-5 years	5-10 years	TBC	TBC

Figure 11: 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 Wimmera-Mallee water resource plan area

The Wimmera, North Central and Mallee CMAs developed site-specific environmental water management goals in consultation with communities through the EWMP process. During development of the Wimmera-Mallee WRP, these were summarised into management goals for the Wimmera-Mallee WRP 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 Wimmera-Mallee water resource plan area.

Management goals
Use environmental water to: - Support diverse, abundant and resilient native fish and vegetation communities; - Support geomorphic diversity; sustainable platypus populations, and - Limit impacts due to poor water quality.
Maintain or improve the values and condition of ecologically healthy or representative rivers, including waterways that have formally recognised significance
Maintain or improve condition of wetlands of International, National or State significance
Improve connectivity and condition along priority wetland systems and riparian corridors
Retain water in isolated wetlands to sustain fauna, especially frogs, wetland and woodland birds
Sustain and where possible increase the abundance of wetland flora, especially threatened species

3.3 Ecological objectives for the Wimmera-Mallee water resource plan area

Thirteen ecological objectives have been developed for the Wimmera-Mallee 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 BWS (MDBA, 2019) and include an additional theme that encompasses platypus, rakali, crayfish, turtles and frogs. They are also cross-referenced to the relevant objectives from the BWS's Expected Environmental Outcomes (EEOs) and Basin Plan environmental watering plan (EWP) (both listed in Appendix K, Table 48 and Table 49).

Table 8: Ecological objectives for the Wimmera-Mallee water resource plan area.

Theme	No.	Objectives	BWS EEOs	EWP Objectives
Connectivity and Functions	L1.1	Improve longitudinal connectivity (between river reaches) to facilitate movement of native fish	B1.1, B1.4, B4.1, B4.6, B4.9, B4.10	8.06,3(a) 8.06,3(b)(i) 8.06,3(f) 8.06,6(b) 8.07,6
	L1.2	Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	B1.1, B1.4, B2.5	8.06,2 8.07,5
	L1.3	Maintain refuges for native fish species	B1.1, B4.1, B4.2, B4.4, B4.5, B4.6, B4.10	8.06,6(b) 8.07,3
	L1.4	Maintain the quality of geomorphic habitat (maintain channel form, clean substrates, prevent stream bed colonisation)	B1.4	8.06,3(a)
Vegetation	L2.1	Improve the abundance and maintain the species richness and extent of aquatic vegetation	B2.11, B2.12	8.06,2 8.06,3(a) 8.06,6(a)
	L2.2	Improve the condition of riparian EVCs	B2.1, B2.8, B2.9	8.05,3(b) 8.06,3(b)(ii) 8.06,6(a) 8.06,6(b)
	L2.3	Improve the condition of wetland EVCs	B2.11	8.06,3(b)(ii) 8.06,6(a) 8.06,6(b)
	L2.4	Maintain the condition of black box dominated EVCs	B2.1, B2.8, B2.9	8.06,3(b)(ii) 8.06,6(a) 8.06,6(b)
Waterbirds	L3.1	Improve breeding opportunities and habitat for waterbirds	B2.1, B3.2, B3.3, B3.4	8.06,6(a) 8.06,6(b)
Fish	L4.1	Improve the abundance of large-bodied fish	B4.1, B4.2, B4.6, B4.8	8.06,6(a) 8.06,6(b) 8.07,3
	L4.2	Improve habitat and movement and maintain species richness of native fish	B4.3, B4.8, B4.10	8.06,3(b)(i) 8.06,3(b)(ii) 8.06,6(a) 8.06,6(b)
Other	L5.1	Improve habitat for Platypus and Rakali communities	N/A	8.06,6(b) 8.07,3
	L5.2	Maintain habitat for crayfish, turtle and frog communities	N/A	8.06,6(b) 8.07,3

Note: EWP Objective codes are the Basin Plan Chapter 8 Environmental Watering Plan objectives (Appendix K Table 48). BWS EEO codes are the Basin-wide environmental watering strategy Expected Environmental Outcomes (Table 49).

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 2.2) and the objectives for each asset can be found in Appendix E.

Table 9: Objectives and assets for the Wimmera-Mallee water resource plan area.

Theme	Objective	Assets
Fish	Improve abundance of large-bodied native fish	Wimmera River (Reaches 2-4); Burnt Creek Upper; Mount William Creek; MacKenzie River
	Improve movement of native fish	Wimmera River (Reaches 2-4); Burnt Creek Upper; Mount William Creek; MacKenzie River
	Maintain species richness of native fish	Wimmera River (Reaches 2-4); MacKenzie River (Reach 2); Burnt Creek Upper; Mount William Creek
Water birds	Improve breeding opportunities for waterbirds	Lake Hindmarsh, Lake Albacutya, Dock Lake
	Improve habitat for waterbirds	Wimmera-Mallee (pipeline) wetlands, Lake Hindmarsh, Lake Albacutya
Vegetation	Maintain the species richness of aquatic vegetation in wetlands	Wimmera-Mallee (pipeline) wetlands
	Maintain the species richness of in-channel aquatic vegetation	Mount William Creek; MacKenzie River (Reach 2); Wimmera River; Burnt Creek
	Maintain the extent of aquatic vegetation	Wimmera River; Mount William Creek; MacKenzie River (Reach 2); Round Lake
	Improve the abundance of aquatic vegetation	Wimmera River; Wimmera-Mallee (pipeline) wetlands
	Improve the condition of riparian EVCs	Wimmera River; Burnt Creek; Mount William Creek; Bungalally Creek; Yarriambiack Creek; MacKenzie River;
	Improve the condition of wetland EVCs	Wimmera-Mallee (pipeline) wetlands Lake Hindmarsh, Lake Albacutya,
	Maintain the condition of Black Box dominated EVCs	Yarriambiack Creek; Wimmera-Mallee Pipeline wetlands
Connectivity and functions	Improve longitudinal connectivity (between river reaches) to facilitate fish movement	Wimmera River; Burnt Creek; Mount William Creek; MacKenzie River
	Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	Wimmera River
	Maintain refuges for native fish species	Wimmera River (Reaches 2 -4); Mount William Creek; MacKenzie River; Burnt Creek
	Maintain the quality of geomorphic habitat (maintain channel form, clean substrates, prevent stream bed colonisation)	Wimmera River (Reaches 2 -4); Mount William Creek; MacKenzie River; Burnt Creek
Other values	Improve habitat for Platypus and Rakali	Wimmera River; MacKenzie River, Mount William Creek
	Maintain habitat for crayfish communities	Wimmera River; Mount William Creek; Burnt Creek
	Maintain habitat for turtle communities	Wimmera-Mallee Pipeline wetlands;
	Maintain habitat for frog communities	Wimmera-Mallee Pipeline wetlands;

3.4 Ecological targets for environmental watering in the Wimmera-Mallee water resource plan area

Targets have been developed for a subset of the objectives developed for this water resource plan area (Table 10). 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 ecological objectives, the targets have been developed based on a set of common terms and definitions. For the purpose of this LTWP:

- '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 Wimmera-Mallee 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 Wimmera-Mallee LTWP is discussed in Section 8.

Table 10: Targets for the Wimmera-Mallee water resource plan area.

Theme	Objective	Previous Target	Revised Target	Recommended Assets *CMA priority
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 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	*Wimmera River; Mount William Creek
	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	*Wimmera River; *MacKenzie River; *Mount William Creek; *Burnt Creek
Waterbirds	Improve breeding opportunities for waterbirds	Deliver water, if and as required, to complement natural flood events to complete breeding events in 1 out of 20 years	Deliver water to support waterbird breeding events in terminal lakes	Terminal lakes
Vegetation	Improve condition of riparian Ecological vegetation classes (EVCs)	A positive trend in the condition score of River red gum dominated EVC benchmarks at 80% of sites over the 10 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	Wimmera River; *Burnt Creek; Mount William Creek; Bungalally Creek; Yarriambiack Creek; *MacKenzie River
Functions	Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	Salinity targets for the Wimmera River at Horsham Weir (end of valley target) met 100% of the time	End-of-valley salinity targets for the Wimmera River at Horsham Weir of median 1,380 EC and eightieth percentile of 1,720 EC are met in every year in the ten years to 2025	Wimmera River

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 12). In regulated rivers, many of the flow components that are needed can be provided through held environmental water (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 12 graphically depicts the benefits of different environmental flow components in rivers.

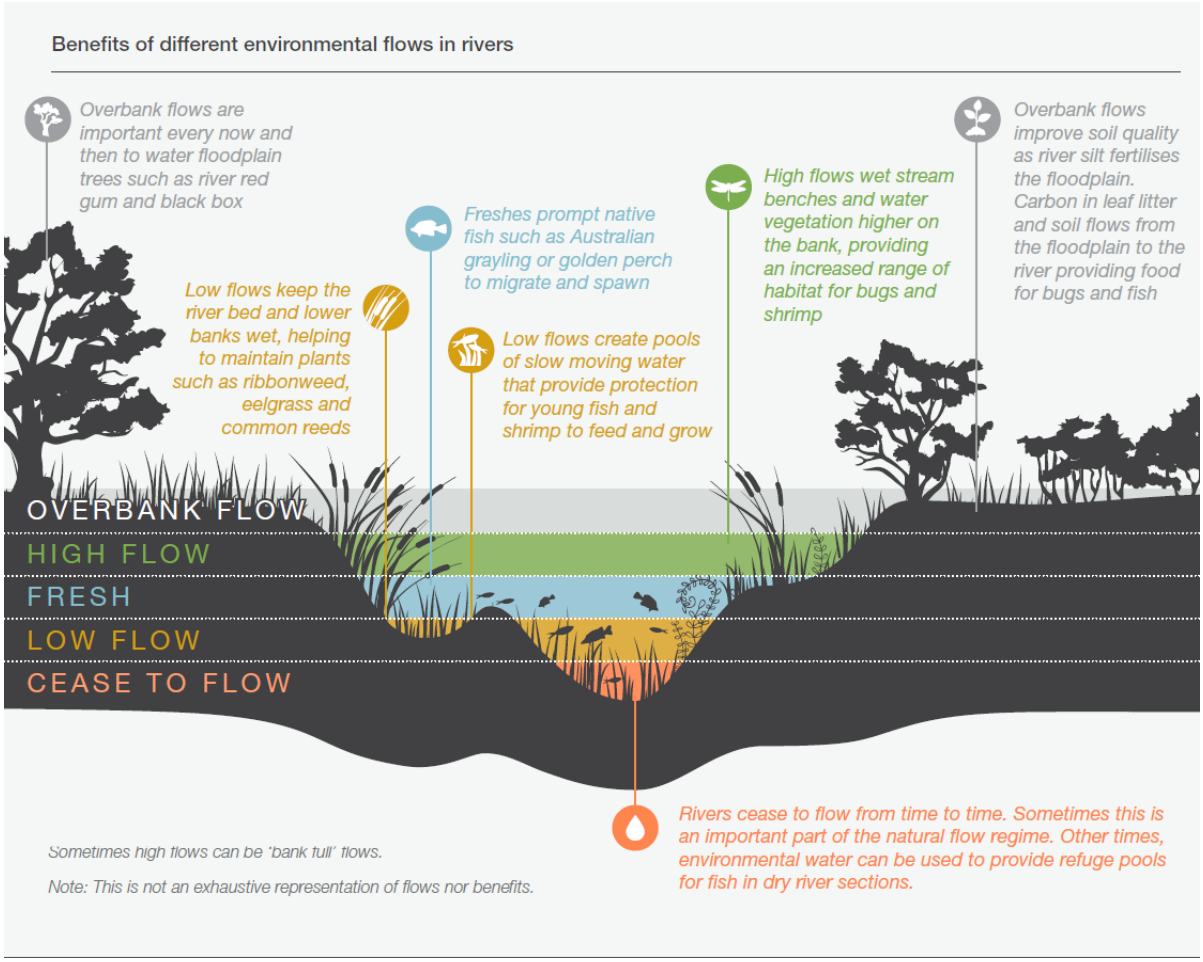


Figure 12: Benefits of different environmental flow components in rivers (VEWH, 2015b)

Table 11 and Table 12 show the flow components required for ecological objectives that apply to river assets. While the flow components apply across all assets, the detail (flow rate, timing, duration) will be asset specific. An example of the timing, magnitude, frequency and duration of flow components required to meet ecological objectives, watering requirements for reaches 2 and 3 of the Wimmera River are presented in

Table 13 (Wimmera CMA, 2020). The watering requirements for the remaining reaches of the Wimmera River are presented in Appendix F.

Table 11: 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 12: 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 13 Environmental flow recommendations for the Wimmera River reaches 2 and 3. (Wimmera CMA, 2020).

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Overarching environmental objective	Detailed environmental objective (Source Alluvium 2013)
Cease to flow	Dec-May	0 ML/d	Drought	As infrequently as possible	Less than 21 days in total	1,2,8,9	Limits cease to flow to ensure stress on environmental values is not exacerbated beyond the point of return.
			Dry				
			Average		Less than 7 days in total		
Baseflow	Dec-May	10 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel for riparian vegetation and to prevent excessive in-stream terrestrial species growth.
	Jun-Nov	100 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9	Prevent terrestrialisation of the lower banks from invasive phragmites and provide increased flow and variability to support fish movement and diversity of habitat.
Freshes	Dec-May	35-40 ML/d	Dry & drought	2 per period	3-7 days	1,4,5,6,7,8,9	Prevent terrestrialisation of the lower banks from invasive phragmites and provide increased flow and variability to support fish movement and diversity of habitat.
	Dec-May	100 ML/d	Average	2 per period	2-7 days	1,4,5,6,7,8,9	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat
			Wet	3 per period			
	Jun-Nov	400 ML/d	Drought	1 per period	1 day	1,4,5,6,7,8,9	Provide variable flow during high flow season for fish movement and to maintain water quality and diversity of habitat. Also flushes surface sediments from hard substrates for macroinvertebrates.
			Dry	3 per period	2 days		
			Average	5 per period	3 days		
			Wet	5 per period	4 days		
	Jun-Nov	1,300 ML/d	Dry	1 per period	1 day	1,4,5,6,7,8,9	Wets benches, entraining organic debris and promoting diversity of habitat.
			Average	2 per period	2 days		
			Wet	3 per period	3 days		

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Overarching environmental objective	Detailed environmental objective (Source Alluvium 2013)
	Jun-Nov	2,600 ML/d	Average	1 per period	2 days	1,4,5,6,7,8,9	Disturbs algae/bacteria/organic biofilm present on rock or wood debris for macroinvertebrates. Wets higher benches entraining organic debris and promoting diversity of habitat.
			Wet	2 per period	3 days		
Bankfull	Any	4,000 ML/d	Average	1 per period or natural	2 days	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.
			Wet	1 per period			
Overbank	Aug-Nov	8,000 ML/d	Wet	1 per period	1 day	3,4,8	Inundate floodplain to maintain condition of adult River Red Gums and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.

Note: Watering requirements for other reaches of the Wimmera System are shown in Appendix F.

3.5.2 Watering requirements for wetland assets

The wetland assets in the Wimmera-Mallee are either terminal lakes (e.g. Lake Hindmarsh) or Pipeline wetlands (e.g. Crow Swamp). As described previously, the terminal lakes only rarely fill, with upstream extraction and a drying climate reducing the frequency of these fill events. Historically, prior to connection, most of the Pipeline wetlands relied on local catchment run-off to fill. This can be episodic – typically occurring during wet winter/spring periods, although very heavy rainfall in summer/autumn can lead to substantial inflows into these wetlands. A handful are also able to be filled during flooding from local waterways.

Environmental water is used to reconnect these wetlands and introduce a more natural watering regime, including a wetting and drying cycle where appropriate

In wetlands, phases of the wetting and drying watering regime include (Figure 13):

- Drying – decline in water volume due to outflows or evaporation
- Dry – no water in wetland
- Filling – the inflow of water as trigger for events
- Full – the wetland full 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 – higher than the sill level during floods or regulated which inundates the managed floodplain of the wetland

Table 14 and Table 15 describe phases of the wetting and drying cycle that contribute to ecological objectives that apply to **wetland** assets. While the cycle components apply across all assets, the detail (timing, duration and frequency) will be site specific. Examples of the watering requirements for terminal lake assets is presented in Table 16. Examples of the watering requirements for Pipeline wetlands are presented in Table 17. The watering requirements for the full suite of priority wetland assets is presented in in detail in Appendix F.

An additional 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), increasing the sustainability of environmental assets.

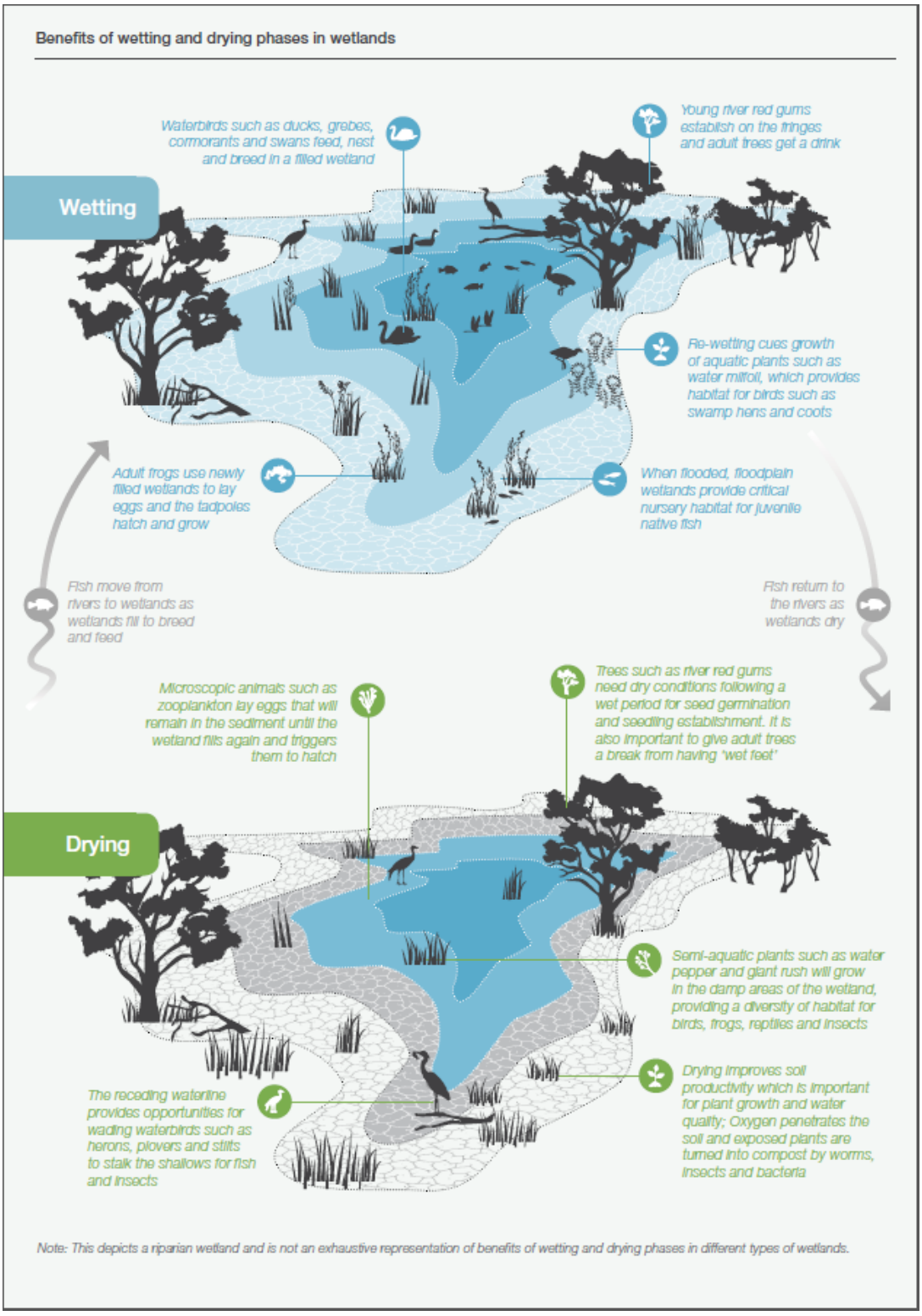


Figure 13: Benefits of wetting and drying phases in wetlands (VEWH, 2015b)

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: Summary of the inundation frequencies required to support wetland EVCs at the terminal lakes and the volumes (rounded to the nearest GL) required to engage (reach the bottom of the extent) and to inundate (cover the whole of the extent) each of the EVCs.

Ecological zone (EVC)	Lake Hindmarsh	Outlet Creek (b/w H & A)	Ross Lakes	Lake Albacutya	Outlet Creek (b/w A & 1st)	First Lake	Outlet Creek (b/w 1st & B)	Lake Brambruk
Lake Bed (EVC 197 Lake Bed Herbland)	Inundate for <3 years in 10, for 1 month to >1 year then dry.	Flow when water is passing to Lake Albacutya. Dry for usually less than 10 consecutive years. Outlet Creek:0.95 GL Cumulative volume: 380 GL	Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 5 -10 years.	Flow when water is passing to Wyperfeld National Park. Dry for usually 15-20 consecutive years. Outlet Creek: 0.65 GL Cumulative volume: 612 GL	Inundate for 1 month to >1 year every approx. 10-20 years.	Flow when water is passing to Wyperfeld National Park. Dry for usually approx. 20 consecutive years. Outlet Creek: 0.65 GL Cumulative volume: 615 GL	Inundate for 1 month to >1 year every approx. 10-20 years.
	Lake specific: 0 – 120 GL		Lake specific:0 – 0.2 GL	Lake specific: 0 – 41 GL		Lake specific: 0 – 0.4 GL		Lake specific: 0 – 3 GL
	Cumulative: 0 – 120 GL		Cumulative: 611 GL	Cumulative: 381 – 422 GL		Cumulative: 612 GL		Cumulative: 615 – 618 GL
Fringing Woodland (EVC 813 River Red Gum)	Inundate for <3 years in 10, for 1 month to >1 year then dry.		Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 10-15 years.		Inundate for 1 month to >1 year every approx. 20 years.		Inundate for 1 month to >1 year every approx. 20 years.
	Lake specific: 28 - 380 GL		Lake specific: 0.01 – 0.7 GL	Lake specific: 20 – 175 GL		Lake specific: 0.2 – 1.5 GL		Lake specific: 1.5 – 11.25 GL
	Cumulative: 28 – 380 GL		Cumulative: 612 GL	Cumulative: 400 – 556 GL		Cumulative: 613 - 614 GL		Cumulative: 617 – 627 GL
Fringing Woodland (EVC 103 Black Box)	NA		Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 10-15 years.		Inundate for 1 month to >1 year every approx. 20 years.		Inundate for 1 month to >1 year every approx. 20 years.
			Lake specific: 0.7 – 0.93 GL	Lake specific: 175 – 230 GL		Lake specific: 1.5 – 2 GL		Lake specific: 11.25 – 15 GL
			Cumulative: 613 GL ML	Cumulative: 556 – 611 GL		Cumulative: 614 – 615 GL		Cumulative: 627 – 630 GL

Table 17: Hydrological objectives and watering frequency and duration for the Mallee Pipeline wetlands. See Appendix Fd)i) for water volumes required to fill each wetland.

Environmental objective	Wetlands	Frequency of events (10 years)			Duration of events (months)			Timing
	*Terrestrial environment water contained within the dam area	Min.	Opt.	Max.	Min.	Opt.	Max.	
Provide watering points for terrestrial fauna and woodland birds	Broom Tank, Chiprick BR, Clinton Shire Dam, Considine*, Coundon Wetland, Cronomby Tanks*, D Smith*, Greens Wetland, Homelea*, J Ferrier Wetland, John Ampt*, Kath Smith*, Mahoods Corner*, Pam Juergens*, Paul Barclay*, Poyner, R Ferrier*, Rickard Glenys*, Roselyn Wetland, Shannons Wayside*, Tchum Lakes Pool (Dam), Towma (Lake Marlbed) FFR, Uttiwillock*	-	10	-	-	12	12	For all four fill dams May to November (due to pipeline delivery constraints) in all climate scenarios, and allow natural drawdown through evaporation. For vegetation provide overbank flow into surrounding floodplain May to November during average to wet years only, and allow natural drawdown.
Provide foraging, refuge and breeding habitat for turtles and frogs	Cokum BR, Considine*, Cronomby Tanks*, Mahoods Corner*, Part of Gap Reserve, Rickard Glenys*, Roselyn Wetland, Towma (Lake Marlbed) FFR, Uttiwillock*	8	10	10	11	12	12	
Maintain the health of fringing Lignum and Black Box communities	Barbers Swamp, Broom Tank, Bull Swamp, Clinton Shire Dam, Cokum BR, Goulds Reserve, Greens Wetland, J Ferrier Wetland, Lake Danaher BR, Morton Plains Reserve, Part of Gap Reserve, Poyner, Roselyn Wetland, Round Swamp BR, Tchum Lakes Reserve (Wetland), Tchum Lakes Pool (Dam), Towma (Lake Marlbed) FFR, Uttiwillock*	1	2	3	2	4	4	
Provide suitable feeding and breeding habitat for various waterbird guilds	Barbers Swamp, Bull Swamp, Cokum BR, Goulds Reserve, Mahoods Corner*, Morton Plains Reserve, R Ferrier*, Rickard Glenys*, Roselyn Wetland, Shannons Wayside*, Tchum Lakes Reserve (Wetland), Tchum Lakes Pool (Dam), Uttiwillock*	2	5	10	1	6	7	

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.

4.1 Regulated surface water systems

4.1.1 Definition

A regulated water system is one where the flow of the river is regulated through the operation of major storages or weirs to secure water supplies. In Victoria, the infrastructure provided for the regulation of rivers is publicly owned and controlled by water corporations.

4.1.2 Environmental water in regulated systems

There are two forms in which water can be provided for environmental watering purposes in regulated systems. The first is via held environmental water, which consists of a range of water access entitlements that are held in perpetuity and used for the benefit of the environment. In general, these held entitlements are a share of the available resource in storages, which can be released to meet specific environmental needs. The distinguishing feature of held environmental water is that, as the name implies, it is a water access entitlement and the water may be called out for delivery by the relevant environmental water manager at a time and in a manner that will best meet the needs of the environment. The delivery of held environmental water is subject to the physical constraints of the water delivery system, the operating rules in place, and any charges for storage and delivery services that are applicable. However, within these limits the environmental manager can exercise quite a high degree of discretion in how and where the water is used.

Held environmental water in regulated systems are generally provided in the following forms:

- Bulk Entitlements (BEs) or Environmental Entitlements (EEs) allocated for environmental purposes and held and managed by the VEWH;
- Water Shares, which are an ongoing entitlement to a **share** of the **water** available in the **water** system. Individuals and agencies may hold water shares, and almost all of the environmental water entitlements held by the CEWH in Victoria are in the form of Water Shares. A notable exception is the Wimmera-Mallee where CEWH has a supply agreement arrangement.

Table 18: Held environmental water in the Wimmera-Mallee water resource plan area.

System	Entitlement	Volume (ML)	Holder
	Wimmera-Mallee Pipeline product*	40,560 (high reliability)	VEWH
	Wetlands	1,000 (low reliability)	VEWH
	Commonwealth Environmental Water Holder	28,000 (very low reliability)	CEWH
	Passing flows**	NA	VEWH and others

* Is used in both the Wimmera and the Glenelg catchments

** Passing flows are specified for rivers in the Glenelg and Wimmera basins

The second form of water for the environment is planned environmental water. The *Commonwealth Water Act* (2007) specifies planned environmental water as another mechanism for providing environmental outcomes. Section 10.09(1) of the Basin Plan requires identification of planned environmental water. A review of Victoria's bulk entitlements and statutory management plans in the Wimmera-Mallee water resource plan area was undertaken during preparation of the Wimmera-Mallee Water Resource PlanWimmera-Mallee Water Resource Plan to determine planned environmental water in the area during the water resource planning process (DELWP, 2019). The review looked for water which had the following conditions:

- 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.

It is difficult to align Victoria's arrangements to the Commonwealth definition of planned environmental water with its exclusive preservation requirements. Generally, water management instruments in Victoria tend to serve a number of outcomes rather than solely environmental. The water resource plan review found that there are only a few locations in northern Victoria where water management instruments meet the definition of planned environmental water under the Commonwealth definition. None of these are located in the Wimmera-Mallee water resource plan area.

Under the Basin Plan it was expected by the MDBA that a large portion of system water and/or above cap water would be identified as planned environmental water. Although all above cap or system water cannot be identified as planned environmental water under Victoria's framework, in Victoria this water is considered to have shared benefits. This can contribute to environmental objectives for priority environmental assets and ecosystem functions, and other environmental values in the Wimmera-Mallee water resource plan area. *Water for Victoria* outlines Victoria's position on achieving shared benefits to meet a maximum amount of uses from limited water resources. Victoria aims to use water to maximise the benefit achieved from environmental water and to meet the objectives of key groups in the community, including Traditional Owners, recreational users, domestic and stock users, and the environment.

4.1.3 Regulated systems of the Wimmera-Mallee

The Wimmera-Mallee headworks system enables water to be shifted between storages and interconnects the three major river basins of the Wimmera, Avoca and Glenelg.

There are four regulated systems in the Wimmera-Mallee water resource plan area (Table 19). A notable feature of these regulated systems is the profound change that has occurred in recent years, following the completion of the Wimmera-Mallee Pipeline in 2010 and the cessation of the Wimmera

Irrigation Area. These two factors have greatly reduced the consumptive water demand requirements from the Wimmera-Mallee headworks system.

Table 19: Regulated systems in the Wimmera-Mallee water resource plan area.

System	Description	Comments
Mt William	Water is diverted from the Wannon River system (in the Glenelg system) at First and Second Wannon Creek, to supplement flows in Fyans Creek in the upper catchment of the Mt William Creek system. Flows in Fyans Creek are then regulated by the Lake Bellfield, Lake Fyans and Lake Lonsdale storages in the upper Mt William Creek catchment. Downstream of Lake Lonsdale, flows in the Mt William Creek can be diverted into the Wimmera River via several flow paths, or diverted into storages downstream of the Wimmera Inlet Channel such as Taylors Lake	Lake Bellfield now provides the primary source of water for the Wimmera-Mallee Pipeline, with Rocklands Reservoir and Taylors Lake providing drought back-up capacity. The primary role of Lake Fyans is to provide a water supply to Stawell, Ararat and Great Western. Together with Rocklands Reservoir, when Lake Lonsdale contains water, it is an important source of held environmental water in the Wimmera-Mallee system.
Lower Wimmera	Flows in the Wimmera River downstream of Huddleston's Weir are affected by diversions from the river into the Wimmera Inlet Channel to supply storages such as Taylors Lake	The harvesting of flows from the Wimmera River at Huddleston's Weir forms an important component of the Wimmera-Mallee headworks system. Passing flow obligations limit the amount of water harvested at this location for consumptive use. Water can also be provided to the river from Taylor's Lake.
MacKenzie	Flows are regulated by Lake Wartook in the upper catchment of the MacKenzie River and affected by numerous diversions that supply water to Taylors Lake and Horsham Treatment Plant for consumptive use. Transfers from Moora Moora Reservoir (in the Glenelg system) can also contribute flows to the MacKenzie River downstream of Distribution Heads	Wartook Reservoir is now a primary source of water for the Wimmera-Mallee Pipeline sub-system located to the south and south-west of Horsham, and an important contributor to the water supply for Horsham
Glenelg	Glenelg River flows are regulated by Rocklands Reservoir. Volumes of water are diverted from the Glenelg system into Moora Moora Reservoir, from various harvesting points along the Moora Channel system and from Rocklands Reservoirs. These diversions supply the Wimmera-Mallee system	Rocklands Reservoir on the Glenelg River is the largest storage in the Wimmera-Mallee Headworks system. It supplies water for both consumptive and environmental use in the Wimmera-Mallee and Glenelg systems

4.2 Unregulated surface water systems

4.2.1 Definition

An unregulated river system is one where no major dams or weir structures have been built to regulate the supply and release of water for consumptive use. In unregulated systems the holder of a water entitlement cannot order the release or delivery of water.

This does not mean that there are no storages in these systems. There are often large numbers of both on and off stream storages in unregulated systems. The key issue is that these storages are privately owned and controlled, and generally sized to store and manage the water entitlements for a single property. The absence of publicly owned storages means that there is no capacity to have held environmental water entitlements in unregulated systems.

4.2.2 Environmental water in unregulated systems

In the Wimmera-Mallee water resource plan area, major unregulated systems include the Avon-Richardson system, the Avoca system and the upper Wimmera River system.

In unregulated systems, the overarching objectives of the Basin Plan are progressed by strengthening existing processes relating to trade and allocation of water entitlements and conditions on water entitlements, to ensure the availability of environmental water is maintained. These systems rely on operational rules or conditions in water management plans or local management rules.

The primary mechanism to manage flows in an unregulated system is to permit or prohibit extraction of water. Therefore, management of water for the environment in such systems typically relies on establishment of trigger flows that initiate the rostering, restriction or suspension of pumping.

Environmental objectives in unregulated systems are to protect the existing hydrology and conditions (habitat), rather than provide a specific flow to meet an environmental objective such as for fish, vegetation or connectivity. However, there are different rules for different times of year in some systems, with base flows for connectivity being a major one.

In unregulated surface water 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 under a streamflow management plan by restricting or banning take for take and use licence holders during times of low flow. Note that domestic and stock take is still permitted during bans which apply to use for irrigation and industry. In unregulated systems the term ‘above cap’ applies to water that remains in the system after consumptive water is extracted.

The Victorian Waterway Management Strategy (DEPI, 2013b) sets out policy positions on the management of environmental water in unregulated systems. Policy 8.15 states that the management of these systems will

> *…focus on maintaining and managing environmental water by strengthening existing processes relating to trade and allocation of water entitlements and conditions on water entitlements, to ensure the availability of environmental water is maintained.*

The Victorian Waterway Management Strategy also commits to the development of formal management arrangements for flow stressed systems:

> *In priority unregulated systems that are flow-stressed in summer, formal management arrangements may be implemented. These arrangements provide for sustainably managing available water resources in an unregulated system to balance the needs of all users, including the environment. Types of existing management plans include:*
>
> - *Streamflow Management Plans – statutory plans for managing water resources of priority unregulated waterways that are under stress, or where there is a demand for more development.*
> - *Integrated water management plans – recognise the connections between groundwater and surface water in systems where these water resources are highly-connected.*
> - *Local management rules – capture and formalise existing rules in unregulated systems where there is no statutory management plan.*

Surface water resources of the Wimmera-Mallee water resource plan area have historically been managed under a series of local management rules in each catchment.

4.3 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.

4.3.1 Groundwater dependency of priority environmental assets

The Wimmera-Mallee Water Resource Plan (DELWP, 2019) and a study of the groundwater dependency of priority environmental assets in northern Victoria (Groundwater Logic, 2019) have been used to identify the groundwater-dependent priority environmental assets in the Wimmera-Mallee water resource plan area. This work also identified 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.

Groundwater dependent riverine and wetland priority environmental assets within the Wimmera-Mallee water resource plan area are listed in Table 20. Whilst the confidence assigned to groundwater dependence varied from high to low, the level of risk posed by groundwater resource use was assessed as low for each of the priority environmental assets (Groundwater Logic, 2019). In addition, the measures in place with existing groundwater management plans were considered sufficient to protect all the groundwater dependent priority environmental assets from excessive groundwater resource use.

Additionally, the environmental watering requirements of the Wimmera River system are provided through environmental flows studies (Alluvium, 2013). These include assessments of groundwater derived baseflow and groundwater derived recharge flow components. As the salinity of local groundwater is considered a threat to the Wimmera River, groundwater resource use is likely to pose a low risk to the environmental values associated with the river.

Within the Mallee CMA area, there are no major rivers or significant surface water features that receive groundwater discharge, so there is a low risk of impacts on key ecosystem function. The Mallee Wetland Strategy (Mallee CMA, 2006) identified saline lakes such as Lake Tyrrell and riverine wetlands (adjacent to the River Murray) at risk from rising saline groundwater levels. However, these have not been identified as priority environmental assets for the purpose of the Basin Plan.

Table 20: Groundwater dependent priority environmental assets in the Wimmera-Mallee water resource plan area. (Groundwater Logic, 2019)

Priority environmental asset	Source water*	Groundwater-dependent features (confidence)	Risk
Wimmera River R3	QA,UTAM	High	Low
Wimmera River R4-7, 8.1, 8.2	QA,UTAM,UTQA	High	Low
Wimmera River R9	BSE,QA,UTAF,UTAM,UTQA	High	Low
MacKenzie River R15-16	BSE,QA,UTAM,UTQA	Medium	Low
MacKenzie River R14	BSE,QA,UTAM,UTQA	Low	Low
Burnt Creek Lower R18	QA,UTAM,UTQA	Medium	Low
Burnt Creek Upper R19	QA,UTAM,UTQA	Low	Low
Mount William Creek R28	QA,UTAM,UTQA	Medium*	Low
Mount William Creek R29	QA,UTAF,UTAM,UTQA	Low	Low
Outlet Creek R1	UTAM	Low	Low
Yarriambiack Creek (Wimmera)	UTAM,UTQA	Low	Low
Yarriambiack Creek (Mallee)	UTAM	Low	Low
Lake Hindmarsh	QA,UTAM,UTD	High	Low

BSE - Palaeozoic and Cretaceous Basement, QA - Quaternary Aquifer, UTAF - Upper Tertiary Aquifer (fluvial), UTAM - Upper Tertiary Aquifer (marine), UTB - Upper Tertiary Basalts, UTQA - Upper Tertiary-Quaternary Aquifer, UTQD - Upper Tertiary-Quaternary Aquitard.

*Another study (Alluvium, 2015) indicates that groundwater dependence confidence is high for Mount William Creek

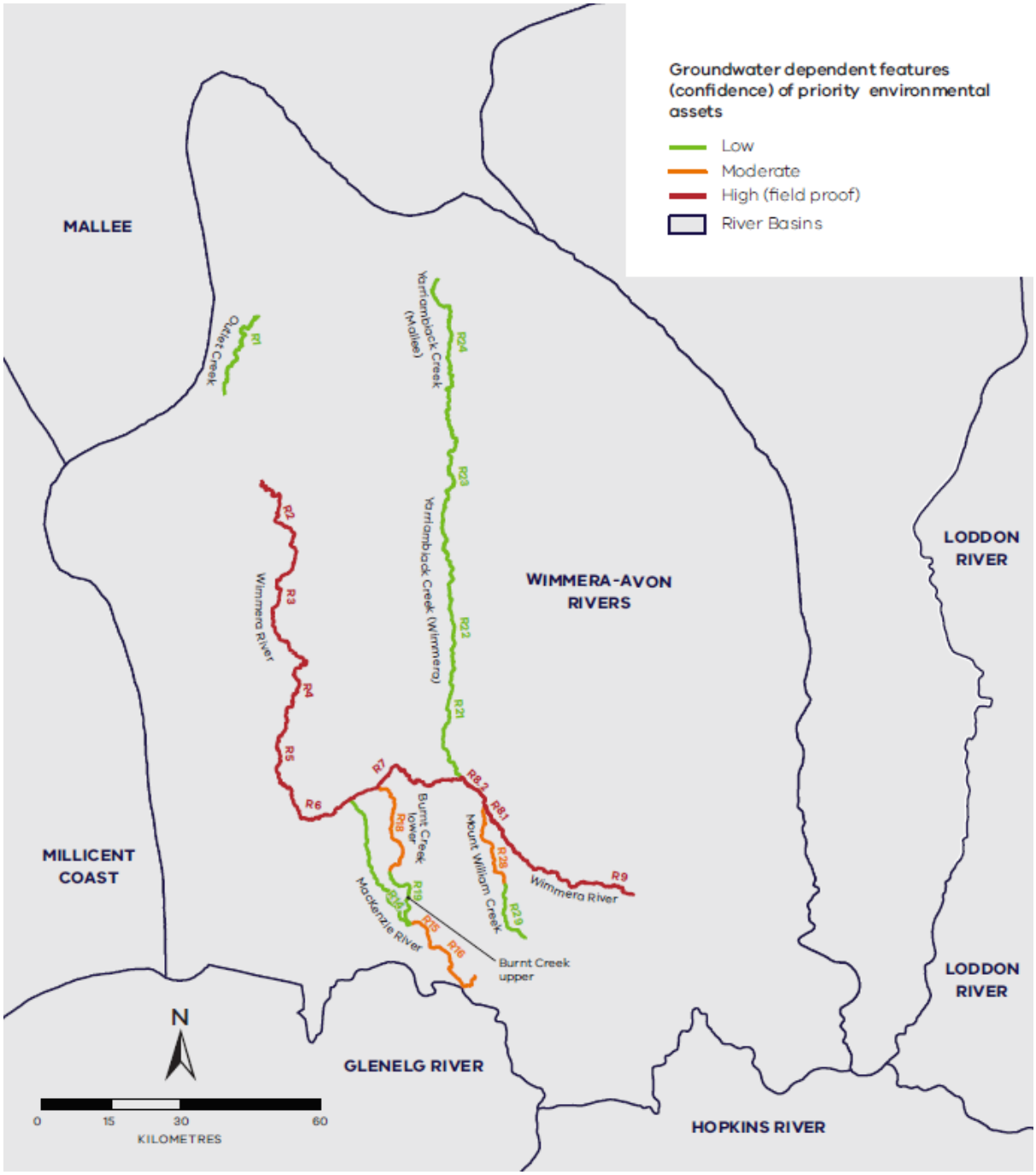


Figure 14: Groundwater dependent priority environmental assets in the Wimmera-Mallee water resource plan area

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

Victoria has strong co-operative arrangements between holders of held environmental water (VEWH, CEWH, the Living Murray program), managers of water regulations (water corporations), managers of environmental assets for the delivery of environmental water (water corporations, CMAs), and community members, including Traditional Owners.

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.

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 5 along with their respective roles and responsibilities, which are summarised as follows:

- **Waterway managers (CMAs)** are responsible for management of the priority environmental assets. 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 Wimmera-Mallee water resource plan area, the responsible CMAs are Wimmera, Mallee, and North Central CMAs.

- **Storage managers** (water corporations) deliver water for all water users, including for waterway managers / environmental water holders. In the Wimmera-Mallee water resource plan area, Grampians Wimmera-Mallee Water is the responsible water corporation.

- **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 have to prioritise across large regions or water resource plan areas. In the Wimmera-Mallee, the environmental water holders are VEWH and CEWH.

- **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 Wimmera-Mallee the public land managers are Parks Victoria, DELWP, local governments and Traditional Owner land management boards. Hindmarsh Shire and Horsham Rural City Council operate weirs on the Wimmera River. The Barengi Gadjin Land Council manage the Ranch Lagoon site.

- **Private land holders and other community members** are actively involved in environmental water planning, for example through involvement in seasonal watering proposal advisory boards. Many of the Wimmera-Mallee Pipeline wetlands are located on private land.

- MLDRIN and the Federation of Victorian Traditional Owner Corporations have roles in advising the State on diverse matters related to water management.

5.3 Coordination processes

Coordination of environmental watering in the surface water system in the Wimmera-Mallee water resource plan area is done through cooperative arrangements between the VEWH, CEWH and the storage manager.

The Victorian Environmental Water Holder leads environmental water planning and coordination for Victorian waterways at a water resource plan area scale, in close consultation with catchment management authorities as the local site managers. The Victorian environmental watering program involves a range of people and organisations. Relationships between local communities, waterway managers, storage managers, environmental water holders and land managers form the foundation of the program. Many public authorities collaborate to deliver the program. These authorities are referred to as program partners.

Delivery of the Commonwealth's water is undertaken by the Commonwealth Environmental Water Holder in line with its supply-by agreement. The Commonwealth collaborate with the VEWH and storage manager and catchment management authorities to ensure it is used in line with regional priorities.

The VEWH's seasonal watering plan outlines the watering priorities of the entire State. The process for development of the seasonal watering plan is shown in **Error! Reference source not found.**.

This process works year-round as follows:

- **Dec-Mar:** 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 and other partners.

- **Apr-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.

- **Jun**: Release of Seasonal Watering Plan.
- **Jul-Jun** (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 to communicate environmental watering decisions.

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

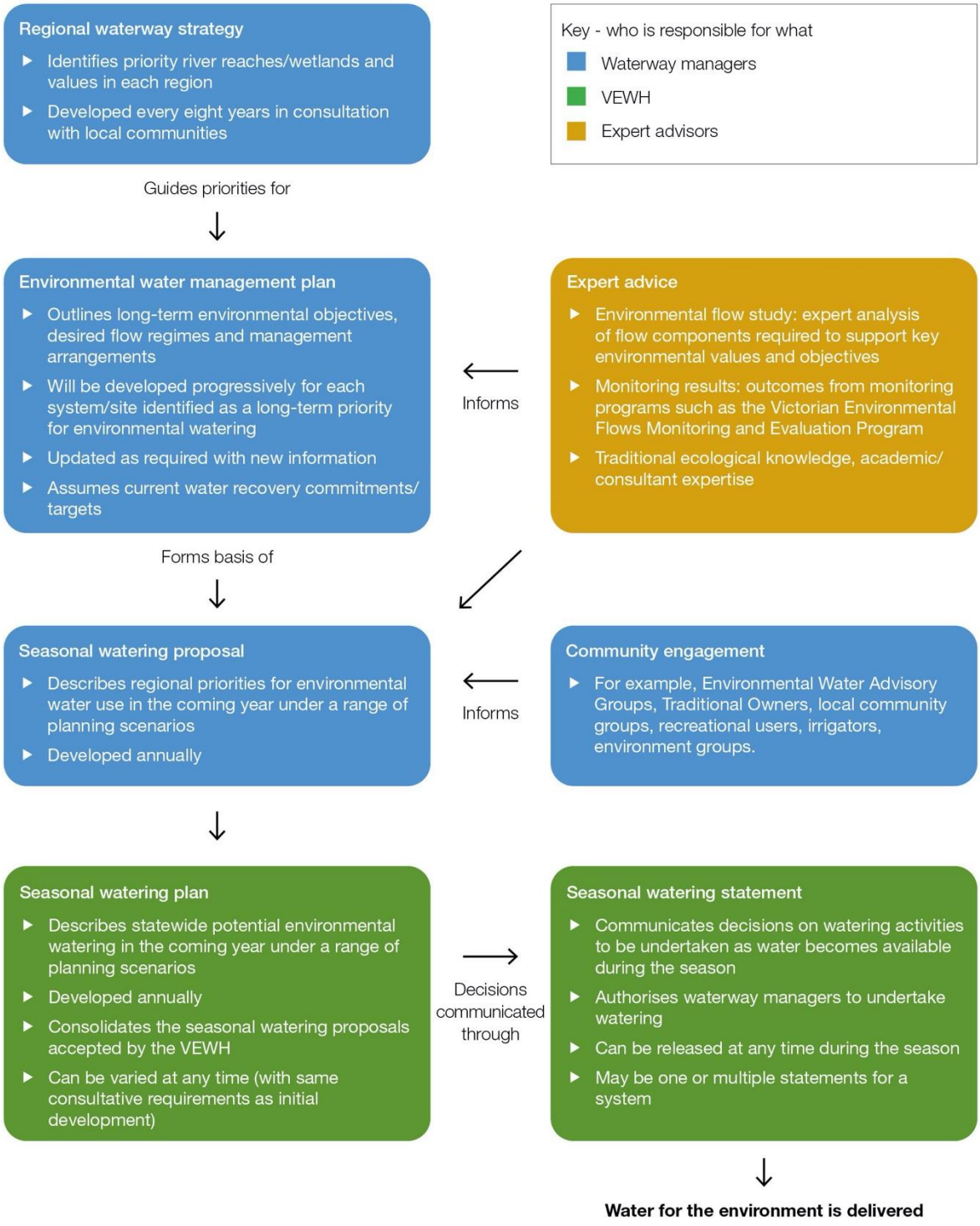


Figure 15: Victoria's annual environmental water planning process (VEWH, 2020)

Ongoing and regular communication between storage managers and environmental water managers provides an opportunity to integrate environmental watering into system operations to optimise outcomes.

Environmental water holders regularly coordinate to discuss priorities, negotiate watering commitments, review watering actions and report on outcomes, in collaboration with environmental water managers. This occurs through consultation between the VEWH, the CEWH and The Living Murray program at a state scale. VEWH and CEWH enter into a partnership agreement in relation to planning and managing the transfer and delivery of environmental water in Victoria, with use of

Commonwealth Environmental Water agreed by the VEWH and CEWH through a watering schedule. In the Wimmera system, Wimmera CMA is a signatory to the schedule.

In Victoria's two other water resource plan areas inter-jurisdictional cooperation occurs through the forum of the Southern Connected Basin Environmental Watering Committee (SCBEWC) and is described in the other LTWPs. However, this forum is not relevant in this LTWP as there is no connection between the priority environmental assets in the Wimmera-Mallee water resource plan area and the River Murray.

Two key opportunities for improving the provision of environmental water through better co-operative arrangements are:

- Ensuring that monitoring is taking place at the right places and
- Optimising watering opportunities through multi-site watering.

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

5.4 Traditional Owners

The Basin Plan also requires environmental water planning to maximise benefits and effectiveness by including Traditional Owner values, uses and aspirations for water in planning and management.

Over the past few years, participation of Traditional Owners in water management has substantially and rightfully increased. In 2019 the Victorian *Water Act 1989* and *Catchment and Land Protection* Act *1994* were amended to establish a greater recognition and involvement of Aboriginal Victorians in the planning and management of waterways and catchments. Other Victorian programs such as the Aboriginal Water Program, which includes the recruitment of Aboriginal water officers across Victoria, are providing Traditional Owners with the necessary resources to be involved in the environmental water program and broader water management, planning processes and decisions.

Traditional Owners in the Wimmera–Mallee water resource plan area (Figure 16) include:

- The Wotjobaluk Peoples represented by Barengi Gadjin Land Council Aboriginal Corporation. The Wotjobaluk Peoples and the State have agreed to negotiate a Recognition and Settlement Agreement under the Traditional Owner Settlement Act 2010 (Vic). Wotjobaluk Country is in the heart of the Wimmera–Mallee water resource plan area. It includes the Wimmera River and Lakes Albacutya and Hindmarsh, and across to Lake Tyrrell, where the Wotjobaluk Peoples hold an Indigenous Land Use Agreement (ILUA) and Registered Aboriginal Party (RAP) status on part of the lake.
- The Jaara people, represented by the Dja Dja Wurrung Clans Aboriginal Corporation. Waterways within Dja Dja Wurrung Country included in the Wimmera–Mallee Water Resource Plan include the Avoca and Avon–Richardson Rivers and Lake Buloke, among other wetlands.
- The Ngintait, Nyeri Nyeri and Latje Latje Nations, represented by the First Peoples of the Millewa–Mallee Aboriginal Corporation. The Murrayville groundwater area of the Wimmera–Mallee Water Resource Plan is on the lands of the First Peoples of the Millewa–Mallee, who have identified highly significant songlines with associated watering points across both the Wimmera-Mallee and Northern Victoria water resource plans. Surface water in the First Peoples of the Millewa–Mallee's proposed settlement area is mainly from the River Murray or connected sources and falls in the Northern Victoria Water Resource Plan.
- Barapa Barapa, Tati Tati, Wadi Wadi, Wamba Wemba and Weki Weki Nations are represented in the Wimmera-Mallee Water Resource Plan through interest in Lake Tyrrell. Lake Tyrrell is connected to Tyrrell Creek, which in turn is connected to the Avoca River, and is an area of significant cultural importance.

During the water resource planning process, Victoria engaged with Traditional Owner groups within the Wimmera-Mallee Water Resource Plan area to:

- outline the purpose, scope and opportunity for providing water to meet Traditional Owner water objectives and outcomes through the Murray-Darling Basin Plan
- define the role of the water resource plans in the Basin, including but not limited to the requirements of the Basin Plan (Chapter 10, Part 14)
- provide the timeline for the development and accreditation of the Wimmera-Mallee Water Resource Plan
- determine each Traditional Owner group's preferred means of engagement and involvement in the development of the Wimmera-Mallee Water Resource Plan
- continue to liaise and collaborate with Traditional Owner groups to integrate specific concerns and opportunities regarding the water planning and management framework identify Aboriginal water objectives for each Traditional Owner group, and desired outcomes.

The views of Traditional Owners in the Wimmera-Mallee water resource plan area are documented in Chapter 12 of the Wimmera-Mallee Water Resource Plan (DELWP, 2019).

Traditional Owners are increasingly involved in all aspects of Victoria's environmental watering program, including the EWMP planning process. In 2020 DELWP has been seeking to strengthen this involvement by engaging with Traditional Owners across northern Victoria about the LTWP and EWMP processes. 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[6] 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.

6. 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. For example, the River Yarns project of Barengi Gadjin Land Council used this tool with Wimmera CMA on the Wimmera River. Additionally, Victoria's Water Resource Plans funded several of these assessments; in the Wimmera-Mallee these occurred with Barapa Barapa, Dja Dja Wurrung, Ngintait Nation and Tati Tati Wadi Wadi.

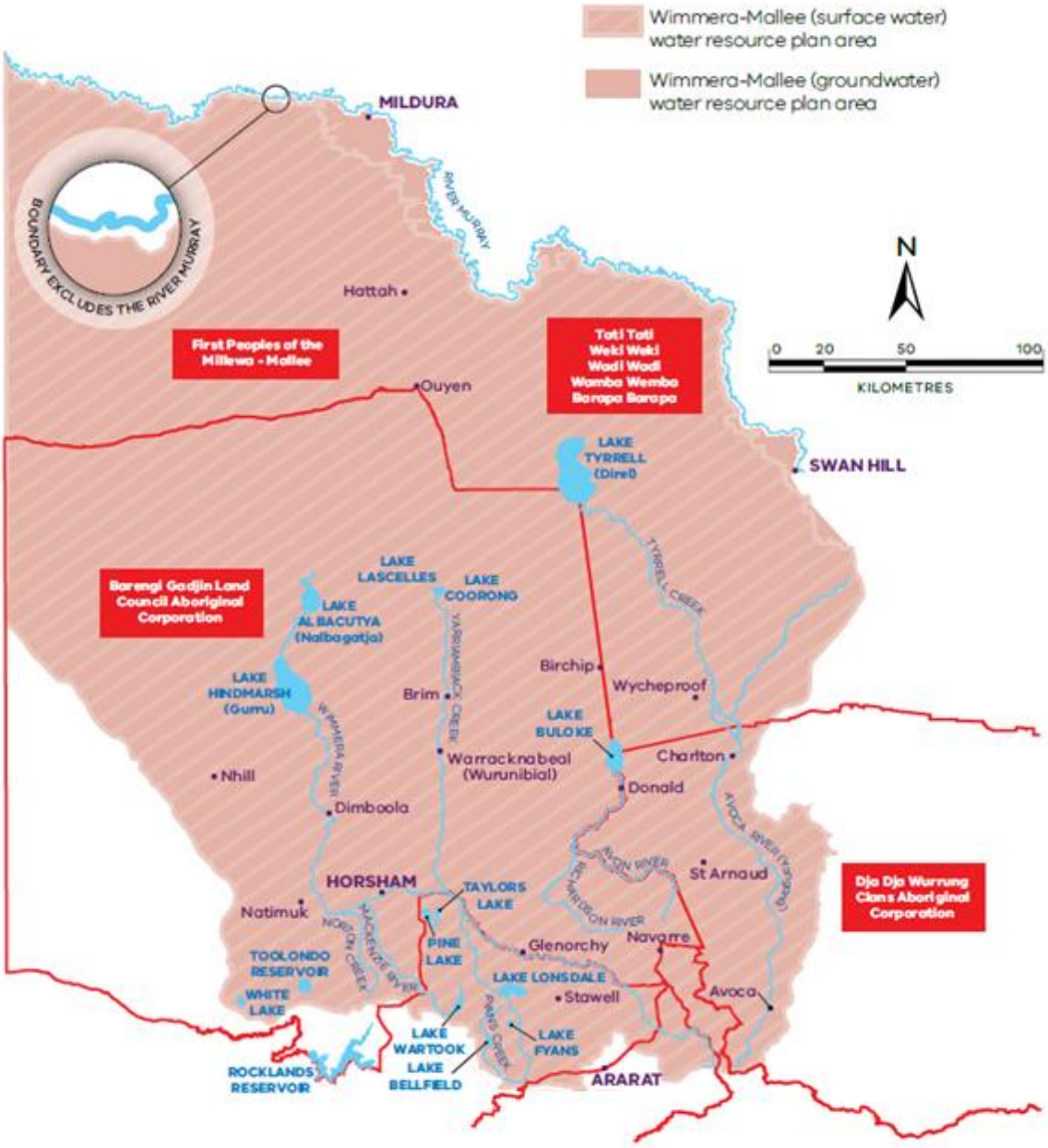


Figure 16: Representation of Traditional Owner groups in the Wimmera-Mallee water resource plan area.

6. Operational constraints

Environmental water delivery is subject to constraints. These constraints may be either physical constraints or operational (and management) constraints. This section identifies the key constraints in the Wimmera-Mallee water resource plan area and strategies to manage or overcome these.

Operational constraints are only one of the three types of constraints considered in the Basin Plan and MDBA's Constraints Management Strategy (CMS) 2013 to 2024 (MDBA, 2013a). In particular, the Basin Plan makes the distinction between physical constraints and operational and management constraints (i.e. c7.08 (1a)), a distinction that is reaffirmed in the CMS. There is no clear distinction between operational and management constraints and the two words are used interchangeably. Definitions of these are given 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 (MDBA Basin Plan, p. 8).

Operational (and management) constraints arise from the operating practices employed to manage water resources across the Basin. Unlike physical constraints, these constraints cannot simply be resolved through infrastructure works, but require policy and procedural changes. An example of an operational constraint is where water accounting frameworks would not allow for crediting of return flows from environmental water use, constraining the ability to achieve multi-site watering from a single water release

Given the spatial scale of the LTWP, this section intentionally focuses on constraints that affect more than one asset across the water resource plan area. While there are numerous other constraints that influence the ability to water specific sites, these are better captured and addressed through the site-based EWMPs and related documents.

The Wimmera-Mallee water resource plan area falls outside the seven key focus areas of the CMS (i.e. where MDBA considered that relaxation of physical constraints would give the greatest return for the environment from a Basin-scale perspective of environmental outcomes). As such, the constraints to environmental watering in the Wimmera-Mallee water resource plan area have received much less attention than the other water resource plan areas in Victoria (i.e. Northern Victoria and Victorian Murray).

The EWMP for the Wimmera River system provides the central resource for identifying multi-asset constraints in the Wimmera-Mallee water resource plan area, and understanding their influence on achieving environmental watering objectives. The following information is taken from the Wimmera River EWMP.

The Wimmera–Mallee Headworks System was designed to harvest and deliver water to the stock and domestic and irrigation channel systems. This typically involved outfalling modest volumes (35 ML/d - 400 ML/d) at constant rates for long periods (typically several months). Therefore, the headworks infrastructure was not originally intended to deliver water to waterways (apart from when they are a conduit for water transfers). Consequently, some sites have undergone upgrades to improve their effectiveness in delivering environmental water. However there remain a number of sites where physical constraints on environmental water delivery remain.

Wimmera River

In 2007, Huddleston's Weir was upgraded through the construction of a V-notch in the weir (and associated rock ramp fishway) as well as installing remote operation of gates that allow water to be harvested from the weir into Taylors Lake via the Wimmera Inlet Channel. This was to enable it to effectively deliver passing flows created from water savings from the Wimmera-Mallee Pipeline. In order to determine compliance with these passing flows permanent streamflow gauging has recently been installed at the site.

Town weirs at Horsham, Dimboola and Jeparit have also been modified with flume gates installed, replacing drop boards to improve the efficiency and accuracy of operation to pass flows through weir pools. Horsham Rural City Council and Hindmarsh Shire Council can operate the weirs to enable the transition of environmental flows through weir pools. This provides opportunities for weir pools to capture unregulated and passing flows at appropriate times to in part reflect historic arrangements (prior to the completion of the Northern and Wimmera-Mallee Pipelines). Consideration was also made around the impact of constant pool heights on the riverbank which has also been an issue raised during consultation for the EWMP.

In 2007 an assessment of various features (low level crossings etc.) that could affect the passage of environmental water releases throughout the Wimmera River System was undertaken. The study identified and provided recommendations for a number of low-level crossings in need of maintenance and/or upgrading to enable them to convey recommended environmental flows based on those made in the original Wimmera River system environmental flows study (SKM, 2008). In their current configuration they pass low flows although at comparatively modest volumes they overtop and cause social impacts (i.e. access issues) and localised erosion.

Mt William Creek

For the lower Mt William Creek, flows above 100 ML/d, such as recommended for winter-spring freshes, may have the potential to inundate rural land downstream of Lake Lonsdale. 200 ML/d was noted by Barlow (Barlow, 1987) to create inundation and access issues (Earth Tech, 2005). However, a transfer of approximately 200 ML/d from Lake Bellfield to Taylor's Lake in 2013 did not cause any known issues. The Mt William Creek Streamflows Study (Alluvium, 2015) looked at the lower Mt William Creek's hydrology and hydraulics involved limited modelling to improve understanding around channel capacities. In particular, when higher volumes are released (>100 ML/d) they enter high flow channels (e.g. Sheepwash Creek) attracting additional in-stream losses which affects the ability to meet recommended volumes at downstream compliance points (Alluvium, 2015). In 1910, landholders modified the creek's course north of the Western Highway, changing its 'main' course from the westerly to the easterly course (Wimmera Mallee Water, 1998). Now only the easterly course flows during low-medium flows, entering the Wimmera Inlet Channel and flowing a short distance (about 1 km) before entering the Wimmera River via the "Big Pipe" regulator.

The Wimmera CMA's main priority for Mount William Creek is to address the low flows leaking into Sheepwash Creek due to Trudgeon's Weir still remaining after it was decommissioned. Leakage into the Wimmera Inlet Channel due to the high invert of Big Pipe is a lower priority.

Automating the outlet valves at Lake Lonsdale has been undertaken in 2020 by GWMWater to improve delivery of environmental water releases to Mt William Creek by removing the requirement of staff to manually change flow rates on a daily basis (to easily ensure appropriate rates of flow rise and fall).

Lake Bellfield's distance from the lower Mt William Creek means that using it to supply the lower Mt William Creek is unlikely under most conditions. The minimum release rate from Lake Bellfield is around 50 ML/d (Earth Tech, 2005) to 30 ML/d (Kym Wilson, GWMWater, pers comm.) due to cavitation issues with the valve opening. So it would only feasibly be able to provide freshes rather than baseflows although there would be high losses due to infrastructure issues such as diversion infrastructure for Lake Fyans.

Dock Lake

There is a channel/pipeline linking Dock Lake with Green Lake which has a capacity of approximately 100 ML/d. Currently the infrastructure is in need of de-silting and repair before it could be used for regular delivery of environmental water (Jacobs, 2015)

6.1 Addressing flow delivery constraints

Recommendations addressing delivery constraints are listed in detail in the following reports;

- Assessing the Physical Constraints on Environmental Flow Delivery in the Wimmera Catchment (Earth Tech, 2005); and
- Wimmera and Glenelg Systems Environmental Metering Program (VEWH, 2014)
- Mt William Creek Streamflows Study (Alluvium, 2015)
- Dock Lake FLOWS study (Jacobs, 2015)

Furthermore, the following reports outline a comprehensive analysis of physical features (crossings, informal weirs, debris blockages etc.) that may prevent the effective delivery of environmental water releases;

- Assessing Influences on Environmental Water Releases in the Wimmera, Phase 1, Stages 1 and 2 (Earth Tech , 2006);
- Assessing Influences on Environmental Water Releases in the Wimmera, Phase 2, Stages 1 and 2 (Earth Tech, 2007);
- Influences on Environmental Water Releases in the Wimmera River (SKM, 2008); and
- Wimmera Catchment Management Authority – Impediments to Environmental Water Releases Site Review (Catchment Health Engineering, 2015).

Wimmera River

Infrastructure constraints prevent the delivery of larger recommended flow components (400 ML/d to 6000 ML/d) from regulated releases alone. Therefore, unregulated and/or passing flows will be required to achieve this in the Wimmera River. The absence of major impoundments on the Wimmera River has meant that large flows cannot be released to meet recommended volumes at compliance points. If necessary, regulated releases from Lake Lonsdale and/or Taylor's Lake can be used to supplement shortfalls in the hydrograph. This will be determined on a case by case basis given increasing risks around unintended inundation of land at higher flows.

The current main priority is the construction of pipeline outlets into drought refuge pools in the lower Wimmera River between Dimboola and Jeparit based on *Wimmera River Drought Refuge Management Strategy* (Alluvium, 2018).

Wimmera CMA is also working with local government in terms of seeking the upgrading of low-level crossings impacted by environmental water releases in terms of ensuring sufficient hydraulic capacity. One such site on the Burnt and Bungalally Creeks was upgraded in 2019.

Mount William Creek

Further investigations are required to determine the most appropriate actions to address constraints in delivery. Larger recommended flows (500 ML/d to 1,500 ML/d) are unable to be delivered by outlets from Lake Lonsdale as well as potentially creating unacceptable impacts on rural land downstream so there are no current proposals to increase the outlet capacity at Lake Lonsdale.

A 2015 study into the creek's hydrology and hydraulics has provided provide further advice around managing releases in order to improve environmental outcomes (Alluvium, 2015). Weirs operated by community members next to the former Trudgeon's Weir and Dadswell's Bridge have a large bearing on the proportion of water entering anabranches or continuing along the main channel. Ongoing management arrangements for these weirs will need to be developed that consider legal, environmental and safety issues. This is a high

priority for the Wimmera CMA given the risks to health and safety and impact on creek flows within Mount William Creek.

Investigations have been made into upgrading infrastructure to enable passage of low to medium flows along the western branch of the Mt William Creek. These indicate that given the current configuration at the bifurcation between the two branches, a permanent upgrade is unfeasible. More investigations are required to better understand the environmental values and watering requirements of the western as opposed to the eastern branch (RPS, 2015). Given the western branch also enters the Wimmera Inlet Chanel upstream of its confluence with the Wimmera River, infrastructure upgrades to enable the effective continuation of flows downstream is required at the Mt William Creek Outfall (RPS, 2015) although the priority is lower than some other sites given the likely infrequent use with the current configuration at the upstream bifurcation.

7. Complementary actions

Environmental water is only one component of the activities and works required to achieve the ecological 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
- Provision of fish passage and appropriate in-channel habitats
- Fish stocking
- Management of invasive species
- Works and measures

7.1 Riparian land management

The success of environmental watering programs is reliant on appropriate riparian land management. In particular, watering programs aimed at maintaining or improving riparian vegetation condition will require programs to protect riparian vegetation from uncontrolled stock grazing and other damage. Where vegetation has been destroyed or removed, revegetation with appropriate species may also be required.

The Victorian Waterway Management Strategy (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. RWSs have been developed for the waterways within the Wimmera-Mallee water resource plan area by the Wimmera, Mallee and North Central CMAs (Wimmera CMA, 2014), (Mallee CMA, 2014), (North Central CMA, 2014). They have documented a number of complementary management activities to try and ensure that the outcomes derived from environmental watering can be maximised. Program logic models were developed which prescribed a range of actions that would address waterway threats (such as modified flow regimes, degraded water quality and riparian vegetation) (GHD, 2012).

The Victorian Waterway Management Strategy 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.

7.2 Provision of fish passage and in-channel habitats

The VWMS emphasises that high quality instream habitat is essential to support healthy populations of aquatic plants and 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.

The success of fish outcomes is reliant on provision of suitable fish passage. 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. It should however be noted that fish passage in the Wimmera is not always desirable as it enables the spread of carp. There is also an absence of flow-dependent breeding fish species in the area.

7.3 Fish stocking

Stocking of appropriate species can assist in rejuvenating existing endemic species, or translocation of a species to a new but viable location. The Wimmera Waterway Strategy has an action relating to the restocking of river blackfish. The Victorian Fisheries Authority manages the stocking of waterways with recreational fishing species such as golden perch and silver perch and potentially river blackfish, which can assist in meeting the objectives and targets outlined in this plan.

7.4 Management of invasive species

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 the conditions, through various complementary actions, 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 e.g. the Wimmera Waterway Strategy (Wimmera CMA, 2014) outlines management actions to control invasive plant and animal species (e.g. rabbit, bridal creeper, boneseed, carp).

7.5 Works and measures

The Victorian environmental works and measures program aims to improve the outcomes that can be achieved with available environmental water. Works may include pumps to supply water to isolated wetlands (when cut off from the floodplain), and regulators, channels and bunds to direct, retain or exclude flows. Measures may involve things like purchase of flood easements to allow for overbank flows or altering river operations to improve environmental outcomes.

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 Wimmera-Mallee water resource plan area is detailed in the Wimmera, Mallee and North Central CMA Regional Waterway Strategies (Wimmera CMA, 2014), (Mallee CMA, 2014), (North Central CMA, 2014).

8. Demonstrating outcomes

This section outlines how the targets set in Section 3 are measured. Wherever possible, monitoring draws upon existing programs in order 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 Basin-wide environmental water strategy 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 The Living Murray program, Victoria's Native Fish Report Card, and the Commonwealth's Long-Term Intervention Monitoring program (replaced in 2020 by the Monitoring, Evaluation and Research Program, or Flow-MER, note the only site in Victoria is the Goulburn River).

A range of these monitoring results will be used by Victoria to report on Schedule 12 Matter 8, the 'achievement of environmental outcomes at an asset scale'.

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.

The Wimmera CMA also conducts occasional event-based ecological monitoring (subject to funding) which collects data on the hydrological, physical or ecological response to environmental water being delivered to a particular site or system.

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 17) 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 17)
- ensuring environmental water needs are understood and met (note this is not shown in Figure 17, but would consist of a parallel branch of learnings coming out from the monitoring and evaluation and feeding in to 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 in order to adapt and improve as required.

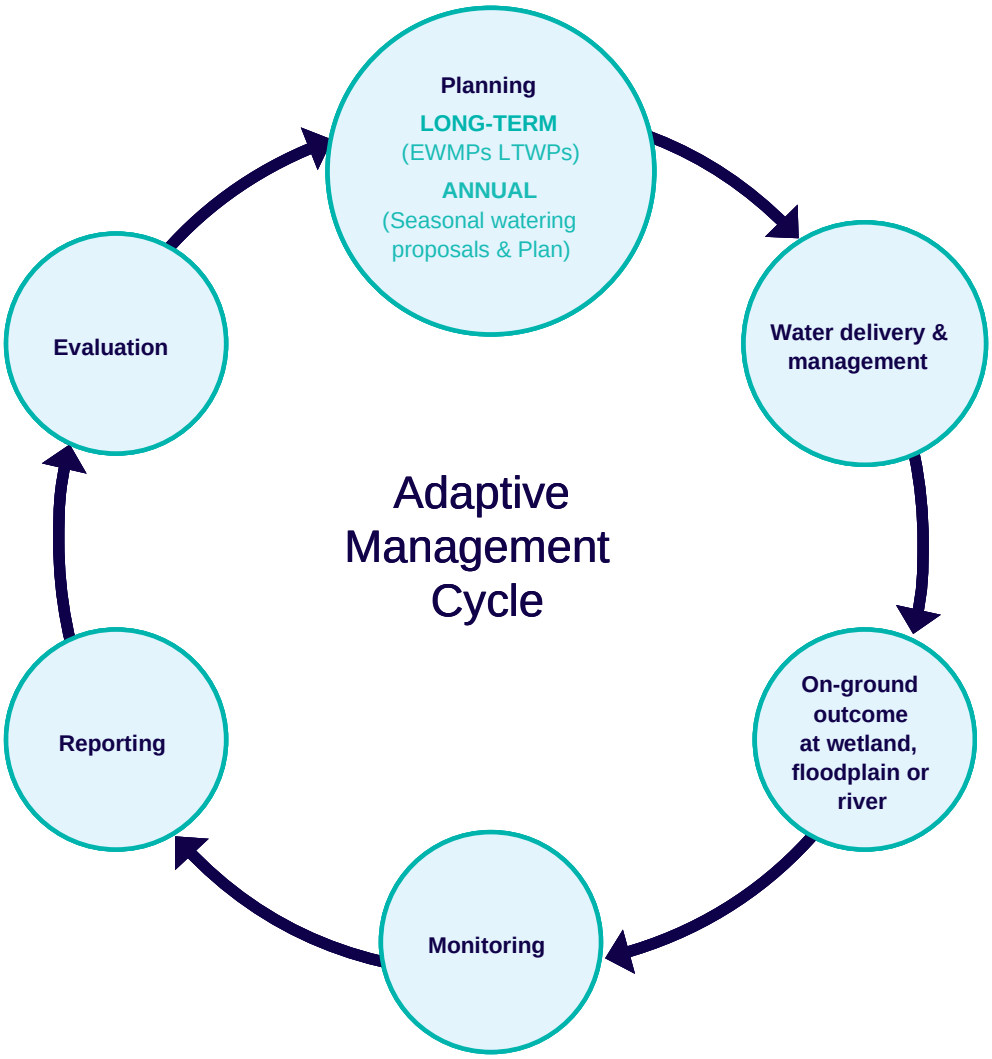


Figure 17: Adaptive management cycle

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. 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 a number of research projects, designed to elucidate cause and effect relationships across Victoria. These projects are conducted by the Arthur Rylah Institute (ARI), Melbourne University, the Murray-Darling Freshwater Research Centre (now the Centre for Freshwater Ecosystems) and CSIRO Australia. Additional independent studies such as Wimmera CMA funded platypus surveys in the MacKenzie River also contribute. 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 21 shows the monitoring programs and assets monitored to assess progress towards meeting these targets.

Two important caveats to Table 21 are: not all current monitoring is considered adequate to assess progress towards targets, generally due to funding limitations; and, targets will continue to be modified as more information is gathered in order to improve their fit to task. 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 21: Objectives, targets and monitoring in the Wimmera-Mallee

Theme	Objective	Revised Target**	Recommended Assets *CMA priority	Current 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	*Wimmera River	NFRC 10 sites, MDBFS 2 sites
			Mount William Creek	VEFMAP6 (2017-18), MDBFS 2 sites
	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	*Wimmera River	NFRC 10 sites, MDBFS 2 sites
			*MacKenzie River	MDBFS 1 site VEFMAP6 2017
			*Mount William Creek	VEFMAP6 2017, MDBFS 2 sites
			*Burnt Creek	VEFMAP6 2017
Waterbirds	Improve breeding opportunities for waterbirds	Deliver water to support waterbird breeding events in Lakes Hindmarsh and Albacutya	Lake Hindmarsh	Water level, voluntary waterbird monitoring
			Lake Albacutya	Water level, voluntary waterbird monitoring
Ve get ati			Wimmera River	None

	Improve condition of riparian Ecological vegetation classes (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	*Burnt Creek	VEFMAP6
			Mount William Creek	VEFMAP6
			Bungalally Creek	None
			Yarriambiack Creek	None
			*MacKenzie River	VEFMAP6
Functions	Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	End-of-valley salinity targets for the Wimmera River at Horsham Weir of median 1,380 EC and eightieth percentile of 1,720 EC are met in every year in the ten years to 2025	Wimmera River	Water quality monitoring at Horsham Weir

NFRC Native Fish Report Card
MDBFS Murray Darling Basin Freshwater Surveys
VEFMAP6 Victorian Environmental Flows Monitoring and Assessment Program Stage 6 (2016-2020)

** 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) ecological 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 across Victoria held in mid-late February. The workshops are attended by relevant program partners such as 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 agencies, identify key risks that may impact on the ability to achieve environmental watering objectives in preparing Environmental Water Management Plans (EWMPs) for priority ecosystem assets, and as part of water resource plans and Regional Waterway Strategies. Key risks are documented in the CMA's EWMPs, along with management measures.

Both these annual and long-term management documents have been drawn upon 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 for environmental water requirements under this LTWP (see Section 3.5) fall into two broad categories:

- Failure to achieve the intended ecological 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, social and economic values. Management measures to address the risks identified in Figure 18 are presented in Appendix H. It should be noted that failure to provide sufficient water through the bulk entitlement process was addressed in the Wimmera-Mallee Water Resource Plan (DELWP 2019, as per Basin Plan clause 10.41).

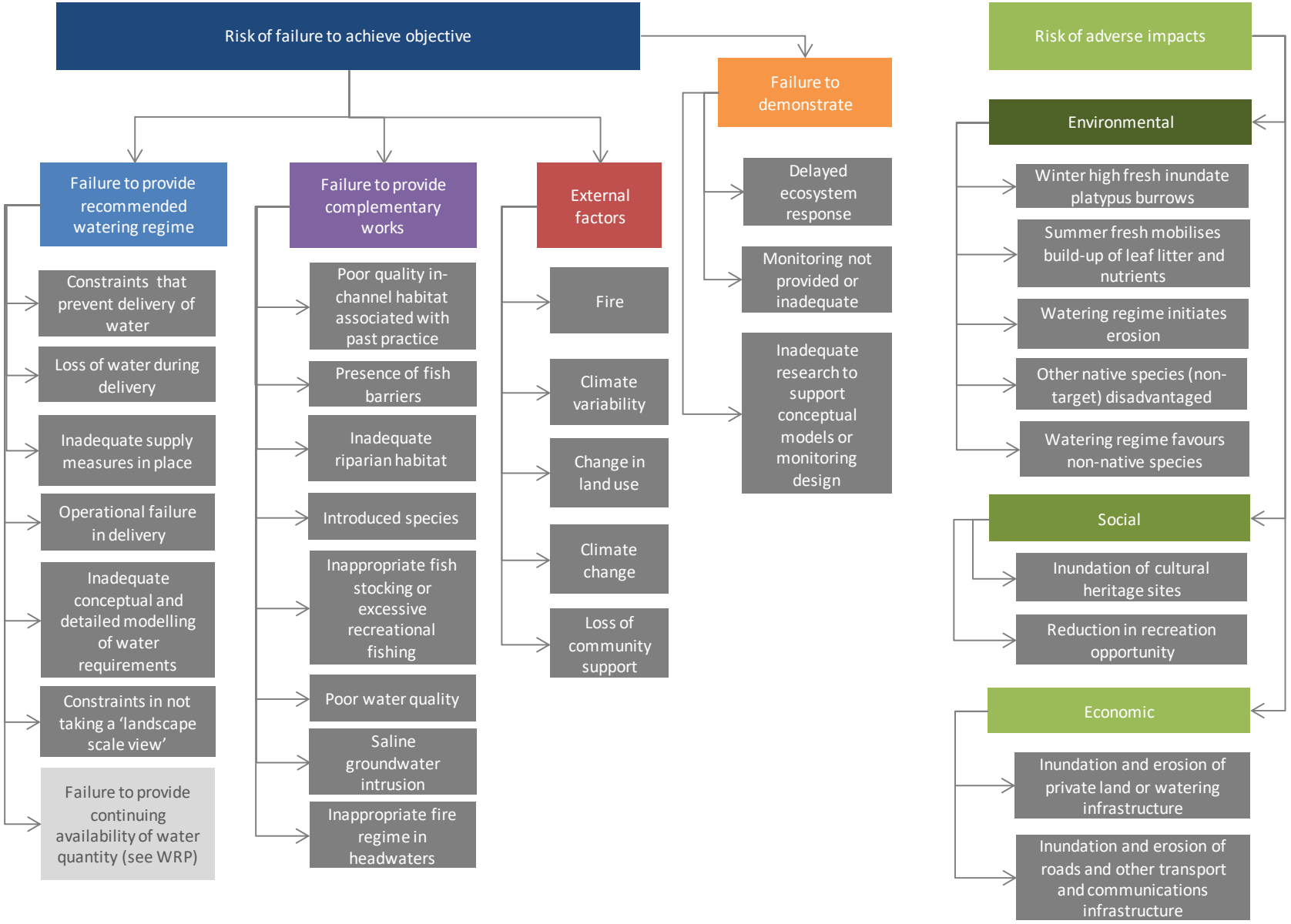


Figure 18: Risk types identified for this LTWP

9.3 Risk identification and assessment approach

While the characterisation of risk in Figure 18 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 the Wimmera-Mallee Water Resource Plan (DELWP 2019), 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 Wimmera-Mallee Water Resource Plan was based on the linkage of causal factors, and their manifestation as threats, in terms of limitations on the use and beneficial outcomes associated with the asset being considered (Figure 19). Threats were then ranked from very low to very high risk based on assessment rubrics of consequence and likelihood (Figure 20):

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, 2019)(Table 22):

- 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.

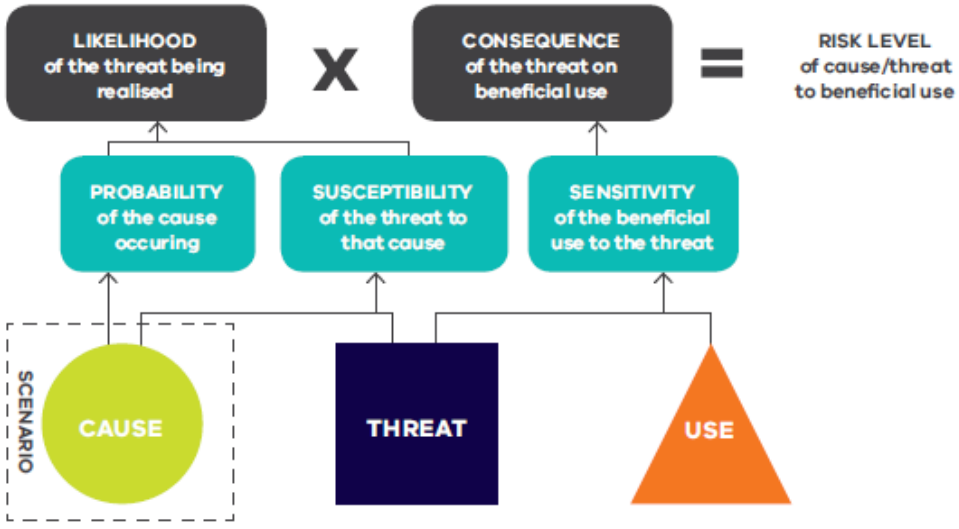


Figure 19: Overview of the risk assessment matrix, including cause-threat-use relationships for the Wimmera-Mallee water resource plan area (from DELWP 2019).

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 20: Risk matrix comprising the combination of likelihood and consequence (Alluvium 2016).

The high priority risks to address (i.e. causes and associated threats listed as 'very high' and 'high' risk to the environment in Table 22) include:

- Climate change
- Extreme events
  - Extreme drought
- Land use and interception
  - Failure to continue to invest in best practice management
  - Pests and weeds.

9.4 Strategies for management

Management actions to address the high priority risks listed above are presented in Table 23. 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 bushfires and extreme wet periods, can also provide mutual benefits by addressing threats that are high level risks to consumptive user, recreational and Aboriginal outcomes. For example, the effects of bushfires could be mitigated by implementing measures to intercept excessive sediment and contaminants in runoff from fire-affected catchments before it reaches waterways and consumptive water supplies.

Table 22: Summary risk levels for the Wimmera-Mallee water resource plan area (DELWP 2019).

Cause category	Cause	Water Availability				Structural Form		Condition			
		Environment	Consumptive	Recreational	Aboriginal	Environment	Aboriginal	Environment	Consumptive	Recreational	Aboriginal
Climate change	Climate change	5	5	5	5	5	5	5	5	5	5
Extreme events	Bushfires	3	3	0	4	0	0	0	3	0	4
	Extreme drought	4	4	4	4	4	4	4	4	3	4
	Extreme wet period	2	2	1	3	3	3	3	4	2	4
	Flooding and overbank inundation	0	0	0	0	3	3	1	2	1	3
	Major asset failure	3	3	3	3	1	1	2	3	2	3
	Point source discharges	0	0	0	0	0	0	1	2	2	3
Land use and interception	Earth resource development	0	0	0	0	0	0	2	3	3	4
	Failure to continue to invest in best practice management	0	0	0	0	3	3	5	5	3	5
	Increase in farm dams	3	3	3	4	2	2	3	3	2	4
	Land use changes (affecting water availability)	3	3	3	3	0	0	0	0	0	0
	Land use changes (affecting water condition)	0	0	0	0	1	1	2	3	1	4
	Pests and weeds	0	0	0	0	3	0	4	4	3	4
Non-compliance	Non-compliance with the Victoria Water Act	2	2	1	3	1	1	3	3	2	4
Water access, take, utilization and location	Increase in the number of rights and volume of entitlements	0	0	0	0	0	0	0	0	0	0
	Increased utilization of water access rights	2	2	1	3	0	0	3	3	1	3
	Timing and location of demand	0	0	0	0	0	0	0	0	0	0

Note: Rankings: 5 = very high risk, 4 = high risk, 3 = medium risk, 2 = low risk, 1 = very low risk, 0 = not plausible

Table 23: Summary of high priority environmental risks and related management measures (adapted from DELWP 2019)

Risk level	Risk cause	Risk threat	Risk impact on beneficial uses	Risk impact on environmental objectives (from Figure 18)	Potential management actions
There is a high risk	That climate change	Leads to a reduction in the volume of water available	Which results in adverse impacts on high-reliability bulk entitlement water uses/users	Failure to meet environmental watering objectives due to: • Failure to deliver the recommended environmental water regime • Failure to demonstrate outcomes due to delays in ecosystem response	• Deliver long-term watering plans, complemented with: – Monitoring watering regime and ecological response – Liaison with water authorities, land holders, other stakeholders and the broader community – Delivery of priority environmental water requirements based on seasonal conditions and within constraints – Develop and implement programs to alleviate physical constraints to water delivery • Environmental water management in a changing climate • Implement Ministerial Guidelines for groundwater licensing and protection of high-value groundwater-dependent ecosystems • Improving understanding of climate science and how it applies to water management • Improving public reporting on water availability and use: user-focused information and reporting • Improving statewide water resource planning and risk assessment • Leading climate change adaptation across Victoria's water system • Maximising the effectiveness of the grid and markets across the State
There is a very high risk	That climate change	Leads to a reduction in the volume of water available	Which results in adverse impacts on low-reliability bulk entitlement water uses/users.	Failure to meet environmental watering objectives due to: • Failure to deliver the recommended environmental water regime • Failure to demonstrate outcomes due to delays in ecosystem response	
There is a very high risk	That climate change	Leads to changes to the seasonal pattern of water available	Which results in adverse impacts on uncontrolled water (above cap water) water uses/users	Failure to meet environmental watering objectives due to: • Failure to deliver the recommended environmental water regime • Failure to demonstrate outcomes due to delays in ecosystem response	
There is a very high risk	That climate change	Leads to changes to the seasonal pattern of water available	Which results in adverse impacts on uncontrolled water (above cap water) water uses/users	Failure to meet environmental watering objectives due to: • Failure to deliver the recommended environmental water regime • Failure to demonstrate outcomes due to delays in ecosystem response	

Risk level	Risk cause	Risk threat	Risk impact on beneficial uses	Risk impact on environmental objectives (from Figure 18)	Potential management actions
There is a very high risk	That climate change	Leads to a reduction in the volume of water available	Which results in adverse impacts on uncontrolled water (above cap water) water uses/users	Failure to meet environmental watering objectives due to: • Failure to deliver the recommended environmental water regime • Failure to demonstrate outcomes due to delays in ecosystem response	• Monitoring and reporting on the benefits of environmental watering • Protecting our waterways and their catchments by strengthening integrated catchment management across Victoria • Provide long-term investment to improve waterway health • Recognising and managing for Aboriginal values • Water resource information supports planning and decisions
There is a high risk	That climate change	Leads to other water quality impacts (water temperature, pH and/or dissolved oxygen)	Which results in adverse impacts on environmental values/aquatic ecosystems of Wimmera–Mallee water uses/users	Failure to meet environmental watering objectives due to: • Failure provide adequate water quality • Failure to provide adequate in-channel habitat	
There is a high risk	That climate change	Leads to elevated levels of salinity	Which results in adverse impacts on environmental values/aquatic ecosystems of Wimmera–Mallee water uses/users	Failure to meet environmental watering objectives due to: • Failure provide adequate water quality • Failure to provide adequate in-channel habitat	• Monitor groundwater and assets • Monitoring, adaptive management of watering regime • Investigate regional groundwater influences • Managing groundwater related risks (including groundwater and surface water connectivity) through Victorian planning and implementation frameworks • Managing salinity, waterlogging and water quality including issues arising from an extreme wet period • Protecting waterways and their catchments by strengthening integrated catchment management across Victoria • Protecting water quality- implementing the State Environment Protection Policy (Waters) • Provide long-term investment to improve waterway health
There is a high risk	That climate change	Leads to elevated levels of suspended sediment and/or nutrients	Which results in adverse impacts on environmental values/aquatic ecosystems of Wimmera–Mallee water uses/users	Failure to meet environmental watering objectives due to: • Failure provide adequate water quality • Failure to provide adequate in-channel habitat	
There is a very high risk	That climate change	Leads to elevated levels of toxicants (pesticides, herbicides, heavy metals, hydrocarbons)	Which results in adverse impacts on environmental values/aquatic ecosystems of Wimmera–Mallee water uses/users	Failure to meet environmental watering objectives due to: • Failure provide adequate water quality • Failure to provide adequate in-channel habitat	

Risk level	Risk cause	Risk threat	Risk impact on beneficial uses	Risk impact on environmental objectives (from Figure 18)	Potential management actions
There is a high risk	That extreme drought	Leads to a reduction in the volume of water available	Which results in adverse impacts on uncontrolled water (above cap water) water uses/users	Failure to meet environmental watering objectives due to: • Failure to deliver the recommended environmental water regime • Failure to demonstrate outcomes due to delays in ecosystem response	• Deliver long-term watering plans, complemented with: – Monitoring watering regime and ecological response – Liaison with water authorities, land holders, other stakeholders and the broader community – Delivery of priority environmental water requirements based on seasonal conditions and within constraints – Develop and implement programs to alleviate physical constraints to water delivery • Provide emergency water supply • Improving understanding of climate science and how it applies to water management • Improving public reporting on water availability and use: user-focused information and reporting • Improving State-wide water resource planning and risk assessment
There is a high risk	That extreme drought	Leads to a reduction in the volume of water available	Which results in adverse impacts on low-reliability bulk entitlement water uses/users.	Failure to meet environmental watering objectives due to: • Failure to deliver the recommended environmental water regime • Failure to demonstrate outcomes due to delays in ecosystem response	
There is a high risk	That extreme drought	Leads to changes to inter-annual patterns of water available	Which results in adverse impacts on uncontrolled water (above cap water) water uses/users	Failure to meet environmental watering objectives due to: • Failure to deliver the recommended environmental water regime • Failure to demonstrate outcomes due to delays in ecosystem response	

Risk level	Risk cause	Risk threat	Risk impact on beneficial uses	Risk impact on environmental objectives (from Figure 18)	Potential management actions
There is a high risk	That extreme drought	Leads to elevated levels of toxicants (pesticides, herbicides, heavy metals, hydrocarbons)	Which results in adverse impacts on environmental values/aquatic ecosystems of Wimmera–Mallee water uses/users	Failure to meet environmental watering objectives due to: • Failure provide adequate water quality • Failure to provide adequate in-channel habitat	• Lead climate change adaptation across Victoria's water system • Managing exceptional circumstances • Managing groundwater-related risks (including groundwater and surface water connectivity) through Victorian planning and implementation frameworks • Managing water quality events • Maximising the effectiveness of the grid and markets across the State • Protecting waterways and their catchments by strengthening integrated catchment management across Victoria • Recognising and managing for Aboriginal values • Water resource information supports planning and decisions
There is a very high risk	That failure to continue to invest in best practice land use initiatives	Lead to elevated levels of salinity	Which results in adverse impacts on environmental values/aquatic ecosystems of Wimmera–Mallee water uses/users	Failure to meet environmental watering objectives due to: • Failure provide adequate water quality • Failure to provide adequate in-channel habitat	• Monitor groundwater and assets • Monitoring, adaptive management of watering regime • Investigate regional groundwater influences

Risk level	Risk cause	Risk threat	Risk impact on beneficial uses	Risk impact on environmental objectives (from Figure 18)	Potential management actions
There is a high risk	That failure to continue to invest in best practice land use initiatives	Leads to elevated levels of suspended sediment and/or nutrients	Which results in adverse impacts on environmental values/aquatic ecosystems of Wimmera–Mallee water uses/users	Failure to meet environmental watering objectives due to: • Failure provide adequate water quality • Failure to provide adequate in-channel habitat	• Managing groundwater related risks (including groundwater and surface water connectivity) through Victorian planning and implementation frameworks • Managing salinity, waterlogging and water quality including issues arising from an extreme wet period • Protecting waterways and their catchments by strengthening integrated catchment management across Victoria • Protecting water quality- implementing the State Environment Protection Policy (Waters) • Provide long-term investment to improve waterway health
There is a high risk	That pests and weeds	Lead to elevated levels of suspended sediment and/or nutrients	Which results in adverse impacts on environmental values/aquatic ecosystems of Wimmera–Mallee water uses/users	Failure to meet environmental watering objectives due to: • Failure provide adequate water quality • Failure to provide adequate in-channel habitat	• Monitor introduced species • Provide watering regimes that provide competitive advantage for native species • Development and implementation of pest management plans • Installation of carp screens • Protecting water quality- implementing the State Environment Protection Policy (Waters)

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 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 ecological 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 (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 ecological objectives and targets in this plan.

10.3 Stakeholder review

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

Further review was carried out of the draft 2020 minor update, with feedback on the draft provided by the relevant CMAs and the VEWH.

As described in section 5.4, consultation on the LTWPs was carried out with Traditional Owner groups across northern Victoria during 2020.

10.4 MDBA Feedback

Much of the content of this 2020 LTWP update was in response to feedback from the MDBA.

10.5 LTWP Review

DELWP commissioned a review of Victoria's LTWPs in 2019 (Peter Cottingham & Associates, 2019), with many of the recommendations incorporated in this update or planned for the 2022-3 update.

11. Next Steps

This LTWP is one of many steps towards full implementation of Basin Plan. Additional facets are required in order to monitor and evaluate the ecological objectives and targets outlined. The monitoring and evaluation plan will continue to be developed to align with Basin Plan Matter 8 reporting on achievement of environmental outcomes at the asset scale.

Work is currently being carried out to update the Victorian 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.

Demonstrating successful achievement of objectives and targets in the LTWP depends on the 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. Operational constraints (physical and management) will need to be addressed, and in some cases, complementary actions will be needed to secure environmental outcomes.

Further work will also be pursued between now and the next LTWP review and update. This is expected to be triggered by the next update of the BWS in 2022-3. Ongoing 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.
- 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 are being carried out in 2020 to improve their adherence to SMART criteria and alignment with Basin Plan.
- Further incorporation of Basin Plan principles and objectives in the VWMS renewal.

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Appendix A Basin Plan obligation 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 24: 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 • ecological 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 2.2 Sections 3.3, 3.4 Appendix E Appendix F
	• A long-term watering plan must identify • priority ecosystem functions in the water resource plan area; and • ecological 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 2.6 Sections 3.3, 3.4 Appendix E 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 held environmental water, 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[7].	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 held environmental water; 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 5 Throughout See Table 25
Consistency with international agreements	A long-term watering plan must not be inconsistent with relevant international agreements.	8.20 (5)	Section 2, in particular 2.5

[7] 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 25: 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.	Ecological objectives for Wimmera-Mallee 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 held environmental water 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 the Wimmera-Mallee Water Resource Plan.
(g) enables information to be shared between the Authority, the Commonwealth, Basin States, holders of held environmental water 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 Wimmera-Mallee 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 Victorian Water Act (1989), held environmental water 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).	

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, 2013 - VWMS).

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 ecological 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 ecological 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 ecological 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 community input 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.

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 ecological 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: Priority environmental assets in the Wimmera-Mallee water resource plan area

Asset Name	CMA	EWMP (or other document)
Bungalally Creek	Wimmera	Environmental Water Management Plan – Wimmera River System
Burnt Creek	Wimmera	Environmental Water Management Plan – Wimmera River System
Lake Albacutya	Wimmera	Environmental Water Management Plan – Wimmera River System
Lake Hindmarsh	Wimmera	Environmental Water Management Plan – Wimmera River System
MacKenzie River	Wimmera	Environmental Water Management Plan – Wimmera River System
Mount William Creek	Wimmera	Environmental Water Management Plan – Wimmera River System
Outlet creek	Wimmera	Environmental Water Management Plan – Wimmera River System
Wimmera-Mallee pipeline wetlands	Wimmera, Mallee, North Central	Environmental Water Management Plan – Wimmera-Mallee Pipeline wetlands – Mallee CMA Region Environmental Water Management Plan – Wimmera-Mallee Pipeline wetlands –North Central CMA Region Environmental Water Management Plan – Wimmera-Mallee Pipeline wetlands – Wimmera CMA Region
Wimmera River	Wimmera	Environmental Water Management Plan – Wimmera River System
Yarriambiack Creek	Wimmera, Mallee	Yarriambiack Creek and Beulah Weir Pool Environmental Water Management Plan Environmental Water Management Plan – Wimmera River System
*Dock Lake	Wimmera	
*Ranch Billabong	Wimmera	

Note: *Dock Lake and Ranch Billabong are being considered for inclusion as priority environmental assets.

Appendix C Determining objectives, targets and watering requirements

This appendix describes the approach used to develop ecological objectives and targets for the Wimmera-Mallee water resource plan area and this LTWP. The overall process is shown in Figure 21 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.

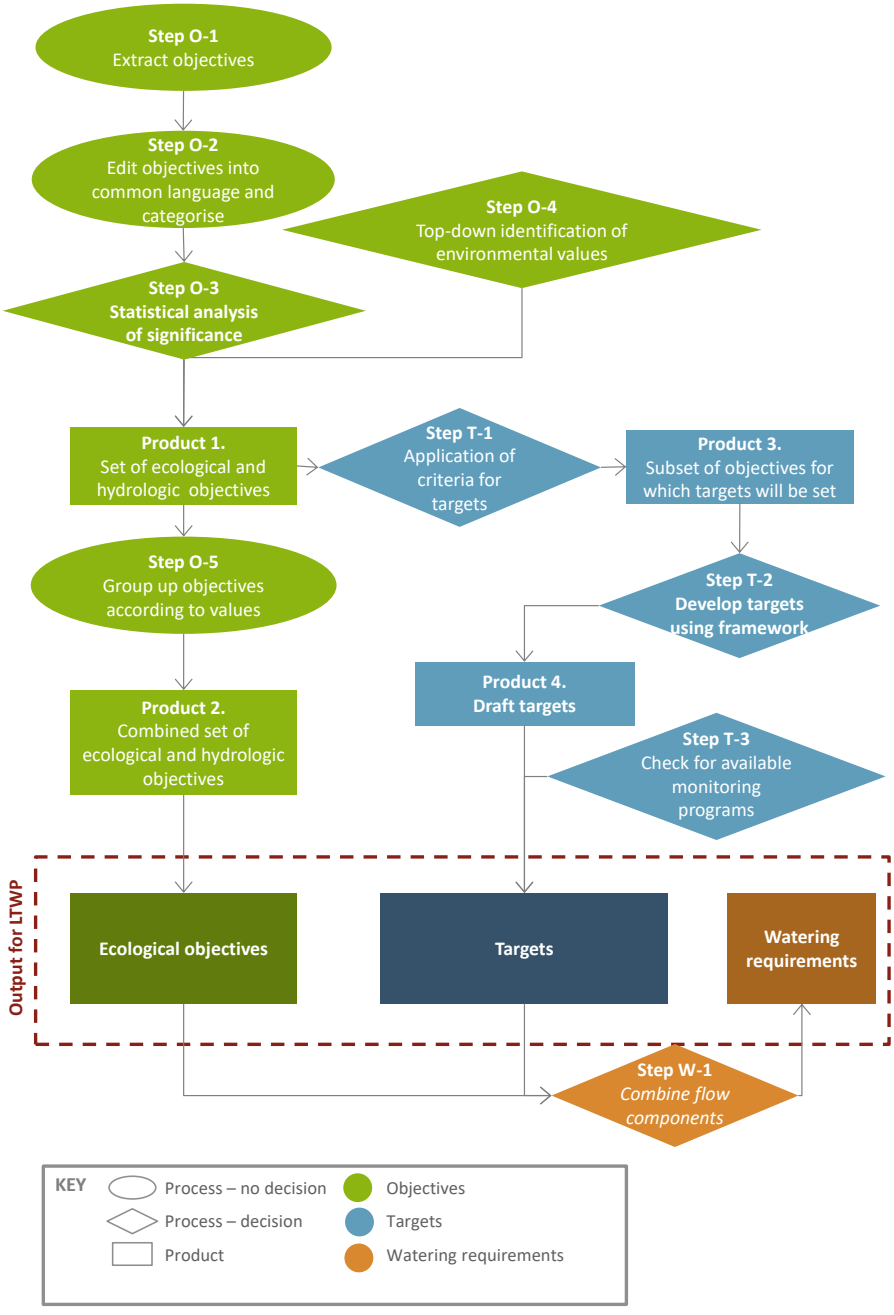


Figure 21: Overview of process for developing objectives and targets

The first step in process was to collate all available ecological 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 22.

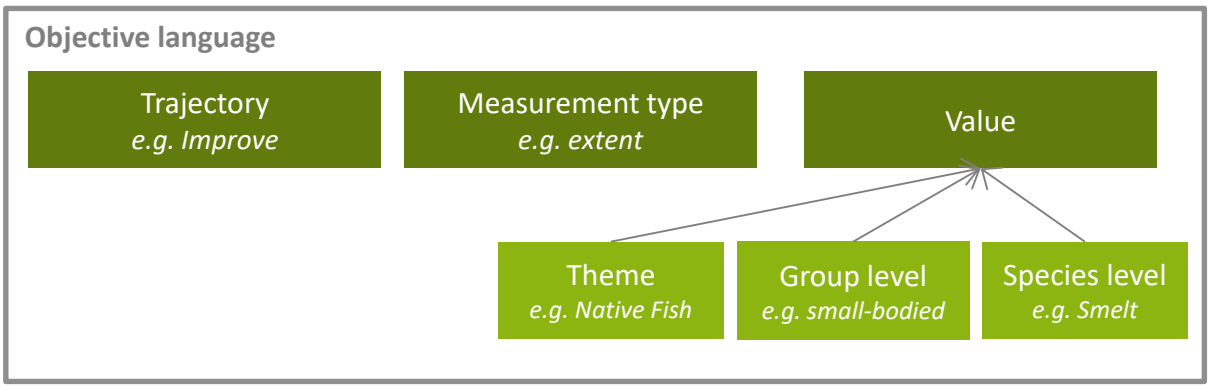


Figure 22: Objective language used to standardise objectives and categorise them

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 23)

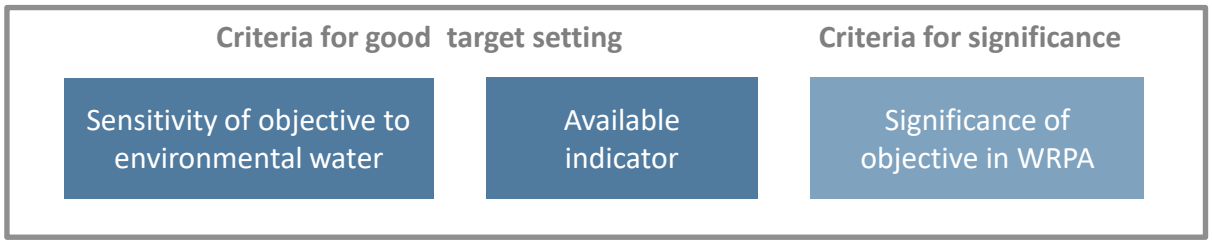


Figure 23: Criteria for target setting

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.

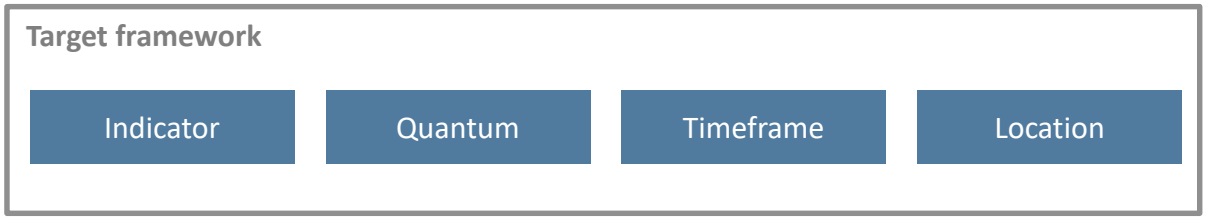


Figure 24: Framework for developing targets

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 to these targets are planned to further improve SMARTness and fitness to task.

Fish Target 1

Fish Target 1 has two parts A and B.

Part A addresses the LTWP objective to "Improve abundance of large-bodied native fish". The target in the 2014 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 subtargets 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 subtargets 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

Fish Target 2 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.

Waterbirds Target 1

Waterbirds Target 1 addresses the LTWP objective to "Improve breeding opportunities for waterbirds" in the Wimmera-Mallee water resource plan area. 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.

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 VEFMAP6.

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 water resource plan area. 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 water resource plan area. 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 VEFMAP6.

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 water resource plan area. 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 VEFMAP6 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 water resource plan area. 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 "Canegrass 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 VEFMAP6:

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

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 water resource plan area. 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 water resource plan area 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 years period must be more than 75% of the highest diversity recorded in any one year.

Appendix E Priority environmental asset goals and objectives

The table below lists management goals and environmental objectives for each priority environmental asset in the Wimmera-Mallee water resource plan area, cross-referenced to LTWP objectives and Basin-wide environmental watering strategy Expected Environmental Outcomes (BWS EEOs) and Basin Plan environmental watering plan objectives where appropriate. Codes used for the BWS EEOs are in Table 49. Goals and objectives are taken from the relevant EWMPS.

Table 27: Management goals and objectives for each priority environmental asset in the Wimmera-Mallee water resource plan area.

Asset Name	CMA	Management Goal	Environmental Objective	Theme	LTWP Objective(s)	BWS EEO(s)	EWP Objective(s)
Wimmera River, Mount William Creek (Wimmera CMA, 2020)	WCMA	Environmental water will maintain and enhance the condition of the Wimmera River System and terminal lakes (Lake Albacutya, Lake Hindmarsh and Outlet Creek) to support its formally recognised status, its role in providing connectivity for flora, fauna, carbon and nutrients as well as maintaining its strong environmental values. This includes diverse, abundant and resilient native fish and vegetation communities, geomorphic diversity, sustainable platypus population and mitigated impacts of poor water quality.					
			Improve the abundance, movement and species richness of native fish species	Fish	L4.2	B4.2, B4.3, B4.4, B4.5, B4.6, B4.7	
			Restore indigenous fish community diversity and abundance (Reach 2 only)		L4.1, L4.2	B4.2, B4.3, B4.4, 4.5, B4.6, B4.7, B4.9	
			Maintain the species richness and extent of in-channel aquatic vegetation, improve the abundance of aquatic vegetation.	Vegetation	L2.1	B1.4, B2.11, B2.12	
			Improve the condition of riparian EVCs		L2.2	B2.2, B2.8	
			Maintain the quality of geomorphic habitat (maintain channel form, clean substrates, prevent stream bed colonisation)	Other	L1.4		
			Improve longitudinal connectivity (between river reaches) to facilitate fish movement	Connectivity	L1.1	B1.1	
			Maintain refuges for native fish species (prevent loss of channel capacity through sedimentation)	Fish, Connectivity and Functions	L1.3, L1.4	B1.1	

Asset Name	CMA	Management Goal	Environmental Objective	Theme	LTWP Objective(s)	BWS EEO(s)	EWP Objective(s)
			Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	Vegetation, Connectivity and Functions	L1.2		
			Maintain macroinvertebrate diversity	Other	N/A		
			Improve habitat for Platypus and Rakali		L5.1		
			Maintain habitat for crayfish communities		L5.2		
Lake Albacutya, Lake Hindmarsh, Outlet Creek (Terminal Lakes)	WCMA		Provide conditions suitable for the establishment and maintenance of vegetation in the lakebed zone of the lower terminal lakes, representative of the wetted and dry phases of an episodically inundated wetland in a semi-arid environment.	Vegetation	L2.3	B1.1, B1.4	
			Provide conditions suitable to maintain vegetation communities in fringing woodland zone.		L2.2	B1.4, B2.1, B2.2, B2.8	
			Support waterbird use of the terminal lakes system through improved access to feeding, roosting and breeding habitat during episodic filling of the lakes and provide extensive wetland habitat to support large populations of waterbirds in the lower terminal lakes in years when widespread natural flooding occurs.	Waterbirds	L3.1	B3.1, B3.3	
			Provide habitat and refuge for migratory and resident woodland bird species, particularly the nationally vulnerable Regent Parrot (Lake Albacutya Ramsar Criterion 3).	Other	N/A	B3.1	
			Promote biomass of macroinvertebrate and fish communities sufficient to provide food resources for waterbirds during wet phases.	Waterbirds	L3.1		
			Support the opportunistic colonisation of wetland habitats and Outlet Creek during inundation events by frog and turtles.	Other	L5.2		
Burnt Creek	WCMA		Facilitate dispersal and establishment of endemic fish species	Fish	L4.2	B4.1, B4.3, B4.4., B4.6, B4.10	
			Protect and restore riparian and floodplain EVCs	Vegetation	L2.2	B2.1, B2.8, B2.9, B2.11	

Asset Name	CMA	Management Goal	Environmental Objective	Theme	LTWP Objective(s)	BWS EEO(s)	EWP Objective(s)
			Maintain structural integrity of stream bed and channel and prevent loss of channel capacity	Connectivity and Functions	L1.4		
			Maintain habitat values through prevention of stream-bed colonisation by terrestrial species		L1.4		
			Improve channel diversity through increasing flow variability	Other	N/A		
			Maintain a 'good' diversity of macroinvertebrate species (based on MBI classifications)		N/A		
Bungalally Creek	WCMA		Protect and restore riparian and floodplain EVCs	Vegetation	L2.2	B2.1, B2.8, B2.9, B2.11	
			Maintain structural integrity of stream bed and channel and prevent loss of channel capacity	Connectivity and Functions	L1.4		
			Prevent excessive stream-bed colonisation by terrestrial species		L1.4		
MacKenzie River	WCMA		Maintain intact indigenous fish communities	Fish, Connectivity and Functions	L4.2	B4.2, B4.3, B4.4, 4.5, B4.6, B4.7, B4.9	
			Maintain fish in refuges in dry conditions through the provision of adequate water quality/habitat		L1.3	B1.1	
			Facilitate dispersal and establishment of endemic fish species		L4.1	B1.1, B1.4, B4.3, B4.4	
			Protect and restore riparian and floodplain EVCs	Vegetation	L2.2	B2.1, B2.8, B2.9, B2.11	
			Maintain submerged and emergent aquatic vegetation quality, diversity and extent for fish habitat		L2.1	B2.11, B2.12	
			Stimulate reproduction and recruitment of *Callistemon wimmerensis* and maintain condition of current mature specimens		L2.1		
			Maintain structural integrity of stream bed and channel and prevent loss of channel capacity	Other, Connectivity and Functions	L1.4		
			Maintain habitat values through prevention of stream-bed colonisation by terrestrial species		L1.4		

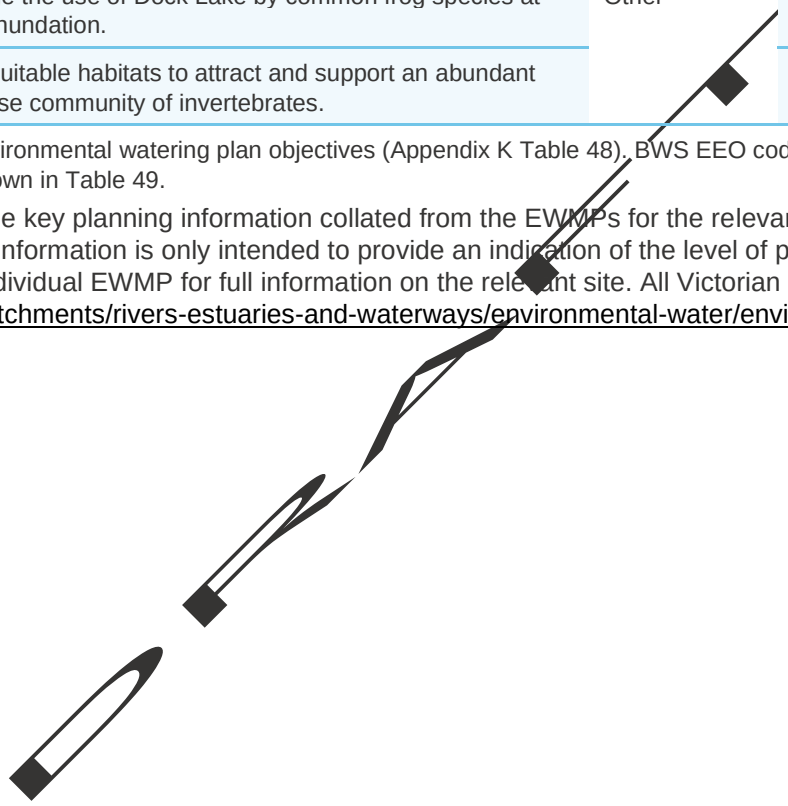
Asset Name	CMA	Management Goal	Environmental Objective	Theme	LTWP Objective(s)	BWS EEO(s)	EWP Objective(s)
			Maintain a 'good' diversity of macroinvertebrate species (based on MBI classifications)		N/A		
			Sustain a platypus population and facilitate its dispersal		L5.1		
			Protect and restore riparian and floodplain EVCs	Vegetation	L2.2	B2.1, B2.8, B2.9, B2.11	
			Maintain habitat values through prevention of stream-bed colonisation by terrestrial species	Other, Connectivity and Functions	L1.4		
	MCMA		Improve health of Black Box community	Vegetation	L2.4	B2.8, B2.9	
Wimmera-Mallee Pipeline wetlands	MCMA	To maintain and enhance a network of wetland habitats and refuges for aquatic and terrestrial fauna across the Wimmera-Mallee landscape.					
			Provide watering points for terrestrial fauna and woodland birds	Other	L5.1		
			Provide foraging, refuge and breeding habitat for turtles and frogs		L5.2		
			Maintain the health of fringing lignum and black box communities and wetland EVCs	Vegetation	L2.1, L2.3, L2.4	B2.2, B2.8	
			Provide suitable feeding and breeding habitat for various waterbird guilds	Waterbirds	L3.1	B3.3	
	NCCMA	Maintain aquatic habitat and refugia through the landscape to provide refuge, shelter, watering points and feeding opportunities for waterbird, turtles, frogs and terrestrial fauna species in the region.					
			Re-establish aquatic habitat and refugia through the landscape for water dependent fauna (frogs, turtles and waterbirds)	Waterbirds	L3.1, L5.2		
			Provide watering points for terrestrial species - provide fresh drinking water for water dependent and terrestrial fauna to ensure persistence of a range of species in the dry landscape		L5.1		
	WCMA	Maintaining and improving the values and condition of waterways that have formally recognised significance; Improved water quality in priority areas for; water supply, environmental condition and recreation; Waterways with high social, cultural and economic values are maintained in a state that continues to support those values in line with climatic conditions.					

Asset Name	CMA	Management Goal	Environmental Objective	Theme	LTWP Objective(s)	BWS EEO(s)	EWP Objective(s)
			Improve vital habitat at Wimmera Pipeline wetlands by 2030, by improving species richness and abundance of aquatic vegetation against 2012-2013 EVC benchmark levels of: a) Black box wetland EVC 369 at Carapugna, Challambra, Harcoans, Mutton, Pinedale and Schultz/Koschitzke wetlands. b) Herb-rich Gilgai Wetland EVC 235 at Fielding's Dam c) Intermittent swampy woodland EVC 813 at Crow Swamp and Sawpit Swamp d) Northern Wimmera Riverine Chenopod Woodland EVC 103 at Carapugna, Challambra, Crow and Pinedale e) Lake Bed Herbland EVC 107 at Challambra, Crow, Harcoans and Mutton f) Lignum Swampy Woodland EVC 823 at Krong Swamp and Tarkedia g) Lignum Shrubland EVC 808 at Krong Swamp h) Floodway Pond Herbland EVC 810 and Floodway Pond Herbland/Riverine Swamp Forest Complex (EVC 945) at Sawpit Swamp i) Cane Grass Wetland/Aquatic Herbland Complex EVC 602, Swamp-Cane Grass Wetland Complex EVC 114 and Red Gum Swamp-Cane Grass Wetland Complex EVC 114 Wal Wal Swamp	Vegetation	L2.1, L2.4	B2.1, B2.9, B2.11, B2.12,	8.05,3(b) 8.05,3(a) 8.06,6(a)
			Maintain breeding of frogs at Wimmera Pipeline wetlands in 80% of years in which water is present by 2030: a) Maintain presence of Spotted Marsh Frog (*Limnodynastes tasmaniensis*) at Carapugna wetland b) Maintain presence of Common Froglet (*Crinia signifera*), Plains froglet (*Crinia parainsignifera*), Pobblebonk (*Limnodynastes dumerili*), and Spotted Marsh Frog (*Limnodynastes tasmaniensis*) at Mutton Swamp c) Maintain presence of Common Froglet (*Crinia signifera*) at Pinedale d) Maintain presence of Common Froglet (*Crinia signifera*) and Spotted Marsh Frog (*Limnodynastes tasmaniensis*) at Sawpit Swamp and Wal Wal Swamp.	Other	L5.2		8.05,3(b) 8.05,3(a) 8.06,6(b)

Asset Name	CMA	Management Goal	Environmental Objective	Theme	LTWP Objective(s)	BWS EEO(s)	EWP Objective(s)
*Dock Lake	WCMA		Return to a seasonal or intermittent wetting and drying cycle to encourage the establishment and maintenance of structurally and floristically diverse native vegetation	Vegetation	L2.1		
			Provide diverse habitat and foraging resources to a suite of birds by varying the water level in the lake over time.	Waterbirds	L3.1		
			Encourage the use of Dock Lake by common frog species at times of inundation.	Other	L5.2		
			Engage suitable habitats to attract and support an abundant and diverse community of invertebrates.		N/A		

Note: EWP codes are the Basin Plan Chapter 8 environmental watering plan objectives (Appendix K Table 48). BWS EEO codes are the Basin-wide environmental watering strategy Expected Environmental Outcomes, as shown in Table 49.

The information in Table 27 presents some of the key planning information collated from the EWMPs for the relevant priority environmental assets in the Wimmera-Mallee water resource plan area. 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



Appendix F Priority environmental asset watering requirements

Watering requirements for priority environmental assets are taken directly from relevant EWMPs.

a) Wimmera River system

i) Flow recommendations for the Wimmera River and Mount William Creek

The water regimes required for achieving ecological objectives listed in Appendix E were developed according to the FLOWS method for determining environmental water requirements in Victoria (DEPI, 2013) for the Wimmera River, Mount William Creek and terminal lakes. This approach makes allowance for seasonal conditions (drought to wet conditions) rather than recommending the same flow regime every year regardless of the prevailing climate. For example, during dry or drought conditions the recommended number and volume of freshes will be fewer than during average or wet conditions and cease to flow periods will be longer. Bankfull and overbank flows may only be recommended during average and/or wet periods. Ecological information (e.g. required frequency of recruitment events to maintain a species) still underpins the recommendations around the frequency of various flow components. Details of magnitude, timing, duration and frequency of each flow component for each reach are given in Table 28 and relevant ecological objectives documented. Recommended rates of rise and fall for flows greater than baseflows have also been developed to assist mitigating negative impacts such as river bank slumping and fish stranding that could occur should flow rates vary too quickly.

These recommendations have been extracted as a subset of priorities to target in the next ten years. However, additional ecological objectives and flow recommendations may be targeted if the opportunity or need arises.

To meet the hydrological requirements of the Wimmera River and terminal lakes EWMP, flow recommendations have been set considering the following factors:

- the preferred timing of watering events
- the recommended duration for watering events
- the tolerable intervals between events (condition tolerances)
- the volume required to provide these events – per event / per season.

Table 28 details the hydrological requirements in terms of the frequency, duration, and timing for all of the ecological objectives.

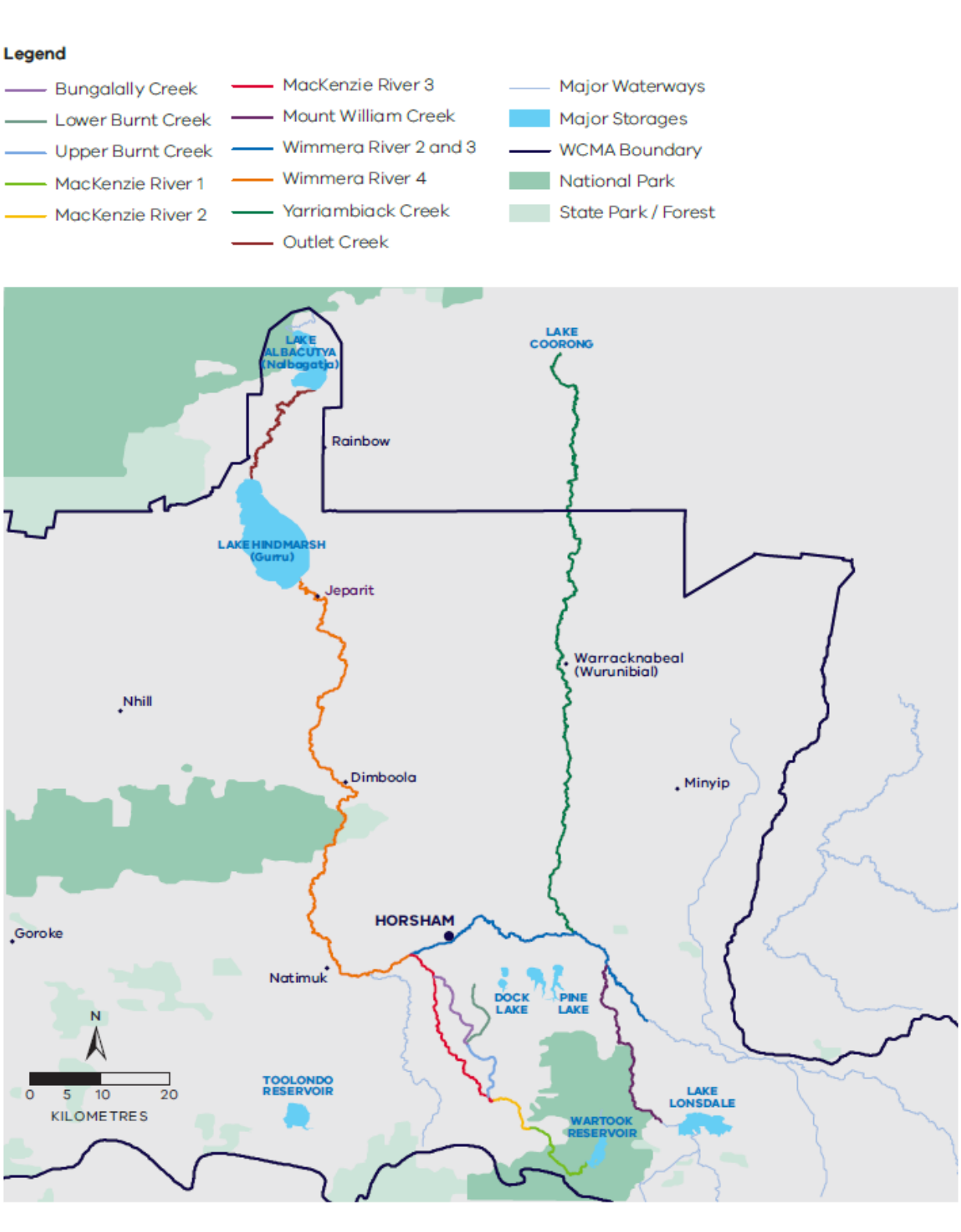


Figure 25: Reaches of the Wimmera River system referred to in the watering requirements.

Table 28: Environmental flow recommendations for Mount William Creek

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Overarching environmental objective	Detailed environmental objective (Source Alluvium 2013)
Cease to flow	Dec-May	0 ML/d	Drought	As infrequently as possible	Less than 90 days in total	1,2,8,9,10	Ensure stress on environmental values is not exacerbated beyond the point of no return. Cease to flow periods should be concluded with fresh lasting at least 7 days duration.
			Dry				
			Average		Less than 30 days in total		
Baseflow	Any	5 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9,10	Maintain edge habitats and shallow water habitat availability for macroinvertebrates and endemic fish and near-permanently inundated stream channel for riparian vegetation and prevent excessive instream terrestrial species growth.
Freshes	Dec-May	20 ML/d	Drought	3 per period	3-7 days	1,4,5,6,7,8,9,10	Prevent water quality decline by flushing pools during low flows.
			Dry	3 per period	4-7 days		
	Dec-May	30 ML/d	Average	3 per period	3-7 days	1,4,5,6,7,8,9,10	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.
			Wet	3 per period			
	Jun-Nov	100 ML/d	Drought	1 per period	3 days	1,4,5,6,7,8,9,10	Wet benches, entraining organic debris and promote diversity of habitat. Flush surface sediments from hard substrates to support macroinvertebrates.
			Dry	3 per period	3 days		
			Average	5 per period	5 days		
			Wet	5 per period	7 days		
	Jun-Nov	500 ML/d	Dry	1 per period	1 day	1,4,5,6,7,8,9,10	Wets highest benches, entraining organic debris and promoting diversity of habitat.

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Overarching environmental objective	Detailed environmental objective (Source Alluvium 2013)
			Average	2 per period	2 days		
			Wet	3 per period	3 days		
			Wet	2 per period	3 days		
Bankfull	Any	750 ML/d	Average	1 per period or natural	2 days	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.
			Wet	1 per year	4 days		
Overbank	Aug-Nov	1,500 ML/d	Wet	1 per year	1 day	3,4,8	Inundate floodplain vegetation to maintain condition and facilitate recruitment of adult River Red Gums. Entrain organic debris from the floodplain to support macroinvertebrates. Maintain floodplain geomorphic features.

Table 29: Environmental flow recommendations for the Wimmera River reaches 2 & 3

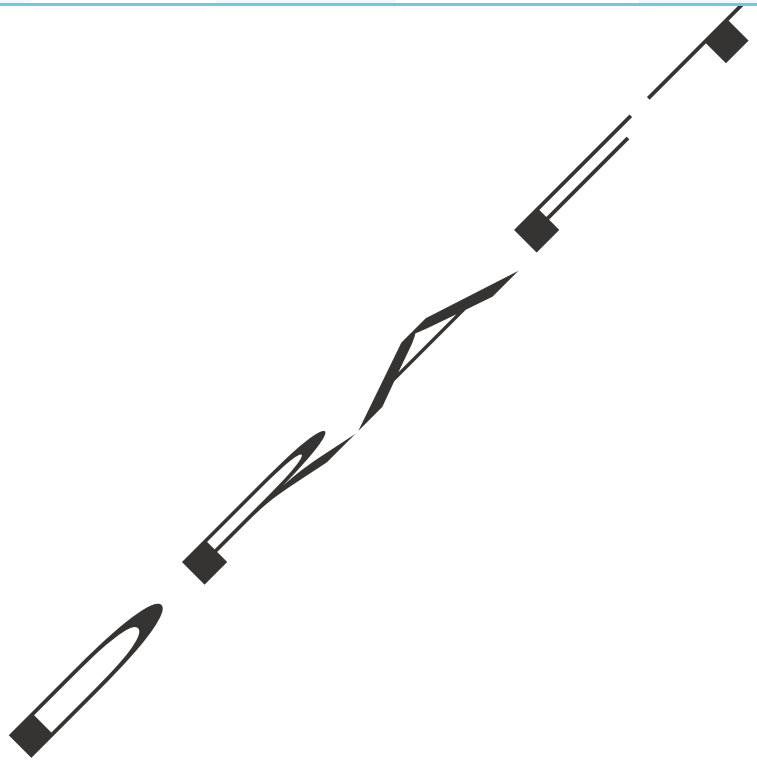
Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Overarching environmental objective	Detailed environmental objective (Source Alluvium 2013)
Cease to flow	Dec-May	0 ML/d	Drought	As infrequently as possible	Less than 21 days in total	1,2,8,9	Limits cease to flow to ensure stress on environmental values is not exacerbated beyond the point of return.
			Dry				
			Average		Less than 7 days in total		
Baseflow	Dec-May	10 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel for riparian vegetation and to prevent excessive in-stream terrestrial species growth.

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Overarching environmental objective	Detailed environmental objective (Source Alluvium 2013)
	Jun-Nov	100 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9	Prevent terrestrialisaton of the lower banks from invasive phragmites and provide increased flow and variability to support fish movement and diversity of habitat.
Freshes	Dec-May	35-40 ML/d	Dry & drought	2 per period	3-7 days	1,4,5,6,7,8,9	Prevent terrestrialisation of the lower banks from invasive phragmites and provide increased flow and variability to support fish movement and diversity of habitat.
	Dec-May	100 ML/d	Average	2 per period	2-7 days	1,4,5,6,7,8,9	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat
			Wet	3 per period			
	Jun-Nov	400 ML/d	Drought	1 per period	1 day	1,4,5,6,7,8,9	Provide variable flow during high flow season for fish movement and to maintain water quality and diversity of habitat. Also flushes surface sediments from hard substrates for macroinvertebrates.
			Dry	3 per period	2 days		
			Average	5 per period	3 days		
			Wet	5 per period	4 days		
	Jun-Nov	1,300 ML/d	Dry	1 per period	1 day	1,4,5,6,7,8,9	Wets benches, entraining organic debris and promoting diversity of habitat.
			Average	2 per period	2 days		
			Wet	3 per period	3 days		
	Jun-Nov	2,600 ML/d	Average	1 per period	2 days	1,4,5,6,7,8,9	Disturbs algae/bacteria/organic biofilm present on rock or wood debris for macroinvertebrates. Wets higher benches entraining organic debris and promoting diversity of habitat.
			Wet	2 per period	3 days		
Bankfull	Any	4,000 ML/d	Average	1 per period or natural	2 days	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.
			Wet	1 per period			
Overbank	Aug-Nov	8,000 ML/d	Wet	1 per period	1 day	3,4,8	Inundate floodplain to maintain condition of adult River Red Gums and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.

Table 30: Environmental flow recommendations for the Wimmera River reach 4

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Overarching environmental objective	Detailed environmental objective (Source Alluvium 2013)
Cease to flow	Dec-May	0 ML/d	Drought	As infrequently as possible	Less than 21 days in total	1,2,8,9	Limits cease to flow to ensure stress on environmental values is not exacerbated beyond the point of return.
			Dry				
			Average		Less than 7 days in total		
Baseflow	Dec-May	15 ML/d or natural	All	Continuous	Continuous	1,2,4,5,7,8,9	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel for riparian vegetation and to prevent excessive in stream terrestrial species growth.
	Jun-Nov	30 ML/d	All	Continuous	Continuous	1,2,4,5,7,8,9	Provides flow variability to maintain diversity of habitats.
Freshes	Dec-May	70 ML/d	Drought	1 per period	2-7 days	1,4,5,6,7,8,9	Prevent water quality decline by flushing pools during low flows. Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.
			Dry	2 per period			
			Average	2 per period			
			Wet	3 per period			
	Jun-Nov	70 ML/d	Drought	1 per period	1 day	1,4,5,6,7,8,9	Increase the baseflow water depth to provide stimulus for fish movement (not required in drought years, frequently required in wet years). Provide flow variability to maintain water quality and diversity of fish habitats.
			Dry	3 per period	2 days		
			Average	5 per period	3 days		
			Wet	5 per period	4 days		
	Jun-Nov	200 ML/d	Dry	1 per period	1 day	1,4,5,6,7,8,9	Wets lower benches, entraining organic debris and promoting diversity of habitat.
			Average	2 per period	2 days		
			Wet	3 per period	3 days		
	Jun-Nov	1,300 ML/d	Average	1 per period	2 days	1,4,5,6,7,8,9	Flush surface sediments from hard substrates to support macroinvertebrates. Wets higher benches, entraining organic debris and promoting diversity of habitat.
			Wet	2 per period	3 days		

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Overarching environmental objective	Detailed environmental objective (Source Alluvium 2013)
Bankfull	Any	2,000 ML/d	Average	1 per period, or natural	2 days	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.
			Wet	1 per period			
Overbank	Aug-Nov	6,000 ML/d	Wet	1 per period or natural	1 day	3,4,8	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain floodplain geomorphic features.



ii) Long-term water regime for the Wimmera River

Table 31: Planned ten-year water regime for reaches 2 to 4 of the Wimmera River (assuming water availability)

Year	1	2	3	4	5	6	7	8	9	10
Objectives 1^	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance	Restore indigenous fish diversity and abundance
2	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish	Recruitment and dispersal of endemic fish and catfish
3	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*	Maintenance of native fish and platypus*
4	Diversity of macroinvertebrates	Diversity of macroinvertebrates	Diversity of macroinvertebrates	Diversity of macroinvertebrates	Diversity of macroinvertebrates	Diversity of macroinvertebrates	Diversity of macroinvertebrates	Diversity of macroinvertebrates	Diversity of macroinvertebrates	Diversity of macroinvertebrates
5	Maintain aquatic vegetation	Maintain aquatic vegetation	Maintain aquatic vegetation	Maintain aquatic vegetation	Maintain aquatic vegetation	Maintain aquatic vegetation	Maintain aquatic vegetation	Maintain aquatic vegetation	Maintain aquatic vegetation	Maintain aquatic vegetation
6				Maintain channel capacity				Maintain channel capacity		
7		Maintain riparian vegetation		Maintain riparian vegetation		Maintain riparian vegetation		Maintain riparian vegetation		Maintain riparian vegetation
8				Maintain floodplain vegetation				Maintain floodplain vegetation		
Summer/ Autumn baseflows	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)

Year	1	2	3	4	5	6	7	8	9	10
Winter/Spring baseflows	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)	✓ (1,3,4,5)
Summer/Autumn freshes	✓ (1,4)	✓ (1,4)	✓ (1,4)	✓ (1,4)	✓ (1,4)	✓ (1,4)	✓ (1,4)	✓ (1,4)	✓ (1,4)	✓ (1,4)
Winter/Spring freshes	✓ (1, 2,4,5)	✓ (1, 2,4,5)	✓ (1, 2,4,5)	✓ (1, 2,4,5)	✓ (1, 2,4,5)	✓ (1, 2,4,5)	✓ (1, 2,4,5)	✓ (1, 2,4,5)	✓ (1, 2,4,5)	✓ (1, 2,4,5)
Winter/Spring High Flows	✓ (4,5)	✓ (4,5)	✓ (4,5)	✓ (4,5)	✓ (4,5)	✓ (4,5)	✓ (4,5)	✓ (4,5)	✓ (4,5)	✓ (4,5)
Autumn/Spring Very High Flows		✓ (4,6,7)		✓ (4,6,7)		✓ (4,6,7)		✓ (4,6,7)		✓ (4,6,7)
Bankfull				✓ (6,7)				✓ (6,7)		
Overbank				✓ (6,7,8)				✓ (6,7,8)		

Note: Numbers in brackets relate to the relevant focus objectives. Rows highlighted in grey are only able to be delivered by natural events (including augmented by 'piggybacking' on natural events. Rows highlighted in green would only be provided by natural (flood) events.^ indicates applicable to Reaches 2 and 3 only * indicates should platypuses re-establish in this reach.

b) Terminal lakes

The priority wetland values of the terminal lakes are the lake-bed and fringing woodland vegetation that relies on periodic inundation, and the significant bird populations that can be supported when the lakes are inundated. Key to these ecological values is that the lakes provide suitable habitat when inundated by the extent of the suitable habitat is very large allowing a significant scale of response following inundation. Smaller scale inflow events that result in short duration, shallow inundation events can also provide significant benefit to ecological values.

The recommended frequency of inundation for wetland vegetation is based on EVC mapping and the associated preferred inundation regimes (Figure 26 and Figure 27). Table 32 summarises the inundation frequencies required to support target EVCs within the terminal lakes system.

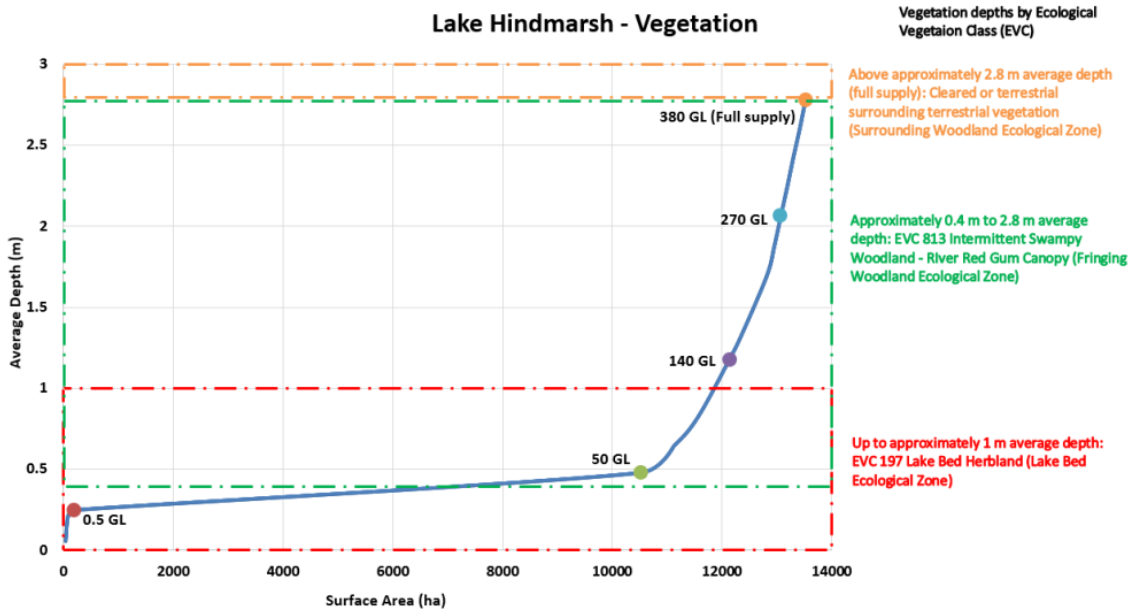


Figure 26: Relationship between surface area (ha), volume (GL) and average depth (m) at Lake Hindmarsh and the range of inundation extents required to inundate the different ecological zones and associated EVCs.

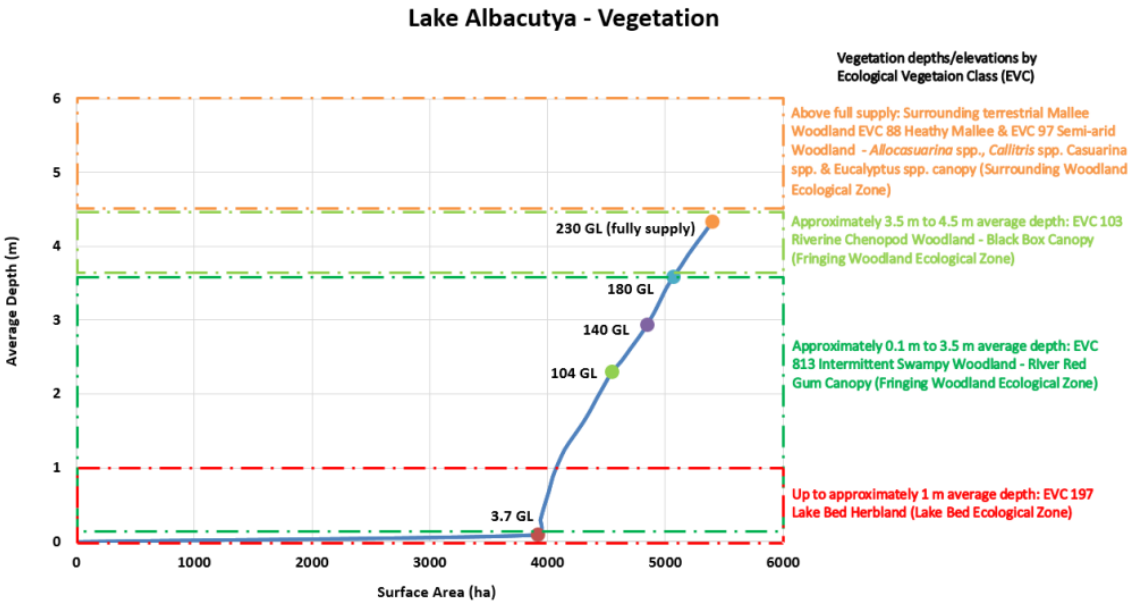


Figure 27: Relationship between surface area (ha), volume (GL) and average depth (m) at Lake Albacutya and the range of inundation extents required to inundate the different ecological zones and associated EVCs (Jacobs, 2019).

Table 32: Summary of the inundation frequencies required to support wetland EVCs at the terminal lakes and the volumes (rounded to the nearest GL) required to engage (reach the bottom of the extent) and to inundate (cover the whole of the extent) each of the EVC

Ecological zone (EVC)	Lake Hindmarsh	Outlet Creek (b/w H & A)	Ross Lakes	Lake Albacutya	Outlet Creek (b/w A & 1st)	First Lake	Outlet Creek (b/w 1st & B)	Lake Brambruk
Lake Bed (EVC 197 Lake Bed Herbland)	Inundate for <3 years in 10, for 1 month to >1 year then dry.	Flow when water is passing to Lake Albacutya. Dry for usually less than 10 consecutive years. Outlet Creek:0.95 GL Cumulative volume: 380 GL	Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 5 -10 years.	Flow when water is passing to Wyperfeld National Park. Dry for usually 15-20 consecutive years. Outlet Creek: 0.65 GL Cumulative volume: 612 GL	Inundate for 1 month to >1 year every approx. 10-20 years.	Flow when water is passing to Wyperfeld National Park. Dry for usually approx. 20 consecutive years. Outlet Creek: 0.65 GL Cumulative volume: 615 GL	Inundate for 1 month to >1 year every approx. 10-20 years.
	Lake specific: 0 – 120 GL		Lake specific:0 – 0.2 GL	Lake specific: 0 – 41 GL		Lake specific: 0 – 0.4 GL		Lake specific: 0 – 3 GL
	Cumulative: 0 – 120 GL		Cumulative: 611 GL	Cumulative: 381 – 422 GL		Cumulative: 612 GL		Cumulative: 615 – 618 GL
Fringing Woodland (EVC 813 River Red Gum)	Inundate for <3 years in 10, for 1 month to >1 year then dry.		Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 10-15 years.		Inundate for 1 month to >1 year every approx. 20 years.		Inundate for 1 month to >1 year every approx. 20 years.
	Lake specific: 28 - 380 GL		Lake specific: 0.01 – 0.7 GL	Lake specific: 20 – 175 GL		Lake specific: 0.2 – 1.5 GL		Lake specific: 1.5 – 11.25 GL
	Cumulative: 28 – 380 GL		Cumulative: 612 GL	Cumulative: 400 – 556 GL		Cumulative: 613 - 614 GL		Cumulative: 617 – 627 GL
Fringing Woodland (EVC 103 Black Box)	NA		Inundate for 1 month to >1 year every 15-20 years.	Inundate for 1 month to >1 year every 10-15 years.		Inundate for 1 month to >1 year every approx. 20 years.		Inundate for 1 month to >1 year every approx. 20 years.
			Lake specific: 0.7 – 0.93 GL	Lake specific: 175 – 230 GL		Lake specific: 1.5 – 2 GL		Lake specific: 11.25 – 15 GL
			Cumulative: 613 GL ML	Cumulative: 556 – 611 GL		Cumulative: 614 – 615 GL		Cumulative: 627 – 630 GL

A similar method was used to estimate volumes of water required in each of the lakes to provide foraging habitat for different bird feeding guilds. The volume, surface area and average depth relationship is annotated in Figure 28 and Figure 29 show the approximate depth range at which various bird guilds are expected to forage and/or breed.

Table 33 summarises the watering requirements to support various bird guilds in feeding and breeding in Lakes Hindmarsh and Albacutya.

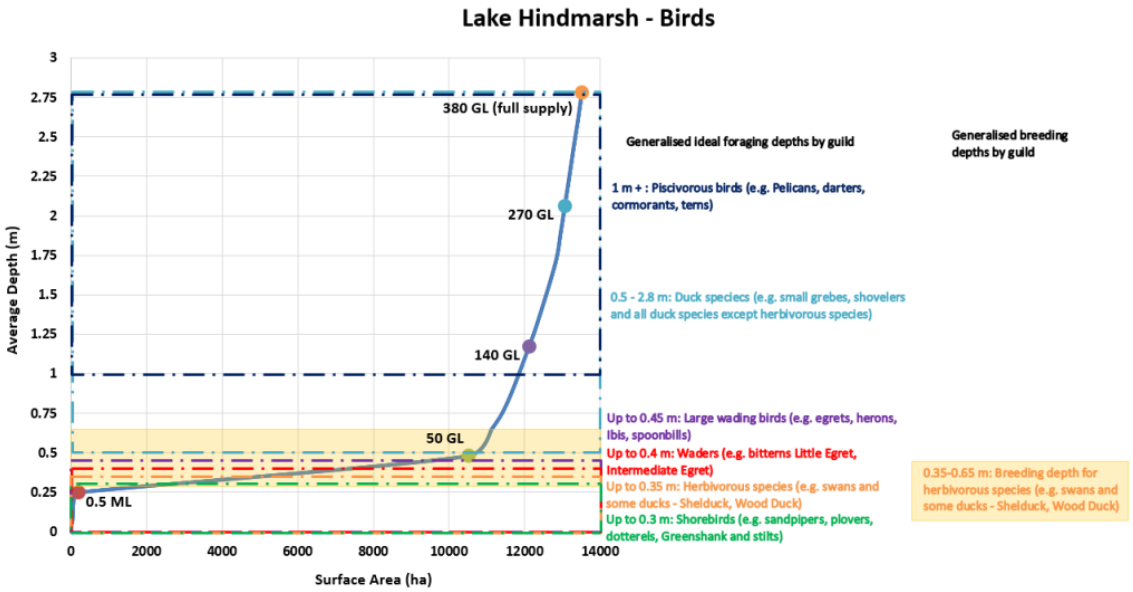


Figure 28: Relationship between surface area (ha), volume (GL) and average depth (m) at Lake Hindmarsh and the range of inundation extents required to provide habitat for different bird guilds.

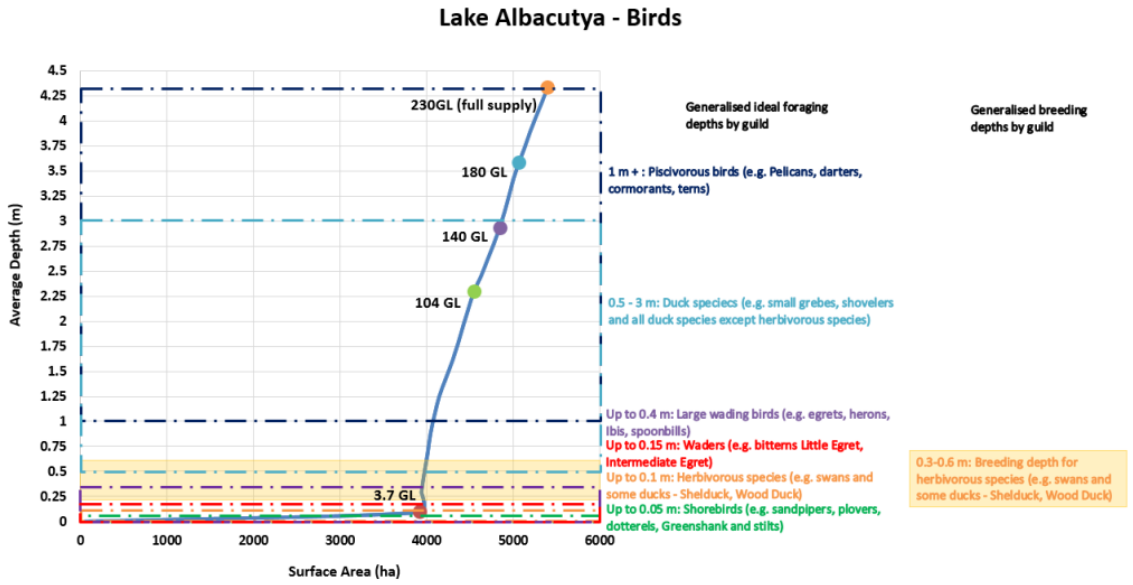


Figure 29: Relationship between surface area (ha), volume (GL) and average depth (m) at Lake Albacutya and the range of inundation extents required to provide habitat for different bird guilds.

Table 33: Range of full supply characteristics of Lake Hindmarsh and Lake Albacutya corresponding with the idealised feeding depth for the different bird guilds and breeding depth for herbivorous species

Bird Guild	Average depth range	Surface area range (approx.)	Volume range (approx.)	Cumulative volume (approx.)
Lake Hindmarsh				
Shorebirds	0 - 0.3 m	0 - 2,000 ha	0 – 60 GL	0 – 60 GL
Herbivorous species	0 - 0.35 m	0 - 4,000 ha	0 -14 GL	0 – 14 GL
Breeding depth of herbivorous species	0.35 - 0.65 m	4,000 - 11,000 ha	14 – 72 GL	14 – 72 GL
Waders	0 - 0.4 m	0 – 5,000 ha	0 – 20 GL	0 – 20 GL
Large wading birds	0 – 0.45 m	0 – 9,000 ha	0 – 41 GL	0 – 41 GL
Duck species	0.5 – 28 m	10,250 – 13,500 ha	51 – 380 GL	51 – 380 GL
Piscivorous birds	1 – 2.8 m	12,000 – 13,500 ha	120 – 380 GL	120 – 380 G:
Lake Albacutya				
Shorebirds	0 – 0.05 m	0 - 4,000 ha	0 – 2 GL	381 – 383 GL
Herbivorous species	0 – 0.1 m	0 - 4,000 ha	0 – 4 GL	381 – 385 GL
Breeding depth of herbivorous species	0.3 -0.06 m	4,000 – 4,000 ha	12 – 24 GL	393 – 405 GL
Waders	0 – 0.15 m	0 – 4,000 ha	0 – 6 GL	381 – 397 GL
Large wading birds	0 – 0.4 m	0 – 4,000 ha	0 – 16 GL	381 – 397 GL
Duck species	0.5 – 3 m	4,000 – 9,000 ha	20 – 147 GL	401 – 528 GL
Piscivorous birds	1 - 4.3 m	4,100 – 5,400 ha	41 – 230 GL	422 – 611 GL

c) Dock Lake

A review of the fauna and flora species and communities that could be supported by Dock Lake was conducted by consulting with local landholders and specialists, databases, reports and academic texts (Jacobs, 2015). Based on this review it was determined that the best outcome for the lake would be gained by using environmental water to mimic a 'natural' watering regime, characterised by periodic inundation followed by slow drawdown and then periods when the lake completely dries. In comparison to holding the lake at a relatively deep level permanently (such as Green Lake) which would benefit relatively few species, a more 'natural' wetting/drying would lead to greater floristic diversity at the lake and increased habitat and foraging resources for range of taxa, especially waterbirds.

This 'natural' water regime, characterised by distinct wetting and drying phases, is similar to that proposed for other northern Victoria wetlands where this water regime has enabled environmental water managers to support a mosaic of plant communities and a diverse range of habitats for birds.

The flows study defined a set of water regime elements which would constitute a 'natural' wetting/drying regime for Dock Lake and these elements provided the broad scale recommendations which should govern the delivery of environmental water to Dock Lake. It was determined that between 271 ML and 973 ML should be delivered for each wetting event. Firm recommendations were not made for dry, average and wet climatic conditions because the wetting/drying regime should retain some variability, however it was recommended that the frequency of wetting be based on the environmental conditions. The environmental water recommendations for Dock Lake are outlined in Table 34.

Table 34: Environmental watering recommendations for Dock Lake under wet, average and dry conditions.

Climate Conditions	Environmental water recommendations
All – Provide under all climate conditions	Fill to between 271 ML (Scenario 16) and 973 ML (Scenario 26) (vary the final volume over wetting events so that across multiple wetting events, the full range of volumes between these scenarios is delivered.) Commence filling between May and September. Inundation period should last at least 3-4 months (but could be as long as 12-14 months). Dry periods (between wetting events) should last for at least 6, but preferably 12 months.
Wet (Annual net evaporation: 805 mm, representative year: 1915)	Wetting events should occur on average five times a decade (once every two years)
Average (Annual net evaporation: 1004 mm, representative year: 1976)	Wetting events should occur on average three times a decade (once every three to four years)
Dry (Annual net evaporation: 1236 mm, representative year: 1965)	Wetting events should occur on average twice a decade (once every five years)
Extended extreme drought conditions	No watering recommended. A long period between inundation events (less than twice per decade) is likely to result in a serious decline in ecological condition.

d) Wimmera-Mallee Pipeline wetlands

Watering of the Wimmera-Mallee Wetlands is prioritised by the VEWH in their seasonal watering plans using information from the CMAs for a range of planning scenarios. Table 35 shows the suggested priorities for the 2020-21 watering season.

Table 35: Potential environmental watering for the Wimmera-Mallee Pipeline wetlands under a range of planning scenarios (VEWH, 2020)

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No catchment inflows to the wetlands are expected	• No catchment inflows to the wetlands are expected	• Some localised catchment inflows may increase water levels in some wetlands	• Catchment inflows are likely to increase water levels in most wetlands
Expected availability of water for the environment	• 700 ML	• 700 ML	• 900 ML	• 1,700 ML

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering[1]	• Barbers Swamp • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Fieldings Dam • Greens Wetland • Harcoans Swamp • John Ampt • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Paul Barclay • Pinedale • Poyner • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Tarkedia Dam • Towma (Lake Marlbed) FFR • Uttiwillock Wetland • Wal Wal Swamp	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Falla Dam • Fieldings Dam • Greens Wetland • Harcoans Swamp • Homelea Wetland • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Lake Danaher • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner • R Ferriers Dam	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chiprick • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans Swamp • Homelea Wetland • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp • Opies Dam • Pam Juergens Dam • Paul Barclay • Part of Gap Reserve • Pinedale • Poyner	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chiprick • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans Swamp • Homelea Wetland • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp • Opies Dam • Pam Juergens Dam • Paul Barclay • Part of Gap Reserve • Pinedale

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering (continued)		• Rickard Glenys Dam • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Dam • Towma (Lake Marlbed) FFR • Uttiwillock Wetland • Wal Wal Swamp	• R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Dam • Tchum Lakes (wetland) • Towma (Lake Marlbed) FFR • Uttiwillock Wetland • Wal Wal Swamp	• Poyner • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Dam • Tchum Lakes (wetland) • Towma (Lake Marlbed) FFR • Uttiwillock Wetland • Wal Wal Swamp
Possible volume of environmental water required to achieve objectives	• 162 ML	• 201 ML	• 392 ML	• 543 ML
Priority carryover requirements	• 122 to 130 ML			

Further information on watering requirements for the Wimmera-Mallee Pipeline (WMP) Wetlands is provided below, divided into three sections by catchment management authority; Mallee, North Central and Wimmera.

i) Mallee CMA Pipeline wetlands:

Includes Barbers Swamp, Broom Tank Reserve, Bull Swamp, Chiprick Reserve, Clinton Shire Dam, Cokum Bushland Reserve, Considine, Coundon Wetland, Cronomby Tanks, D Smith, Goulds Reserve, Greens Wetland, Homelea, J Ferrier Wetland, J Ampt, K Smith, Lake Danaher Bushland Reserve, Mahoods Corner, Morton Plains Reserve, P Juergens, Part of Gap Reserve, P Barclay, Poyner, R Ferrier, Rickard, Roselyn Wetland/Reids Dam, Round Swamp Bushland Reserve (Newer Tank), Shannons Wayside, Tchum Lakes Wetland, Tchum Lakes Dam, Towma (Lake Marlbed), Uttiwillock Wetland.

(1) Mallee CMA Pipeline wetlands hydrological objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at each site. The ecological objectives at each site are centred on maintaining the health of the wetland sites and providing fauna watering points at terrestrial dam sites. The hydrological objectives to achieve each of these ecological objectives are presented in Table 36 for each site. Table 37 provides the areas to be targeted and the maximum volume of environmental water required.

Black box woodlands require flooding to occur every three to seven years with durations of two to six months. This species can tolerate shorter flood durations but plant vigour will suffer. Although timing of flood events is not crucial for black box it will affect the understorey and other woodland biota. Black box trees may survive prolonged periods of 12 to 16 years with no flooding but tree health will suffer and woodland will become dysfunctional (Roberts, 2011). For EVCs with a chenopod understorey, flood duration of no longer than 1 month is preferred (Cook, 2014).

A flooding regime dominated by spring, rather than summer, flooding promotes higher macrophyte diversity and abundance (Robertson, Bacon and Heagney, 2001). Semi-emergent macrophytes occupy shallower water that is generally flooded from one to two metres (Ecological Associates, 2006).

Tangled lignum can tolerate a wide range of wet and dry conditions as well as moderate salinity levels. Flood requirements vary with frequencies of one to three years needed to maintain large shrubs with vigorous canopy, and flooding every three to five years for maintenance of healthy shrubs. Intervals of seven to ten years can be tolerated by small shrubs but growth will decline and these plants do not accommodate nesting by birds. Durations of three to seven months is required to sustain vigorous canopy, but continuous flooding is detrimental. Although timing of flooding is not crucial for lignum, following natural seasonality is encouraged to provide for understorey and wetland plants (Roberts, 2011).

In wetlands which include cane grass, environmental watering should only occur if it has been naturally dry for two consecutive years; inundation should not persist for longer than six months. Cane grasslands respond well to frequent shallow flooding. This can trigger flowering and improve species richness by allowing development of aquatic understorey species. It can tolerate dry conditions, however clumps tend to be sparse. For abundance and good vigour, cane grass requires shallow flooding of less than 0.5 m for durations of up to six months every one to two years (Roberts, 2011).

Eastern long-necked turtle habitat includes swamps, billabongs and slow-flowing waterways with soft, sandy areas and logs or rocks for basking. The turtle can aestivate in soil (lower its metabolic rate and lie ‘dormant’) during dry periods, but is also known to travel large distances in search of permanent waterbodies. Adults breed from December to February and incubate eggs for four months. Rapid drawdown can impact on survival of hatchlings. Egg predation by foxes is a common threat.

Table 36: Hydrological objectives for the Mallee CMA Pipeline wetlands

Environmental objective	Wetlands	Frequency of events (10 years)			Duration of events (months)			Timing	
	*Terrestrial environment water contained within the dam area	Min.	Opt.	Max.	Min.	Opt.	Max.		
Provide watering points for terrestrial fauna and woodland birds	Broom Tank, Chiprick BR, Clinton Shire Dam, Considine*, Coundon Wetland, Cronomby Tanks*, D Smith*, Greens Wetland, Homelea*, J Ferrier Wetland, John Ampt*, Kath Smith*, Mahoods Corner*, Pam Juergens*, Paul Barclay*, Poyner, R Ferrier*, Rickard Glenys*, Roselyn Wetland, Shannons Wayside*, Tchum Lakes Pool (Dam), Towma (Lake Marlbed) FFR, Uttiwillock*		-	10	-	-	12	12	For all four fill dams May to November (due to pipeline delivery constraints) in all climate scenarios, and allow natural drawdown through evaporation. For vegetation provide overbank flow into surrounding floodplain May to November during average to wet years only, and allow natural drawdown.
Provide foraging, refuge and breeding habitat for turtles and frogs	Cokum BR, Considine*, Cronomby Tanks*, Mahoods Corner*, Part of Gap Reserve, Rickard Glenys*, Roselyn Wetland, Towma (Lake Marlbed) FFR, Uttiwillock*		8	10	10	11	12	12	
Maintain the health of fringing Lignum and Black Box communities	Barbers Swamp, Broom Tank, Bull Swamp, Clinton Shire Dam, Cokum BR, Goulds Reserve, Greens Wetland, J Ferrier Wetland, Lake Danaher BR, Morton Plains Reserve, Part of Gap Reserve, Poyner, Roselyn Wetland, Round Swamp BR, Tchum Lakes Reserve (Wetland), Tchum Lakes Pool (Dam), Towma (Lake Marlbed) FFR, Uttiwillock*		1	2	3	2	4	4	
Provide suitable feeding and breeding habitat for various waterbird guilds	Barbers Swamp, Bull Swamp, Cokum BR, Goulds Reserve, Mahoods Corner*, Morton Plains Reserve, R Ferrier*, Rickard Glenys*, Roselyn Wetland, Shannons Wayside*, Tchum Lakes Reserve (Wetland), Tchum Lakes Pool (Dam), Uttiwillock*		2	5	10	1	6	7	

Table 37: Inundation extents and volumes of environmental water required for the Mallee CMA Pipeline wetlands

Site Name *Terrestrial environment water contained within the dam area	Maximum inundation extent (ha)	Maximum volume of environmental water required (ML)
Barbers Swamp	2.1	15
Broom Tank	2.1	10
Bull Swamp	15.2	10
Chiprick BR	2.0	9
Clinton Shire Dam	5.5	10
Cokum BR	3.7	8
Considine*	0.4	5
Coundon Wetland	2.0	4
Cronomby Tanks*	1.0	8
D Smith*	0.1	1
Goulds Reserve	15.8	40
Greens Wetland	4.7	10
Homelea*	0.1	1
J Ferrier Wetland	1.9	10
John Ampt*	0.2	4
Kath Smith*	0.1	1
Lake Danaher*	2.8	2
Mahoods Corner*	0.2	3
Morton Plains Reserve	0.5	5
Pam Juergens*	0.1	0.5
Part of Gap Reserve	5.2	10
Paul Barclay*	0.2	5
Poyner*	0.2	4
R Ferrier*	0.4	8
Rickard Glenys*	0.3	3
Roselyn Wetland	2.6	20
Round Swamp BR	2.9	10
Shannons Wayside*	0.2	3
Tchum Lakes Reserve (Wetland)	37.2	100
Tchum Lakes Pool (Dam)	12.6	11
Towma (Lake Marlbed)*	0.2	2
Uttiwillock*	2.0	15

(2) Mallee CMA Pipeline wetlands seasonally adaptive approach

The broad ranging values and ecological significance of the Wimmera-Mallee Pipeline sites requires environmental water delivery annually for many of the sites, with the depth and the associated volume varying depending on climatic conditions and the period since the last inundation. Sites have been prioritised based on a range of considerations, as outlined below in Appendix Fd)i)(3). Scenario planning for the various climatic conditions is summarised in Table 38.

In a drought scenario, the water allocation is likely to be restricted, impacting on the number of sites able to be watered, and the depth to which each site can be watered. The watering action seeks to provide watering points for local fauna and as such the inundation extents would be retained within the dam/wetland perimeter. The water allocation against the environmental entitlement is likely to be zero in a drought and in a dry scenario and carryover the only source available. 22 sites have been given 'very high' priority status for watering in a drought scenario, with a volume of 56.5ML required. The 'very high' priority sites should receive the recommended volumes first through allocation of carryover. This recognises the importance of these sites in providing refuge to aquatic and terrestrial fauna during drier years.

In a dry scenario the number of priority watering actions increases to 28 and the volume of water required to 87.5ML. The watering actions centre on provision of watering points for local fauna as well as aquatic vegetation objectives, the inundation extent would be retained to the dam area. Site priorities have been identified using a tiered approach.

In an average scenario, allocations against the entitlement are expected and watering actions expanded to include growth, reproduction and small-scale recruitment of flora. The inundation extent would extend beyond the dam into the surrounding vegetation for some of the sites. All 31 Wimmera-Mallee Pipeline sites are priority watering actions in an average scenario requiring 186.5ML.

For wet years, when additional water is likely to be available, some sites are recommended to be overtopped to inundate surrounding vegetation such as black box, lignum and cane grass and to improve the health of aquatic ecosystems. In a wet scenario 330.5ML of environmental water is required, although the watering regime may be met by natural inflows at some sites.

Depending on the ecological objective being targeted, water may be delivered to fill the dam/wetland to the perimeter, or further water may be delivered to overtop the dam and inundate the surrounding floodplain.

Ongoing field monitoring and adaptive management may see changes to the ecological and hydrological objectives, and the volumes assigned to the Wimmera-Mallee Pipeline sites.

Table 38: Climate Scenario Planning for Mallee CMA Pipeline wetlands

	Drought Dry		Average	Wet
Inflow Scenario	0%	10%	50%	75%
Expected climatic conditions and water availability (ML)	0	0	250	1000
Ecological Objectives	Provide watering points for terrestrial fauna and woodland birds	Provide watering points for terrestrial fauna and woodland birds Provide foraging, refuge and breeding habitat for turtles and frogs Maintain the health of fringing lignum and black box communities	Provide watering points for terrestrial fauna and woodland birds Provide foraging, refuge and breeding habitat for turtles and frogs Maintain the health of fringing lignum and black box communities Provide suitable feeding and breeding habitat for waterbird guilds	All
Estimated environmental water requirement (total ML)	56.5	87.5	186.5	330.5
High priority carryover requirements	56.5	56.5	56.5	56.5

(3) Mallee CMA Pipeline wetlands watering regime

The hydrological regime for each of 31 Mallee CMA Pipeline sites under drought, dry, average and wet scenarios is seen below in Table 39, Table 40, Table 41 and Table 42. The watering regime has been derived from the ecological and hydrological objectives. All water deliveries are planned to occur between May and November, due to constraints around Wimmera-Mallee Pipeline system demand peaks, minimising impacts on other users and achieving more efficient delivery rates to each site. Therefore, the watering regime for each site involves filling the sites between May and November and allowing natural drawdown through evaporation.

The priority setting for each wetland is based on the capacity to deliver to both the wetland and the adjacent floodplain area, the topography of the wetland and its ability to retain water over the summer months (high water holding capacity), environmental values at the site, the proximity to other wetlands, and the amount of water required to fill the floodplain area of the wetland. Sites have been prioritised based on ecological values recorded and their proximity to other water bodies. Importantly, refuge sites are considered the highest priority during drought and dry conditions.

Table 39: Very high priority Mallee CMA Pipeline wetlands

Site Name	Capacity*	Target Delivery Volumes (ML) Seasonally Adaptive Approach			
		Drought	Dry	Average	Wet
Barbers Swamp	Can be overtopped	4	6	10	15
Bull Swamp	Can be overtopped	4	4	8	10
Clinton Shire Dam*	Can be overtopped	3	3	4	10
Cokum BR	Can be overtopped	3	4	8	8
Considine*	Do not overtop	4	4	4	5
Cronomby Tanks*	Do not overtop	6	8	8	8
D Smith*	Do not overtop	1	1	1	1
Greens Wetland	Can be overtopped	2	2	4	10
J Ferrier Wetland	Can be overtopped	2	3	7	10
John Ampt*	Do not overtop	2	4	4	4
Mahoods Corner*	Do not overtop	2	3	3	3
Morton Plains Reserve	Can be overtopped	1	2	5	5
Paul Barclay*	Do not overtop	3	4	5	5
Poyner	Do not overtop	3	3	4	4
R Ferrier*	Do not overtop	6	8	8	8
Rickard Glenys*	Do not overtop	3	3	3	3
Roselyn Wetland	Can be overtopped	3	5	10	20
Towma (Lake Marlbed) FFR	Do not overtop	2	2	2	2

Wetland Inundation: No Delivery Planned; Inundation contained within wetland/dam site; inundation of surrounding floodplain/wetland.

***Terrestrial fauna refuge site**

Table 40: High priority Mallee CMA Pipeline wetlands

Site Name	Capacity*	Target Delivery Volumes (ML) Seasonally Adaptive Approach			
		Drought	Dry	Average	Wet
Broom Tank	8ML, overtopped	0	1	10	10
Chiprick*	Can be overtopped	0	5	9	9
Coundon Wetland*	6 ML leaves space for runoff	0	1	2	4
Homelea*	Do not overtop	0	1	1	1
Kath Smith*	Do not overtop	0	1	1	1
Pam Juergens*	Do not overtop	0	0.5	0.5	0.5
Tchum Lakes Swimming Pool (North Lake - Dam)	11 ML (full) can be overtopped, or wetland watered from South connection	0	3	4	11

Wetland Inundation: No Delivery Planned; Inundation contained within wetland/dam site; inundation of surrounding floodplain/wetland

*Terrestrial fauna refuge site

Table 41: Medium priority Mallee CMA Pipeline wetlands

Site Name	Capacity*	Target Delivery Volumes (ML) Seasonally Adaptive Approach			
		Drought	Dry	Average	Wet
Goulds Reserve	Can be overtopped	0	0	20	40
Newer Tank (Round Swamp BR)	Can be overtopped	0	0	10	10
Tchum Lakes Lake Reserve (North Lake - Wetland)	Outlet releases to wetland, can inundate entire wetland extent (refer Appendix 1)	0	0	20	100

Wetland Inundation: No Delivery Planned; Inundation contained within wetland/dam site; inundation of surrounding floodplain/wetland.

Table 42: Low priority Mallee CMA Pipeline wetlands

Site Name	Capacity*	Target Delivery Volumes (ML) Seasonally Adaptive Approach			
		Drought	Dry	Average	Wet
Lake Danaher BR	Do not overtop. No EW in ave-wet yrs due to poss GW salinity issues	0	2	0	0
Part of Gap Reserve	Can be overtopped	0	2	8	10
Shannons Wayside	Do not overtop	0	2	3	3

Wetland Inundation: No Delivery Planned; Inundation contained within wetland/dam site; inundation of surrounding floodplain/wetland.

ii) North Central CMA Pipeline wetlands

The North Central CMA wetlands are Chirrup Swamp, Corack Lake, Creswick Swamp, Davis Dam, Falla Dam, Jeffcott Wetland and Jesse Dam. Hydrological objectives for these wetlands are shown in the table below.

Table 43: North Central CMA Pipeline wetlands hydrological objectives

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
1.	Complex															
1.1 All	1.1.1 Re-establish a spread of open water in the landscape	All sites	See ecological objectives 2, 3, 4, 5, 6, 7 and													
	1.1.2 Provide watering point for terrestrial species	All sites	Variable- frequency, duration, timing and depth is dependent on the status of nearby waterbodies in the landscape (i.e. lack of open water during very dry years may increase need for permanency). Management to be adaptive and consider other waterbodies in the landscape.													
2.	Chirrup Swamp															
2.1 Wetland	2.1.1 Maintain extent and health of Cane Grass	Bed	1	2-3	5-7	1	6	9	1	2	7	Aug- Oct	0.2	Species is considered drought tolerant and has a persistent rootstock. Flooding to replenish seed stock is needed every seven years, based on seed longevity.	Up to 105	45
	2.1.2 Maintain extent and health of fringing vegetation	Bed/ riparian zone	1	3	7	1	3	6	1	2	7	Aug- Oct	0.4	Flooding for regeneration should follow Black Box seed drop (as seed bank does not form) and/or 9-12 months post establishment of lignum seedling to increase success.	Up to 105.4	167
	2.1.3 Maintain waterbird feeding and breeding opportunities	Bed/ riparian zone	See ecological objectives 2.1.1, 2.1.2 and 2.1.5. Wetting and drying promotes a diversity of habitat types and food sources (i.e. mudflats, fringing zones etc.)											Waterbird feeding opportunities are based on ensuring a range of habitat and food sources are available through appropriate wetting and drying (as per 2.1.1, 2.2.1 and 2.1.5) - See Appendix 8 for general feeding requirements.		See 2.1.1, 2.1.2 and 2.1.5
		Bed/ riparian zone	Variable			4	6-7	10	Productivity increases with wetting and drying and flooding stimulates breeding			Aug-Oct	Variable	Waterbird breeding opportunities based on ensuring a range of habitat types (as per 2.1.1 and 2.2.1) as well as appropriate flooding cues to stimulate breeding- See Appendix 8 for general breeding requirements. *NB. Hydrological objectives are generalised to suit a range of species present.*		See 2.1.1 and 2.2.1

	2.1.4 Maintain opportunistic frog and turtle feeding and breeding opportunities[1]	Bed/ Riparian	Variable however prefer permanent to semipermanent conditions	2	3-6	12	Variable- some species able to burrow during dry periods others limited	Variable depending on species	Variable	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 2.1.1 and 2.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general requirements.	See 2.1.1 and 2.2.1

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
		Bed/ riparian	Prefer ephemeral or semi-permanent waterbodies but will retreat to permanent conditions when there is a lack of water in the landscape									Spring/ summer	Variable	Turtle feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 2.1.1 and 2.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general requirements. Please note that control of foxes is also required to achieve objective.	See 2.1.1 and 2.2.1	
2.2 Dam	2.2.1 Improve a**quatic and littoral vegetation** cover and diversity	Dam	Variability and fluctuations in water level important for promoting a diversity of species. Australian wetland species generally have long-lived seed banks (at least 15 years for many species)									Aug- Oct	Variable- up to 2.6 metres	Objective aimed at promoting aquatic and littoral plant growth in the absence of significant constraints. In reality, the achievement of this ecological objective would require modifications to the morphology of the dam and revegetation (to introduce diversity).	≤105	≤1.2
	2.2.2 Increase/ improve **frog and turtle breeding and feeding** opportunities	Dam	Variable- dependent on 2.2.5 (opportunities for recolonisation) i.e. only maintain dam as a permanent system when Cherrip Swamp is dry. During flood events, the dam may drawdown.									Spring/ summer	1-2.6	Turtle feeding and breeding based on promoting aquatic habitat, food sources (as per 2.2.1 and 2.2.4) and appropriate cues to stimulate breeding. Please note that control of foxes is also required to achieve objective. At least 1 metre depth recommended for maintenance of turtle population unless alternative sites are present (see 2.2.5)	103.4-105	0.2-1.2
		Dam and fringe	Variable- dependent on 2.2.5 (opportunities for recolonisation)			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable depending on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 2.2.1 and 2.2.4) and appropriate cues to stimulate breeding- see Appendix 8 for general requirements.	Up to 105	Up to 1.2
	2.2.3 Improve **macroinvertebrate** assemblage	Dam	See ecological objective 2.2.1. Improving and increasing aquatic vegetation will promote return of grazer/ scraper and shredder macroinvertebrates, improving the macroinvertebrate assemblage.											Macroinvertebrate diversity relies on promoting a range of habitat and feeding opportunities for macroinvertebrates (as per 2.2.1) - see Appendix 8 for general requirements.	Up to 105	Up to 1.2
	2.2.4 Maintain a point source for **recolonisation** of nearby waterbodies	Dam	Maintain permanent conditions (with fluctuations) until flooding of Chirrup Swamp or other nearby (i.e. less than <2-3 km away) occurs to facilitate recolonisation											Management to be adaptive and consider other waterbodies in the landscape.	Up to 105	Up to 1.2
	2.2.5 Maintain a **watering point** for terrestrial fauna	Dam														

Component	Ecological objective	Water mgt area	Hydrological objectives													
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
2 Corack Lake																
3.1 Wetland	3.1.1 Maintain/ increase diversity of native **amphibious species and aquatic species** associated with the wetland bed	Bed	3	5	7	6	12	24	0.5	2	5	Aug- Sept	0.8	Variability will dictate which species are present at any one time	Up to 113.4	12 ML
	3.1.2 Maintain health, recruitment and diversity of **River Red Gum and Black Box** age classes	River Red Gum- Bed/ fringe	3	5	7	3-6	9-12	18	0.5	2	5	Aug- Sept	<1.2	Flood recession in spring (or later) to provide warm and moist conditions for germination and seed establishment (no seed bank maintained)	Up to 113.8	24 ML
		Black Box- Riparian	3	5	7	1	3	6	0.5	3	12	Aug- Sept	1.2	Flooding for regeneration should follow seed drop as seed bank does not form	Up to 115	77 ML
	3.1.3 Maintain **waterbird breeding and feeding** opportunities	Bed/ riparian zone	Variable			See ecological objectives 3.1.1, 3.1.2 and 3.1.4. Wetting and drying promotes habitat variability (i.e. mudflats, open water, fringing zones etc.)						Variable	Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 3.1.1, 3.1.2 and 3.1.4) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general requirements.	See 3.1.1, 3.1.2 and 3.1.4	
		Bed/ riparian zone	Variable			>4	6-8	12	Productivity increases with wetting and drying- Flooding stimulates breeding			Aug- Oct	Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 3.1.1, 3.2.1 and 3.1.5) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements	See 3.1.1, 3.1.2 and 3.1.5	
	3.1.4 Maintain opportunistic **frog and turtle feeding and breeding** opportunities[1]	Bed	Variable however prefer permanent to semipermanent conditions			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable depending on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 3.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 3.1.2	
		Bed/ riparian zone	Prefer ephemeral or semi-permanent waterbodies but will retreat to permanent conditions when there is a lack of water in the landscape ** Control of foxes required to achieve turtle objective*									Spring/ summer	Variable	Turtle feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 3.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 3.1.2	
3.2 Dam	3.2.1 Maintain/ increase cover and structural diversity of **aquatic vegetation**	Dam and fringe	Variability and fluctuations in water level important for promoting a diversity of species									Aug- Sept	Variable- up to 0.6	Opportunity to overtop dam to partially achieve 3.1.2	≤112.8	≤0.3

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
	3.2.2 Maintain nursery habitat for juvenile **turtles and frogs**	Dam	Variable- dependent on 3.2.5 (opportunities for recolonisation) * *Control of foxes required to achieve turtle objective*									Spring/ summer	Up to 0.6	Juvenile turtle habitat facilitated through appropriate aquatic habitat and food sources (as per 3.2.1 and 3.2.3).	See 3.2.1 and 3.2.3	
		Dam and fringe	Variable- dependent on 3.2.5 (opportunities for recolonisation)			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable dependin g on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 3.2.1 and 3.2.4) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 3.2.1 and 3.2.3	
	3.2.3 Maintain permanent refuge conditions **for turtles and frogs** in Dam No. 2	Dam and fringe	See above													
	3.2.4 Increase **waterbird feeding** opportunities (particularly shoreline foragers)	Dam and fringe	Variable			See ecological objectives 3.2.1 and 3.2.3 Wetting and drying promotes habitat variability (i.e. mudflats, fringing zones etc.)						Variable		Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 3.1.1, 3.2.1 and 3.1.5) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements.	See 3.2.1 and 3.2.3	
3 Creswick Swamp																
4.1 Wetland (reserve component only)	4.1.1 Maintain diversity of **aquatic vegetation**	Bed	3	6	7	3	6	9	0.5	2	3	July- Sept	<0.4	Objective may be currently unachievable due to road and risk of flooding private land (see Section 16 for recommendations)	<139	14
	4.1.2 Increase/re-establish extent of **Marbled Marshwort** in bed of wetland	Bed	3	6	7	3	6	9	0.5	2	3	July- Sept	<0.4	Ideal flood frequency, duration, timing and depth are unknown. Requirements are therefore based on Plains Grassy WetlandLignum Swamp Complex EVC. Objective may be currently unachievable due to road and risk of flooding private land (see Section 16 for recommendations)	<139	14
	4.1.3 Increase health and recruitment of **shrubs**	Bed	3	5	7	3	5	7	1	2	7	May-Aug for germination	<0.4	Follow up flooding required within 9-12 months after seed establishment. Objective may be currently unachievable due to road and risk of flooding private land (see Section 16 for recommendations)	<139	14
	4.1.4 Re-establish **waterbird feeding and breeding** opportunities, in particularly Brolga	Bed	Variable- although Brolgas prefer ephemeral and semipermanent wetlands for			4	6	9	Productivity increases with wetting and drying- Flooding stimulates breeding			July- Nov	prefer 0.3-0.4	Waterbird breeding opportunities based on ensuring a range of suitable habitat types (as per 4.1.1, 4.1.2 and 4.1.3) as well as appropriate cutes to stimulate breeding-	139	14

Component	Ecological objective	Water mgt area	Hydrological objectives													
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
			breeding)											See Appendix 8 for general breeding requirements. *N.B. hydrological objectives are based on requirements of Brolga.* Objective may be currently unachievable due to road and risk of flooding private land (see Section 16 for recommendations)		
		Bed	Variable			See ecological objectives 4.1.1, 4.1.2 and 4.1.3. Wetting and drying promotes habitat variability (i.e. mudflats, shallow meadows etc.)							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 4.1.1, 4.1.2 and 4.1.3) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements.	See 4.1.1, 4.1.2 and 4.1.3	
4.2 Dam	4.2.1 Maintain high diversity of **aquatic plants**	Dam	Variability and fluctuations in water level important for promoting a diversity of species									Aug-Oct	Variable up to 1.6	Variability in water level to encourage a diversity of species	138.6	0.8
	4.2.2 Increase **diversity of littoral vegetation** (i.e. emergent vegetation)	Fringe	Variability and fluctuations in water level important for promoting a diversity of species **Modifications to the morphology of the dam combined with revegetation would be required to achieve objective*									Aug-Oct	Variable 1.6-1.8	Opportunity to overtop dam to partially 4.1.1/4.1.2	138.6-138.8	0.8-1
	4.2.3 Re-establish **Marbled Marshwort** in dam	Dam	3	6	8	3	6	9	0.5	2	3	July- Sept	Variable/ likely to establish in shallow fringe	Ideal flood frequency, duration, timing and depth are unknown. Requirements are therefore based on Plains Grassy WetlandLignum Swamp Complex EVC	138.6	0.8
	4.2.4 **Maintain turtle and frog breeding and feeding** opportunities	Dam and fringe	Variable- dependent on 4.2.5 (opportunities for recolonisation)			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable dependin g on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 4.2.1 and 4.2.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	Up to 138.6	0.8
		Dam and fringe	Prefer ephemeral or semi-permanent waterbodies but will retreat to permanent conditions when there is a lack of water in the landscape. * *Control of foxes required to achieve turtle objective*									Spring/ summer	1-1.6	Turtle feeding and breeding based on promoting aquatic habitat, food sources (as per 4.2.1 and 4.2.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements. At least 1 metre depth recommended for maintenance of turtle population unless alternative sites are present (see 4.2.5)	138-138.6	0.2-0.8
4 Davis Dam																
5.1 Wetland	5.1.1 Maintain **Cane Grass**	Bed	1	2-3	5-7	1	6	9	1	2	7	Aug- Oct	0.4	Intermittent watering required	107	3

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
	vegetation															
	5.1.2 Maintain and promote recruitment of **Black Box** vegetation	Riparian	1	3	7	1	3	6	0.5	3	12	Aug- Sept	0.3	Flooding for regeneration should follow seed drop as seed bank does not form	107.2	11
	5.1.3 Maintain **frog breeding and feeding** opportunities[1]	Bed/ riparian	Variable however prefer permanent to semipermanent conditions			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable depending on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 5.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 5.1.1 and 5.2.1	
5.2 Dam	5.2.1 Increase **aquatic and littoral vegetation**[3]	Dam and fringe	Variability and fluctuations in water level important for promoting a diversity of species **Modifications to the morphology of the dam combined with revegetation may be required to achieve objective*									Aug-Sept	1	Opportunity to overtop dam to partially achieve 4.1.1 and/or 4.1.2	107.4	0.2
	5.2.2 Maintaining **waterbird feeding** opportunities	Dam and fringe	Variable			See ecological objectives 5.2.1. Wetting and drying promotes habitat variability							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 5.2.1) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general requirements	See 5.2.1	
	5.2.3 Provide a **watering point** for terrestrial species	Dam	Variable- frequency, duration, timing and depth is dependent on the status of nearby waterbodies in the landscape (i.e. lack of open water during very dry years may increase need for permanency)											Management to be adaptive and consider other waterbodies in the landscape	Up to 107.4	0.2
5 Falla Dam																
6.1 Dam	6.1.1 Increase **aquatic vegetation** diversity and abundance[3]	Dam and fringe	Variability and fluctuations in water level important for promoting a diversity of species **Modifications to the morphology of the dam combined with revegetation would be required to achieve objective*									Aug- Oct	Variable- up to 4	Lack of aquatic species currently present	117	5
	6.1.2 Increase **frog and turtle feeding and breeding**[1]	Dam and fringe	Variable however prefer permanent to semi-3-6 permanent conditions			2		12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable depending on species	Frog feeding and breeding based on promoting habitat and feeding opportunities (as per 5.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 6.1.1	
		Dam and fringe	Variable- dependent on 6.1.4 (opportunities for recolonisation) * *Control of foxes required to achieve turtle objective*									Spring/ summer	Variable	Turtle feeding and breeding based on promoting aquatic habitat, food sources (as per 6.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements. At least 1 metre depth recommended for maintenance of turtle population unless alternative sites are present (see 6.1.4)	116.2-117	2-5
	6.1.3 Provide a **watering**	Dam	Variable- frequency, duration, timing and depth is dependent on the status of nearby waterbodies in											Management to be adaptive and consider	Up to 117	Up to 5

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
	point for terrestrial species		the landscape (i.e. lack of open water during very dry years may increase need for permanency)											other waterbodies in the landscape		
6 Jeffcott Wetland																
7.1 Wetland (reserve component only)	7.1.1 Increase health of **understorey vegetation**	Bed	3	5	7	1	3	6	0.6	2	4	Aug-Oct	0.8	Objective currently unachievable due to flooding of private land (see Section 16 for recommendations)	<126.6	34
	7.1.2 Maintain/ increase health of **Black Box**	Bed/ riparian	3	5	7	1	3	6	0.5	2	5	Aug- Sept	1	Objective currently unachievable due to flooding of private land (see Section 16 for recommendations)	126.6-127.6	34-260
	7.1.3 Maintain **waterbird feeding and breeding** opportunities	Bed/ riparian	Variable			5	7-8	12	Productivity increases with wetting and drying- Flooding stimulates breeding Wetting and drying promotes habitat variability (i.e. mudflats, shallow meadows etc.)			Aug-Oct	Variable	Waterbird feeding and breeding opportunities based on ensuring a range of habitat and food sources (as per 7.1.1, 7.1..2 and 7.1.4) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements	See 7.1.1, 7.1.2 and 7.1.4	
	7.1.4 Maintain **frog and turtle breeding and feeding** opportunities[1]	Bed/ fringe	Variable however prefer permanent to semipermanent conditions			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable depending on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 7.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 7.1.1	
		Bed/ fringe	Prefer ephemeral or semi-permanent waterbodies but will retreat to permanent conditions when there is a lack of water in the landscape ** Control of foxes required to achieve turtle objective*									Spring/ summer	Variable	Turtle feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 7.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 7.1.1	
7.2 Dam	7.2.1 Maintain high diversity of **aquatic plants**	Dam and fringe	Variability and fluctuations in water level important for promoting a diversity of species **Modifications to the morphology of the dam combined with revegetation would be required to achieve objective*									Aug- Oct	Variable-up to 3	Good aquatic vegetation present	127.8	4-6
	7.2.2 Maintain **turtle and frog feeding and breeding** opportunities	Dam and fringe	Variable- dependent on 7.2.6 (opportunities for recolonisation) * *Control of foxes required to achieve turtle objective*									Spring/ summer	Variable	Turtle feeding and breeding based on promoting aquatic habitat, food sources (as per 7.2.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements. At least 1 metre depth recommended for maintenance of turtle population unless alternative sites are present (see 7.2.6)	124.8-127.8	4-6
		Dam and	Variable however prefer			2	3-6	12	Variable- some species able			Spring/	Variable	Frog feeding and breeding based on	See 7.2.1	

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
		fringe	permanent to semipermanent conditions						to burrow during dry periods others limited			summer	dependin g on species	promoting habitat and feeding opportunities (as per 7.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.		
	7.2.3 Maintain **waterbird feedin**g opportunities	Dam and fringe	Variable			See ecological objectives 7.2.1 and 7.2.3 Wetting and drying promotes habitat variability particularly at fringe							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 7.2.1 and 7.2.3) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general requirements	See 7.2.1 and 7.2.3	
	7.2.4 Provide a **watering point** for terrestrial fauna	Dam	Variable- frequency, duration, timing and depth is dependent on the status of nearby waterbodies in the landscape (i.e. lack of open water during very dry years may increase need for permanency)											Management to be adaptive and consider other waterbodies in the landscape	Up to 127.8	4-6
7 Jesse																
8.1 Wetland	8.1.1 Improve diversity of **grassy-herbaceous flora species**	Bed	3	5	7	3	6	9	0.5	3	5	Aug-Oct	0.8	Variability will dictate which species are present at any one time. Improved native diversity will further assist with reducing weed cover.	159.2	118
	8.1.2 Improve diversity and health of **sedge, shrub and emergent vegetation**	Bed and fringe	3	5	7	2	3-4	6	0.5	3	5	Aug-Oct	0.2		159-159.2	85-118
	8.1.3 Reinstate extent of **Marbled Marshwort** in the 'Lily Pond' and throughout the wetland bed	Bed	3	6	8	3	6	9	0.5	2	3	July- Sept	0.8	Ideal flood frequency, duration, timing and depth are unknown Requirements are therefore based on Plains Grassy WetlandLignum Swamp Complex EVC	159.2	118
	8.1.4 Re-establish **waterbird feeding and breeding** opportunities, in particularly Brolga	Bed and fringe	Variable- although Brolgas prefer ephemeral and semipermanent wetlands for breeding)			4	6	9	Productivity increases with wetting and drying- Flooding stimulates breeding			July- Nov	prefer 0.3-0.4	Waterbird breeding opportunities based on ensuring a range of suitable habitat types (as per 8.1.1 and 8.1.3) as well as appropriate cutes to stimulate breeding- See Appendix 8 for general breeding requirements. *N.B. hydrological objectives are based on requirements of Brolga*	<159.2	<118
		Bed and fringe	Variable			See ecological objectives 8.1.1, 8.1.3, 8.1.4 Wetting and drying promotes habitat variability (i.e. mudflats, open water, grasslands etc.)							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 8.1.1, 8.1.3, 8.1.4) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements.	See 8.1.1, 8.1.3, 8.1.4	
8.2 Dam	8.2.1 Increase cover and	Dam and	Variability and fluctuations in water level important for promoting a diversity									Aug-Oct	Variable	Opportunity to overtop dam to partially	158	0.2

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
	structural diversity of **aquatic vegetation** (particularly in the wetland area immediately surrounding the dam)[2]	fringe	of species.										up to 0.4	achieve 8.1.1. However, ensure that the site dries by summer to prevent dominance of water couch (only site with this species recorded).		
	8.2.2 Re-establish **Marbled Marshwort** in dam	Dam	3	6	8	3	6	9	0.5	2	3	July- Sept	Variable/ likely to establish in shallow fringe	Ideal flood frequency, duration, timing and depth are unknown Requirements are therefore based on Plains Grassy WetlandLignum Swamp Complex EVC	158	0.2
	8.2.3 Maintain/ increase **frog feeding and breeding** opportunities[1]	Dam and fringe	Variable- dependent on 8.2.4 (opportunities for recolonisation)			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable dependin g on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 8.2.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	Up to 158	Up to 0.2
	8.2.4 Increase **waterbird feeding opportunities** (particularly shoreline foragers)	Dam and fringe	Variable			See ecological objectives 8.2.1. Wetting and drying promotes habitat variability							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 8.2.1) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general requirements	See 8.2.1	

1 For the purpose of this EWMP timing is depicted as the range of months considered the most optimum for the ecological objective. However, natural variability should be maintained by providing fills/ top-ups outside of this period from time to time.

Sources: D. Cook (pers. comm., 21 August 2014), Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2012), DSE (2012), Roberts & Marston (2011), Rogers & Ralph (2011).

iii) Wimmera CMA Pipeline wetlands

The Wimmera CMA Pipeline wetlands are Carapugna Wetland, Challambra Swamp, Crow Swamp, Fieldings Dam, Harcoan's Swamp. Krong Swamp, Mutton Swamp, Opie's Dam, Pinedale, Sawpit Swamp, Schultz/Koschitzke, Tarkedia, Wal Wal Swamp. Hydrological objectives for these wetlands are shown in the tables below.

(1) Carapugna Wetland

Hydrological Objectives at Carapugna Wetland (Source: Australian Ecosystems (2013))[8]

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
826	Plains Savannah	NA	NA	NA	NA
103_62	Northern Wimmera Riverine Chenopod Woodland	Sporadic therefore not to be artificially watered	< 1 month	0.1	20 ML
369	Black Box	If not inundated within the last 5 years	1 < 4 months	0.3	50.4 ML

Recommended watering regime[9]

- Keep dam at Carapugna above 0.5m deep by filling dam during winter/spring and allowing evaporative drawdown over summer/autumn.
- Water wetlands to shallow levels (<0.3m) if they have been dry for five years. Given there are three separate wetlands this can be done sequentially over three years using the three separate outlets constructed in 2015 (Figure 7-5).

(2) Challambra Swamp

Hydrological objectives at Challambra Swamp (Source: Australian Ecosystems (2013))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
826	Plains Savannah	NA	NA	NA	NA
107	Lake Bed Herbland	3 to 7 years in 10	> 1 month	0.8	46.6 ML
369	Black Box	If not inundated within the last 5 years	1 < 4 months	0.3	32.2 ML

Recommended watering regime

- Keep Challambra Swamp's northern dam above 0.5m deep by filling dam during winter/spring and allowing evaporative drawdown over summer/autumn. This will promote a more diverse aquatic flora communities (Australian Ecosystems, 2013).
- Water Lake Bed Herbland EVC area by every alternate year by filling and overtopping northern dam.

[8] At Wimmera CMA Pipeline wetlands hydrological objectives are generally based on maximising EVC condition unless stated otherwise. The depths and durations for all hydrological objectives are informed by Frood (2012).

[9] Watering regimes for all Wimmera CMA Pipeline wetlands are derived from the listed ecological and hydrological objectives. Regimes will be subject to water availability and seasonal conditions.

(3) Crow Swamp

Hydrological Objectives at Crow Swamp (Source: Australian Ecosystems (2013))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
86	Ridged Plains Mallee	NA	NA	NA	NA
107	Lake Bed Herbland	3 to 7 years in 10	> 6 months	1.5	37.5
813	Intermittent Swampy Woodland	3 to 7 years in 10	1 < 6 months	0.5	14
103_62	Northern Wimmera Riverine Chenopod Woodland	Sporadic therefore not to be artificially watered	< 1 month	0.1	2.4

Recommended watering regime

- Keep dam at Crow Swamp's above 0.5m deep by filling during winter/spring and allowing evaporative drawdown over summer/autumn.
- Water Lake Bed Herbland every alternate year through letting water overtop the dam and spill out into the surrounding wetland.

(4) Fieldings Dam

Hydrological Objectives at Fielding's Dam (Source: (Rakali Consulting, 2014))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
235	Plains Woodland – Herb-rich Gilgai Wetland Complex	3 to 8 years in 10	< 3 months	0.1	10.8

Recommended watering regime

Keep Fielding's Dam above 0.5m deep by filling during winter/spring and allowing evaporative drawdown over summer/autumn.

(5) Harcoan's Swamp (Burrereo Bushland Reserve)

Hydrological Objectives at Harcoan's Swamp (Source: Australian Ecosystems (2013))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
826	Plains Savannah	NA	NA	NA	NA
107	Lake Bed Herbland	< 3 to 10 years in 10	> 1 year	0.5	40
369	Black Box Wetland	If not inundated within the last 5 years	< 4 months	0.3	2.1

Recommended watering regime

- Provide water to fill Harcoan's Swamp's dam during wet years.
- Water Lake Bed Herbland every fifth year if a natural inundation event has not occurred through filling and overtopping dam.

(6) Krong Swamp

Hydrological Objectives at Krong Swamp (Source: Australian Ecosystems (2013))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
826	Plains Savannah	NA	NA	NA	NA
808	Lignum Shrubland	If not inundated in the last 2 years	< 6 months	0.5	11
823	Lignum Swampy Woodland	< 3 to 7 years in 10	> 1 month, <6 months	0.2	4
369	Black Box Wetland	If not inundated within the last 5 years	< 4 months	0.2	18.6

Recommended watering regime

- Provide water to fill Krong Swamp dam during wet years.
- Water Lignum Shrubland every third year if it has been dry in the interim through filling dam, once the dam fills water will flow along the channel into the Lignum Shrubland.

(7) Mutton Swamp

Hydrological Objectives at Mutton Swamp (Source: Australian Ecosystems (2013))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
803	Plains Woodland	NA	NA	NA	NA
107	Lake Bed Herbland	If not inundated in the last 2 years	1 < 8 months	0.5	39
369	Black Box Wetland	If not inundated within the last 5 years	1 < 4 months	0.2	40

Recommended watering regime

- Keep Mutton Swamp's dam above 0.5m deep by filling it during winter/spring and allowing evaporative drawdown over summer/autumn. This will promote more diverse aquatic flora communities (Australian Ecosystems, 2013).
- Water Lake Bed Herbland every third year if it has been dry in the interim through filling and overtopping the dam.

(8) Opie's Dam

Hydrological Objectives

The hydrological objective is to retain sufficient water in the dam to support a population of Growling Grass Frogs as well as other water-dependent fauna.

Recommended watering regime

- Keep Opie's Dam above 0.5m deep by filling during winter/spring and allowing evaporative drawdown over summer/autumn. This will promote a more diverse aquatic flora communities (Australian Ecosystems, 2013). A residual pool of at least 0.5m depth will provide habitat to allow the survival and metamorphosis of Growling Grass Frog tadpoles

(9) Pinedale

Hydrological Objectives at Pinedale (Source: Australian Ecosystems (2013))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
103-62	Northern Wimmera Riverine Chenopod Woodland	Should not be artificially watered	< 1 months	0.1	8.9
369	Black Box Wetland	If not inundated within the last 5 years	< 4 months	0.2	12.9

Recommended watering regime

- Keep Pinedale's southern dam above 0.5 m deep by filling during winter/spring and allowing evaporative drawdown over summer/autumn. This will promote a more diverse aquatic flora communities (Australian Ecosystems, 2013).
- Water Black Box Wetland every fifth year if it has been dry in the interim through redirecting water into the low-lying areas between the pipeline outlet and dam.

(10)Sawpit Swamp

Hydrological Objectives at Sawpit Swamp (Source: Australian Ecosystems (2013))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
803	Plains Woodland	NA	NA	NA	NA
945	Floodway Pond Herbland- Riverine Swamp Forest Complex	If not inundated in the last 2 years	< 4 months	0.5	65.5
810	Floodway Pond Herbland	If it has been dry for > 6 months	< 12 months	01.2	40
813	Intermittent Swampy Woodland	If not inundated in the last 2 years	< 2 months	0.2	17.4

Recommended watering regime

- During wet years provide water to central low level dam area. This will promote a more diverse aquatic flora communities (Australian Ecosystems, 2013).
- Water Floodway Pond Herbland – Riverine Swamp Forest Complex every third year if it has been dry in the interim (outer horseshoe shaped part of wetland).

(11)Schultz/Koschitzke

Hydrological Objectives at Schultz/Koschitzke (Source: Rakali Consulting (2014))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
808	Lignum Shrubland	If not inundated within the last 5 years	< 6 months	0.5	50.7
369	Black Box Wetland	If not inundated within the last 5 years	< 4 months	0.2	24.5

Recommended watering regime

- Keep Schultz/Koschitzke's eastern dam above 0.5m deep by filling during winter/spring and allowing evaporative drawdown over summer/autumn. This will promote a more diverse aquatic flora communities (Australian Ecosystems, 2013).
- Water Lignum Shrubland every fifth year through the other pipe outlet (under Beilby Road) if it has been dry in the interim.

(12)Tarkedia

Hydrological Objectives at Tarkedia (Source: Rakali Consulting (2014))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
826	Plains Savannah	NA	NA	NA	NA
819	Spike-sedge Wetland	NA	NA	NA	NA
823	Lignum Swampy Woodland	If not inundated in last 3 years	< 6 months	0.2	13.5
369	Black Box Wetland	If not inundated within the last 5 years	< 4 months	0.2	0.5

Recommended watering regime

- Keep Tarkedia's dam above 0.5m deep by filling during winter/spring and allowing evaporative drawdown over summer/autumn. This will promote a more diverse aquatic flora communities (Australian Ecosystems, 2013).
- Water Black Box wetland every fifth year if it has been dry in the interim using the pipeline outlet constructed in ealy 2015 (Figure 7-63).

(13)Wal Wal Swamp

Hydrological Objectives at Wal Wal Swamp (Source: Australian Ecosystems (2013))

EVC No.	EVC Name	Environmental Watering Frequency	Duration	Depth (m)	Estimated Volume (ML)
815	Riverine Swampy Woodland	Not recommended to be artificially watered	< 1 month	0.1	2.2
602	Cane Grass Wetland/Aquatic Herbland Complex	If not inundated in the last 2 years	< 8 months	0.5	16.5
235	Plains Woodland/Herbrich Gilgai Wetland	NA	NA	NA	NA
114	Red Gum Swamp/Cane grass Wetland	If not inundated in the last 2 years	< 6 months	0.3	24

Recommended watering regime

- Keep water above 0.5m deep in the deeper area located in the dam. It can be kept close to full through top ups in winter/spring and having evaporative drawdown over summer/autumn. This will promote a more diverse aquatic flora communities (Australian Ecosystems, 2013).

Appendix G Roles and responsibilities

The Victorian Waterway Management Strategy, Chapter 8, outlines the range of agencies and authorities that are involved in managing and delivering environmental flows. The ministers and agencies are listed in Table 44.

Table 44: Responsible minister and agencies

Minister / Agency	Responsibilities
Minister for Environment, Climate Change and 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
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 and Minister for Environment and Climate Change Develop state policy for the management of environmental water in regulated and unregulated systems Act on behalf of the Minister for Environment and Climate Change 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 (Wimmera, North Central, and Mallee CMAs for this WRPA)	Waterway management authorities under Part 10 of the Water Act. 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
Water corporations (Grampians Wimmera-Mallee Water and Lower Murray Water in this WRPA)	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

Minister / Agency	Responsibilities
MLDRIN	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.
Barengi Gadjin Land Council Aboriginal Corporation	Hold Registered Aboriginal Party (RAP) status over parts of the Wimmera-Mallee WRPA. RAPs have responsibilities under the Act relating to the management of Aboriginal cultural heritage, including: • evaluating Cultural Heritage Management Plans • providing advice on applications for Cultural Heritage Permits • making decisions about Cultural Heritage Agreements • providing advice or application for interim or ongoing Protection Declarations

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 45 relates to risks that result in failure to achieve objectives.

Table 46 relates to risks that arise from the provision of environmental water.

Table 45: 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 ecological objectives for the WRPA	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 ecological objectives for the WRPA	
	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 ecological objectives for the WRPA	
	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 ecological objectives for the WRPA	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

Risk category	Threat	Implication	Themes and related objectives at risk	Management options
	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
	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	Delayed ecosystem response	Objective may be achieved, but may not be demonstrated	May apply to all objectives	Monitoring and adaptive management of watering regime
	Monitoring not provided			

Risk category	Threat	Implication	Themes and related objectives at risk	Management options
achievement of ecological objectives	Inadequate research to support conceptual models or monitoring design			Ongoing research into ecosystem response to environmental water

Table 46: 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 Wimmera-Mallee water resource plan area were found to be either not groundwater dependent or at low risk.

Appendix J Waterway types

The table below shows the Australian National Aquatic Ecosystems (ANAE) (Brooks, 2017) waterway type(s) of each priority environmental asset in the Wimmera-Mallee water resource plan area.

Table 47: Waterway types of priority environmental assets in the Wimmera-Mallee water resource plan area

Asset Name	ANAE Type	Area (ha)
Wetlands and Floodplains		
Broom Tank	Lt1.1: Temporary lake	2.2
Bull Swamp	Pt1.8.2: Temporary shrub swamp	7.7
Challambra Swamp	Pt1.6.2: Temporary woodland swamp	9.7
Challambra Swamp	Pt1.2.2: Temporary black box swamp	5.8
Chiprick	Pt1.8.2: Temporary shrub swamp	3.1
Chirrup Swamp	Pt2.3.2: Freshwater meadow	35.3
Corack Dam	Pt2.3.2: Freshwater meadow	5.3
Creswick Swamp	Pt3.1.2: Clay pan	17.0
Cronomby Tanks	Pt1.8.2: Temporary shrub swamp	1.1
Crow Swamp	Pt2.3.2: Freshwater meadow	7.9
Goulds Reserve	Pt1.6.2: Temporary woodland swamp	1.1
Greens Wetland	Pt1.8.2: Temporary shrub swamp	16.6
Harcoans Swamp	Pt1.6.2: Temporary woodland swamp	8.5
Jeffcott Wildlife Reserve	Pt2.3.2: Freshwater meadow	22.6
Jesse Swamp	Pt3.1.2: Clay pan	17.6
Jesse Swamp	Pt2.3.2: Freshwater meadow	9.7
Krong Swamp	Pt1.2.2: Temporary black box swamp	2.6
Lake Albacutya	Lt1.1: Temporary lake	5832.0
Lake Danaher Bushland Reserve	Pt1.8.2: Temporary shrub swamp	4.5
Lake Hindmarsh	Lt1.1: Temporary lake	13879.9
Moreton Plains Reserve	Pt1.6.2: Temporary woodland swamp	1.6
Mutton Swamp	Pt1.7.2: Temporary lignum swamp	12.5
Pam Juergens Dam	Pt1.6.2: Temporary woodland swamp	0.6
Part of Gap Reserve	Pt1.6.2: Temporary woodland swamp	0.8
Pinedale	Pt1.8.2: Temporary shrub swamp	12.4
Round Swamp Bushland Reserve	Pt1.8.2: Temporary shrub swamp	3.3
Sawpit Swamp	Pt1.1.2: Temporary river red gum swamp	5.1
Schultz/Koschitzke	Pt1.2.2: Temporary black box swamp	6.7
Tchum Lakes Lake Reserve and Tchum Lakes Swimming Pool	Pt1.2.2: Temporary black box swamp	34.3
Towma (Lake Marlbed)	Pt1.6.2: Temporary woodland swamp	21.1

Asset Name	ANAE Type	Area (ha)
Wal Wal Swamp	Pt1.1.2: Temporary river red gum swamp	9.5
Rivers		
Bungallaly Creek	Rt1.4: Temporary lowland stream	19.2
Burnt Creek	Rt1.4: Temporary lowland stream	54.3
MacKenzie River	Rt1.4: Temporary lowland stream	52.6
MacKenzie River	Rt1.1: Temporary high energy upland stream	12.1
MacKenzie River	Unallocated	9.7
MacKenzie River	Rt1.2: Temporary transitional zone stream	6.8
MacKenzie River	Rt1.3: Temporary low energy upland stream	1.7
Mount William Creek	Rt1.4: Temporary lowland stream	43.8
Mount William Creek	Rt1.2: Temporary transitional zone stream	1.4
Mount William Creek	Unallocated	0.6
Outlet Creek	Rt1.4: Temporary lowland stream	30.4
Outlet Creek	Unallocated	5.9
Outlet Creek	Rt1.2: Temporary transitional zone stream	0.4
Wimmera River	Rt1.4: Temporary lowland stream	215.0
Wimmera River	Unallocated	9.8
Wimmera River	Rt1.2: Temporary transitional zone stream	1.9
Wimmera River	Rt1.3: Temporary low energy upland stream	0.0
Yarriambiack Creek (Mallee)	Rt1.4: Temporary lowland stream	43.2
Yarriambiack Creek (Wimmera)	Rt1.4: Temporary lowland stream	111.1
Yarriambiack Creek (Wimmera)	Unallocated	0.9

Note: a number of priority environmental assets are not yet included in this assessment.

Appendix K Basin Plan objectives

Table 48. 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 49: Basin-wide environmental watering strategy (2019) Expected Environmental Outcomes relevant to Victoria.

Theme	Code.	Sub-theme		BWS Expected Environmental Outcome	Relevant to Wimmera-Mallee	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		
	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		
	B1.4			A 10 to 20% increase of freshes and bank-full events in the Campaspe, Loddon and Wimmera catchments	X	31
	B1.5			Current levels of connectivity maintained in the Kiewa, and Ovens catchments		
	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		
	B2.3		Ovens	Maintain extent and condition** of water-dependent vegetation (10,200ha RRG, <100ha BB) near river channels and on the floodplain		
	B2.4		Goulburn–Broken	Maintain extent of water-dependent vegetation near river channels and on lowlying areas of the floodplain. Improve condition[i] of black box and river red gum (19,800ha RRG, 500ha BB)		

	B2.5		Campaspe	Maintain extent and condition** of water-dependent vegetation near river channels (1,900ha RRG, <100ha BB)		
	B2.6		Loddon	Maintain extent and condition** of water- dependent vegetation near river channels (2,200ha RRG, 700ha BB)		
	B2.7		Murray	Maintain extent of water-dependent vegetation near river channels and on low-lying areas of the floodplain. Improve condition[i] of black box and river red gum (90,600ha RRG, 41,700ha BB NSW & Vic).		
	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 Murray River from the junction with the Wakool River to downstream of Lock 3, including Chowilla and Hattah Lakes		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		
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	50
	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	50
	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 (*check spp relevant to Wimmera*)	X	50
	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	
	B4.10			Significant increases in the distributions of key species (see key fish spp table) in the southern Basin.	X	116